

BIOMEDICAL APPLICATION OF DANDELION

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Technology degree in Biotechnology

By

Malini Sree.K (38230021)



DEPARTMENT OF BIOTECHNOLOGY

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI 600119

APRIL 2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

JEPPIAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119

www.sathyabama.ac.in

DEPARTMENT OF BIOTECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Malini Sree.K(38230021)** who carried out the project entitled “**BIOMEDICAL APPLICATION OF DANDELION**” under our supervision from January 2022 to April 2022.

Internal Guide

(Dr. Inbathamizh)

Head of the Department

Dr. Ramesh Kumar. V

Submitted for Viva voice Examination held on _____ 2022

Internal Examiner

External Examiner

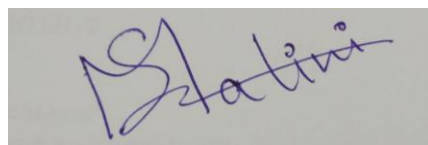
DECLARATION

I, **Malini Sree.K (38230021)** hereby declare that the Project Report entitled **“BIOMEDICAL APPLICATION OF DANDELION”** done by us under the guidance of **Dr. Inbathamizh** is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE



ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. Ramesh Kumar. V**, Head of the Department, Dept. of Biotechnology for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide, **Dr. Inbathamizh** for her valuable guidance, suggestions, and constant encouragement that paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Biotechnology who were helpful in many ways for the completion of the project.

(MALINI SREE)

ABSTRACT

UV irradiation damages skin by producing excessive reactive oxygen species (ROS) and inducing matrix metalloproteinases (MMPs), which leads to skin photoaging. Dandelion extracts have long been used in traditional Chinese and Native American medicine to treat cancer, hepatitis, and digestive disorders, but less is known about their impact on skin photoageing. When applied before UVB irradiation or shortly after irradiation, dandelion leaf and flower extracts greatly prevent UVB irradiation-inhibited cell viability. UVB irradiation-stimulated MMP activity and ROS production were reduced by dandelion leaf and flower extracts. Dandelion leaf and flower extracts were proven to help absorb UVB irradiation. Furthermore, dandelion extracts dramatically reduced H₂O₂-induced cellular senescence in HDFs. Finally, dandelion extracts, particularly leaf and flower extracts, protect HDFs from UVB damage and H₂O₂-induced cellular senescence by reducing ROS production and MMP activities while also aiding UVB absorption. The goal of this study was to create a sunscreen cream formulation using natural ingredients and determine the sun protection factor (SPF). Dandelions leaf and flower extract, shea butter as a moisturiser, and EDTA as a preservative are used to make the sunscreen. Avocado oil, olive oil, and carrot seed oil are among the oils found in the oil phase. Inorganic physical sun blockers such as titanium dioxide are used in sunscreen. When shea butter was used, the best cream texture was obtained. Avocado oil and carrot seed oil in equal quantities provide the finest sunscreen cream solubility. When comparing the SPF ratings of other oils, olive oil provides the highest protection. As a result, it can be established that essential oils exhibit UV absorption, allowing them to be employed as emollients and sun blockers in sunscreen formulations. This sunscreen cream's formulation emphasises natural components, a creamy texture, and efficacy.

Content

S.No	Topic	Page No
1.	Introduction	1
2.	Review of literature	3
3.	Aim and objectives	10
4.	Materials and methods	11
5.	Results and Discussion	14
6.	Summary and Conclusion	15
7.	References	16

LIST OF SYMBOLS AND ABBREVIATIONS

i.	<i>Taraxacum officinale</i>	:	<i>T.officinale</i>
ii.	UV -RAYS	:	Ultra Violet rays
iii.	SPF	:	Sun protection factor
iv.	mg	:	Milligram
v.	µg	:	Microgram
vi.	ml	:	Millilitre
vii.		:	
viii.		:	
ix.		:	
x.		:	
xi.			
xii.			

LIST OF FIGURES

S.No	Title	Page no
5.1	Dandelion petals	11
5.2	Dandelion leaves	11
5.3	Collection of dandelion plant	11
5.4	Dried petals	12
5.5	Dried leaves	12
5.6	Powdered leaves	12
5.7	Powdered petals	12
5.8		
5.9		
5.10		

1. INTRODUCTION

Skin becomes more translucent, loose, and brittle as it ages. Solar radiation, particularly its ultraviolet (UV) component, is one of the most destructive factors to human skin, causing clinical and histologic damage. UV irradiation alters connective tissues by causing an increase in reactive oxygen species (ROS) and the activation of matrix metalloproteinases (MMPs).

The destruction of the collagenous extracellular matrix (ECM) by MMPs is responsible for the majority of connective tissue damage in photodamaged skin. Dermal fibroblasts are in charge of producing ECM and allowing the skin to heal after an injury. UVA, UVB, and UVC are the three components of UV irradiation. Unlike UVA and UVB, which reach the earth in sufficient quantities to cause skin harm, UVC is nearly totally absorbed by the ozone layer. UVA (320-400 nm), UVB (290–320 nm), and UVC (200–290 nm) are artificially split into three wavelengths of ultraviolet radiation. Sunscreens are the most frequent products used to protect the skin against UVB radiation from the sun, which causes sunburn, photoaging, skin cancer, telangiectasia, and pigmentation disorders.

Sunburn, photoaging, erythema, and inflammation can all be caused by UVA and UVB rays. Sunlight in Canada is intense enough to cause skin cancer and premature skin ageing. Sunscreen is commonly used to protect skin from UV damage caused by the sun. Sunscreen absorbs UV rays and stops them from accessing the skin. However, several sunscreen chemicals, such as oxybenzone, benzophenone, and octocrylene, have been found to be potentially carcinogenic to the skin or to infiltrate our bodies and cause other health problems. It's critical to select natural anti-aging and UV protection treatments that are effective, safe, and environmentally friendly.

The dandelion, *Taraxacum officinale*, is extensively distributed in the Northern Hemisphere's warmer temperate zone. Dandelion extracts have been used to treat malignancies, hepatitis, and digestive problems for ages in traditional Chinese and Native American medicine. Dandelion extracts have anti-

inflammatory, antioxidant, and anticarcinogenic properties. However, few scientific research have been conducted to examine the effects of dandelion extracts in the treatment of skin problems, particularly photoageing .

The goal of this research was to see if dandelion leaf, flower extracts can protect human dermal fibroblasts (HDFs) from UVB damage and cellular senescence. We discovered that dandelion leaf and flower extracts protect HDFs from UVB damage and H₂O₂-induced cellular senescence by inhibiting ROS production and MMP activity.

Titanium dioxide (TiO₂) white particles are the most common inorganic UV filters used in the cosmetic and pharmaceutical industries. Furthermore, titanium dioxide is slightly more effective in UVB protection, whereas zinc oxide absorbs UVA more extensively. Through its reflection and scattering capabilities, titanium dioxide can filter UV rays. Their highest permissible concentration in a UV filter is 25%.

2. REVIEW OF LITERATURE

Sunscreen application by consumers is frequently insufficient for ultraviolet protection according to the advertised sun protection factor (SPF). Although sunscreen SPF's are marketed with a 2 mg/cm² application density, actual protection is generally significantly less due to consumer application densities varying from 0.5 to 1 mg/cm². Even when applied in insufficient amounts by users, high-SPF sunscreens may provide appropriate protection.(Hao Ou-Yang et al.,2011)

The dandelion (*Taraxacum officinale*) is a member of the sunflower family Asteraceae. Because dandelion has a wide range of pharmacological qualities, including anti-microbial, anti-viral, anti-inflammatory, and anti-infectious as well as anti-oxidation, its leaves, stems, and roots have been utilised in traditional Chinese herbal medicine for a long time. Since dandelion extract has minimal toxicity on the skin, even non-toxic according to the British Herbal Pharmacopoeia recommendation, a clinical investigation of dandelion extracts on skin acne and a simple preparation method of the dandelion extract would be presented.(Siukan Law et al.,2021)

Dandelion (*Taraxacum officinale* L.) has been consumed in various forms since ancient times as a good source of nutrients, minerals, and vitamins that can also help with a variety of complex ailments. It's a harmless herb with a lot of biological activity, according to the description. The goal of this review is to present the multidirectional activity of numerous dandelion products, whose consumption may help to prevent or reduce the risk of a variety of diseases, including cancer, obesity, hepatitis, arthritis, and cardiovascular disease. In addition, the study provides a review of current data based on in vitro and in vivo studies, as well as a history of dandelion use.(Bernadetta Lis.,2019)

Hepatitis, cirrhosis, and liver transplant have all been linked to acetaminophen (APAP) hepatotoxicity. Because APAP hepatotoxicity is linked to the generation of reactive oxygen species (ROS) and excessive oxidative stress, natural antioxidant substances have been investigated as an alternative therapy for APAP-induced

hepatic dysfunction. Dandelions, or *Taraxacum officinale* Weber (Family Asteraceae), are used in medicine for their choleretic, diuretic, antioxidant, anti-inflammatory, and hepatoprotective effects. The hepatoprotective efficacy of *T. officinale* leaf extract against APAP-induced hepatotoxicity was investigated in this study. *T. officinale* was able to reduce thiobarbituric acid–reactive substance levels created by 200 mg/kg APAP (p.o.) and prevent sulfhydryl levels from dropping as a result of the APAP therapy. *T. officinale* has been shown to have a hepatoprotective effect against toxicity.(Dirleise Colle et al.,2012)

UV irradiation damages skin by producing excessive reactive oxygen species (ROS) and inducing matrix metalloproteinases (MMPs), which leads to skin photoaging. Dandelion extracts have long been used in traditional Chinese and Native American medicine to treat malignancies, hepatitis, and digestive disorders, but little is known about their impact on skin photoageing. When applied before UVB irradiation or shortly after irradiation, dandelion leaf and flower extracts greatly prevent UVB irradiation-inhibited cell viability. UVB irradiation-stimulated MMP activity and ROS production were reduced by dandelion leaf and flower extracts. Dandelion root extracts had poorer protection against UVB-induced MMP activity, ROS production, and cell death in HDFs. Glutathione production and glutathione reductase mRNA expression were both increased in the presence of root extracts. Furthermore, in the presence or absence of UVB irradiation, dandelion leaf and flower extracts, but not root extracts, increased glutathione production and glutathione reductase mRNA expression. Dandelion leaf and flower extracts were also proven to help absorb UVB irradiation. Furthermore, dandelion extracts dramatically reduced H₂O₂-induced cellular senescence in HDFs. Finally, dandelion extracts, particularly leaf and flower extracts, protect HDFs from UVB damage and H₂O₂-induced cellular senescence by decreasing ROS production and MMP activity while also aiding UVB absorption. (Yafan Yang and Shuangshuang Li.,2015)

Because of its diuretic and hepatoprotective qualities, dandelion (*Taraxacum officinale* L.) has been widely employed in traditional and modern medicine. It contains polyphenols, vitamins, and terpenes, which are antioxidant chemicals. Natural antioxidants protect organisms from oxidative stress, which has a role in the ageing process as well as the development of cancer, cardiovascular disease, neurological illness, and a variety of other disorders.(Anna Nowak et al.,2019)

Patch testing and photopatch testing with a battery of Compositae and conventional allergens were performed on 16 individuals with summer-exacerbated dermatitis. The thresholds for UVA and UVB, as well as IgE and RAST, were determined. Six female and two male patients developed allergic contact dermatitis after coming into touch with one or more Compositae extracts from common flowers in Sweden, which are also used in skin care products. In individuals with summer-exacerbated dermatitis, testing with Compositae allergens is critical, according to the study. Patients with multiple contact responses, photosensitivity, and atopic dermatitis flare-ups fall into this category. (Karin Wrangsjö, 1990)

Due to its therapeutic qualities such as antioxidant, anti-inflammatory, analgesic, and antibacterial activity, traditional herbs have been utilised in the treatment of sickness and discomfort. One of the most common groups of plants used in folk medicine is the Asteraceae family. In Northwest Spain, the plants *Achillea millefolium*, *Arnica montana*, *Bellis perennis*, *Calendula officinalis*, *Chamaemelum nobile*, *Eupatorium cannabinum*, *Helichrysum stoechas*, and *Taraxacum officinale* were utilised in various treatments. Some of them, such as *C. nobile* and *H. stoechas*, are already used in cooking and culinary applications, such as cocktails, desserts, and savoury foods. The goal of this study was to analyse existing information on the nutritional and beneficial characteristics, as well as bioactive components, of these plants, which aren't commonly eaten but could be used as food substitutes. (P. Garcia-Oliveira et al., 2021)

The amount of phenolics and flavonoids, antioxidant activity, and cytotoxicity of methanol extracts of different plant sections of *T. officinale* F. H. Wigg were determined in a laboratory experiment. *T. officinale* flower extracts had the highest total phenolic content, followed by leaf, root, and stalk extracts. The total flavonoid level resulted in a similar propensity to differential total phenolics contents among plant parts, although with lesser quantity ranges. The antioxidant activity of methanol extracts from all plant sections increased in a dose-dependent manner. Cell viability of for human lung cancer for human gastric carcinoma exhibited test cell viability highest cytotoxicity, followed by leaf, root, and stalk extracts of *T. officinale*. The findings revealed that the levels of total phenolics and total

flavonoids in various plant sections of *T.officinale* were highly correlated with antioxidative or with cytotoxic activities (Chon, Sang-Uk et al.,2016)

Sunscreens should stay on the skin surface or impregnate the initial layers of the stratum corneum only, not penetrating into the underlying living tissue, as their primary function is to protect the skin from the detrimental effects of sun irradiation. The purpose of this study was to determine the penetration of titanium dioxide (TiO₂) and methylene bis-benzotriazolyl tetramethylbutylphenol (MBBT), which were both included in a broad-spectrum sunscreen formulation, into human skin in vivo and in vitro, using the tape stripping method. Another goal was to provide a simple and non-invasive method for assessing the percutaneous uptake of sunscreens after topical administration. Colorimetric test and HPLC analysis were used to measure TiO₂ and MBBT, respectively.(Mavon A et al.,2007)

DESCRIPTION OF SELECTED PLANT

1.2 *Taraxacum officinale*

TAXONOMICAL CLASSIFICATION

Kingdom – Plantae

Class – Magnoliopsidia

Order – Asterales

Family – Asteraceae

Genus – Taraxacum

Phylum – Vascular Plant

General information

Taraxacum is a large [genus](#) of [flowering plants](#) in the family [Asteraceae](#), which consists of species commonly known as **dandelions**. The scientific and hobby study of the genus is known as taraxacology. The genus is native to Eurasia and North America, but the two most commonplace species worldwide, [T. officinale](#) (the common dandelion) and [T. erythrospermum](#) (the red-seeded dandelion), were introduced into North America from Europe and now propagate as [wildflowers](#). Both species are [edible](#) in their entirety. The common name *dandelion* is also given to specific members of the [genus](#). Like other members of the family Asteraceae, they have very small flowers collected together into a composite [flower head](#). Each single flower in a head is called a [floret](#). In part due to their abundance, along with being a [generalist species](#), dandelions are one of the most vital early spring [nectar](#) sources for a wide host of [pollinators](#). Many *Taraxacum* species produce seeds [asexually](#) by [apomixis](#), where the seeds are produced without [pollination](#), resulting in offspring that are genetically identical to the parent plant

History

Dandelions are thought to have evolved about 30 million years ago in [Eurasia](#). [Fossil](#) seeds of *Taraxacum tanaiticum* have been recorded from the [Pliocene](#) of southern [Russia](#). Dandelions have been used by humans for food and as an [herb](#) for much of recorded history. They were well known to ancient

Egyptians, Greeks and Romans, and are recorded to have been used in [traditional Chinese medicine](#) for over a thousand years. The plant was used as food and medicine by [Native Americans](#). Dandelions were brought to North America on the [Mayflower](#) for their medicinal benefits

NUTRITION

Raw dandelion greens contain high amounts of vitamins [A](#), [C](#), and [K](#), and are moderate sources of [calcium](#), [potassium](#), [iron](#), and [manganese](#). Raw dandelion greens are 86% water, 9% [carbohydrates](#), 3% [protein](#), and 1% [fat](#). A 100 gram (3+ $\frac{1}{2}$ oz) reference amount supplies 45 [calories](#)

PROPERTIES

Edibility

The entire plant, including the leaves, stems, flowers, and roots, is edible and nutritious, with nutrients such as vitamins A and K as well as calcium and iron. Dandelions are found on six continents and have been gathered for food since prehistory, but the varieties commercially cultivated for consumption are mainly native to [Eurasia](#) and [North America](#). A [perennial plant](#), its leaves grow back if the taproot is left intact. To make leaves more palatable, they are often [blanched](#) to remove bitterness, or [sauteed](#) in the same way as [spinach](#). Dandelion greens have been a part of traditional [Kashmiri cuisine](#), [Spanish cuisine](#), [Italian cuisine](#), [Albanian cuisine](#), [Slovenian](#), [Sephardic Jewish](#), [Chinese](#), [Greek cuisine](#) and [Korean cuisines](#).

The flower [petals](#), along with other ingredients, usually including [citrus](#), are used to make [dandelion wine](#). Its ground, roasted roots can be used as [a caffeine-free coffee alternative](#). Dandelion was also traditionally used to make the traditional British soft drink [dandelion and burdock](#), and is one of the ingredients of [root beer](#). Dandelions were once considered delicacies by the Victorian gentry, who used them mostly in salads and sandwiches.

Dye

The yellow flowers can be dried and ground into a yellow-pigmented [powder](#) and used as a [dye](#).

Allergies

Dandelion pollen may cause [allergic reactions](#) when eaten, or adverse skin reactions in sensitive individuals. [Contact dermatitis](#) after handling has also been reported, probably from the latex in the stems and leaves.

Herbalism

Dandelion has been used in [traditional medicine](#) in Europe, North America, and China

3. AIM

To Prepare sunscreen lotion from dandelion flower and leaf extract and analyze antibacterial activity and cytotoxicity.

Objectives

- ❖ Drying of dandelion flower and leaf in sunlight
- ❖ Extraction of Flower and Leaf
- ❖ To evaluate the antibacterial activity and analyze Cytotoxicity.

4. MATERILAS AND METHODS

4.1 PLANT COLLECTION

Dandelion (*Taraxacum officinale*) have been collected. The collected plants were washed properly and allowed to dry in sunlight for 6 - 7 days

A



B



C



Figure 1: (A) Dandelion Flower, (B) Dandelion leaves, (C) Dandelion plant

4.2. EXTRACTION

Dandelions were harvested when they were in flowering. Leaf and petal were separated, washed, and sun-dried before being extracted for 6-7 days in distilled water for 4 hours. To avoid cell contamination, the water extracts were vacuum filtered through grade 1 Whatman filter paper, concentrated, and then dissolved in distilled water after filtration through a 0.2 m filter. A 300 mg/mL stock aqueous extract was generated and stored at 4 C for experimental use.



Figure 1 : (A) Dried dandelion petals (B) Dried dandelion leaves
(C) Powdered dandelion leaf (D) Powdered dandelion petals

4.3 PRODUCT PREPARATION

For 15 minutes, the ingredients are heated to 70°C.

Any bacteria that may be present in both phases will be destroyed.

With stirring, the extracts and moisturising product are progressively added to the oil.

The solar blocker and preservative are next added, and the mixture is well mixed using a vortex.

After the cream has cooled, pour it into a box, seal it firmly, and cover it with a white tissue until the SPF is measured.

Any cream or lotion's pH can be checked, and then the pH can be modified by adding citric acid to a pH of 6 to 6.5, which is the ideal pH for adult skin.

5. RESULTS AND DISSCUSION

The dandelion extracts were prepared from dandelion leaves, flowers, separately, and the extract rate was 10.6%, 11.2% respectively. Dandelion extracts alone at 10–3000 $\mu\text{g/mL}$ had no effect on HDFs cell viability. When dandelion extracts (30, 100, and 300 $\mu\text{g/mL}$) were added into HDFs for 30 minutes before UVB irradiation or when added promptly after irradiation, leaf and flower extracts significantly protected UVB irradiation and inhibited cell viability. The antioxidant activity of extracts from plant components increased in a dose-dependent manner. Flower extracts had the strongest DPPH (1,1-diphenyl-2-picrylhydrazyl radical) free radical scavenging activity ($\text{IC}_{50} = 624.3 \text{ mg kg}^{-1}$), followed by *T. officinale* leaf extracts ($p < 0.05$). Cell viability of Calu-6 for human pulmonary carcinoma and SNU-601 for human gastric carcinoma showed the lowest IC_{50} value in the flower extracts (IC_{50} value = 85.7 and 311.4 mg kg^{-1} , respectively) using the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) assay, indicating the highest cytotoxicity. The findings revealed that antioxidative ($r^2 = 0.7280$ to 0.9971) and cytotoxic ($r^2 = 0.5795$ to 0.9515) activities were substantially associated in different plant sections of *T. officinale*. Dandelion extracts may aid in the absorption of UV rays. Flower and leaf extracts showed the highest UV absorption capability at wavelengths of 300 nm and 310 nm. Dandelion extracts have a higher UV absorption ability at 290 nm than dandelion leaf extract but a much lower UV absorption ability than dandelion flower extract. These findings imply that dandelion extracts protect against UV irradiation in part through UV absorption.

6. SUMMARY AND CONCLUSION

Dandelion (*Taraxacum officinale*) was collected. Leaf and petal were separated, washed, and sun-dried before being extracted for 6-7 days in distilled water for 4 hours. To avoid cell contamination, the water extracts were vacuum filtered through grade 1 Whatman filter paper, concentrated, and then dissolved in distilled water after filtration through a 0.2 μ m filter. A 300 mg/mL stock aqueous extract was generated and stored at 4 °C for experimental use. For 15 minutes, the ingredients are heated to 70°C. Any bacteria that may be present in both phases will be destroyed. With stirring, the extracts and moisturising product are progressively added to the oil. The solar blocker and preservative are next added, and the mixture is well mixed using a vortex. After the cream has cooled, pour it into a box, seal it firmly, and cover it with a white tissue until the SPF is measured. . Dandelion extracts may aid in the absorption of UV rays. Flower and leaf extracts showed the highest UV absorption capability at wavelengths of 300 nm and 310 nm. Dandelion extracts have a higher UV absorption ability at 290 nm than dandelion leaf extract but a much lower UV absorption ability than dandelion flower extract. These findings imply that dandelion extracts protect against UV irradiation in part through UV absorption. The findings revealed that antioxidative ($r^2 = 0.7280$ to 0.9971) and cytotoxic ($r^2 = 0.5795$ to 0.9515) activities were substantially associated in different plant sections of *T. officinale*.

7. REFERENCES

- A. Mart'inez, E. Conde, A. Moure, H. Domnguez, and R. J. Estevez, "Protective effect against oxygen reactive species and skin fibroblast stimulation of *Couroupita guianensis* leaf extracts," *Natural Product Research*, vol. 26, no. 4, pp. 314–322, 2012.
- A. R. Silva, C. Seidl, A. S. Furusho, M. M. S. Boeno, G. C. Dieamant, and A. M. Weffort-Santos, "In vitro evaluation of the efficacy of commercial green tea extracts in UV protection," *International Journal of Cosmetic Science*, vol. 35, no. 1, pp. 69– 77, 2013.
- Acker, S., Hloucha, M. & Osterwalder, U., (2014) The Easy Way to Make a Sunscreen. *sofwjournal* 140 (7), 24-30.
- Agbahungba G, Depommier D (1989) *World Oil Seeds Chemistry, Technology and Utilization*. Van Nostrand Rein Hold, New York. p.554.
- Alfred T (2002) "Fats and Fatty Oils". *Ullmann's Encyclopedia of Industrial Chemistry*. Weinheim: Wiley-VCH.
- B. Polj'sak and R. Dahmane, "Free radicals and extrinsic skin aging," *Dermatology Research and Practice*, vol. 2012, Article ID 135206, 4 pages, 2012.
- B. R. Zhou, H. B. Yin, Y. Xu et al., "Baicalin protects human skin fibroblasts from ultraviolet A radiation-induced oxidative damage and apoptosis," *Free Radical Research*, vol. 46, pp. 1458– 1471, 2012.
- B.-M. Hwang, E.-M. Noh, J.-S. Kim et al., "Curcumin inhibits UVB-induced matrix metalloproteinase-1/3 expression by suppressing the MAPK-p38/JNK pathways in human dermal fibroblasts," *Experimental Dermatology*, vol. 22, no. 5, pp. 371– 374, 2013.
- B.-R. Lee, J.-H. Lee, and H.-J. An, "Effects of *taraxacum officinale* on fatigue and immunological parameters in mice," *Molecules*, vol. 17, no. 11, pp. 13253–13265, 2012.
- Baba, K., S. Abe and D. Mizuno. 1981. Antitumor activity of hot water extract of dandelion, *Taraxacum officinale* correlation between antitumor activity and timing of administration. *Yakugaku Zasshi* 101:538-543. https://doi.org/10.1248/yakushi1947.101.6_538
- Bartholomey, E., House, S. & Ortiz, F. A. (2016) Balanced Approach for Formulating Sunscreen Products Using Zinc Oxide. *sofwjournal* 142 (3), 18-25.

Begoun, P. (2009) The Original Beauty Bible: Skin Care Facts for Ageless Beauty, 3rd , Washington, Beginning Press.

Blois, M.S. 1958. Antioxidant determinations by use of a stable free radical. Nature 26:1199-1200.

C. M. Park, J. Y. Park, K. H. Noh, J. H. Shin, and Y. S. Song, "Taraxacum officinale Weber extracts inhibit LPS-induced oxidative stress and nitric oxide production via the NF- κ B modulation in RAW 264.7 cells," Journal of Ethnopharmacology, vol. 133, no. 2, pp. 834–842, 2011.

Cho, Y.S., J.Y. Park, Y.J. Oh and J.Y. Jang. 2000. Effect of dandelion leaf extracts on lipid metabolism in rats fed high cholesterol diet. J. Korean Soc. Food Sci. Nutri. 29:676-682.

Choi, J.S., S.H. Park and I.S. Kim. 1989. Studies on the active principles of wild vegetables on biotransformation of drug. Korean J. Pharmacogn. 20:117-122.

D. M. Palmer and J. S. Kitchin, "Oxidative damage, skin aging, antioxidants and a novel antioxidant rating system," Journal of Drugs in Dermatology, vol. 9, no. 1, pp. 11–15, 2010

Di Vincenzo D, Maranz S, Serraiocco A, Vito R, Wiesman Z et al. (2005) Regional Variation in Shea Butter Lipid and Triterpene Composition in Four African Countries. J. Agric. Food Chem. 53: 7473-7479.

Diffey, B. L., Ferguson, J. (2009) Assessment of Photoprotective Properties of Sunscreens. In H. W. Lim & Z. D. Draelos (Eds.), Clinical Guide to Sunscreens and Photoprotection (pp. 11-38). New York, NY, Informa Healthcare USA, Inc.

Donglikar, M. M. & Deore, S. L. (2016) Sunscreens: A review, Pharmacognosy Journal, 8 (3), 171-179.

Dutra, E. A., Oliveira, D. A. G. C., Kedor-Hackmann, E. R. M.; Santoro, M. I. R. M. (2004) Determination of sun protection factor (SPF) of sunscreens by ultraviolet spectrophotometry. Braz. J. Pharm. Sci. 40 (3), 381-385.

E. Hwang, S. Y. Park, H. J. Lee et al., "Vigna angularis water extracts protect against ultraviolet b-exposed skin aging in vitro and in vivo," Journal of Medicinal Food, vol. 17, no. 12, pp. 1339– 1349, 2014.

El-Mahmood A M, Doughari J H, Ladan N (2008) Antimicrobial screening of stem bark extracts of *Vitellaria paradoxa* against some enteric pathogenic microorganisms. *African Journal of Pharmacy and Pharmacology* Vol. 2(5). pp. 089-094.

Emsley, J. (2007) *Better Looking, Better Living, Better Loving. How Chemistry can Help You Achieve Life's Goals*. Weinheim, WILEY-VCH Verlag GmbH & Co.KGaA.

F. Liebel, S. Kaur, E. Ruvolo, N. Kollias, and M. D. Southall, "Irradiation of skin with visible light induces reactive oxygen species and matrix-degrading enzymes," *Journal of Investigative Dermatology*, vol. 132, no. 7, pp. 1901–1907, 2012.

Ferris R S B, Collinsom C, Wanda K, Jagwe J, Wright P (2001) Evaluating the Market Opportunities for Shea Nut and Shea Nut Processed Products in Uganda. Submitted to USAID, The United States Agency for International Development (available at http://www.foodnet.cgiar.org/Projects/Sheanut_Rep.pdf accessed on 13-8-2014)

Fonseca A. P. & Rafael, N. (2013). Determination of sun protection factor by UV-vis spectrophotometry. *Health care current*. 1(1), 108.

G. Bens, "Sunscreens," *Advances in Experimental Medicine and Biology*, vol. 810, pp. 429–463, 2014.

G. Yang, K. Zhao, Y. Ju et al., "Hydrogen sulfide protects against cellular senescence via s-sulfhydration of keap1 and activation of Nrf2," *Antioxidants and Redox Signaling*, vol. 18, no. 15, pp. 1906–1919, 2013.

Gabriel, J. (2008), *The green beauty guide: your essential resource to organic and natural skin care, hair care, makeup, and fragrances*, Florida, Health Communications, Inc.

González-Arjona, D., López-Pérez, G., Domínguez, M. M., Looken S. C. V. (2015) Study of Sunscreen Lotions, a Modular Chemistry Project, *Journal of Laboratory Chemical Education*, 3(3), 44-52.

Gray, J.I. and L.R.Jr. Dugan. 1975. Inhibition of N-nitrosamine formation in model food systems. *J. Food Sci.* 40:981-984. <https://doi.org/10.1111/j.1365-2621.1975.tb02248.x>

Grieve, M. 1994. *A modern herbal*. Dorset Press. pp. 249-255.

H.-S. Wong, J.-H. Chen, P.-K. Leong, H.-Y. Leung, W.-M. Chan, and K.-M. Ko, " β -sitosterol protects against carbon tetrachloride hepatotoxicity but not gentamicin nephrotoxicity in rats via the induction of mitochondrial glutathione redox cycling," *Molecules*, vol. 19, no. 11, pp. 17649–17662, 2014.

Ho, C., E.J. Choi, G.S. Yoo, K.M. Kim and S.Y. Ryu. 1998. Desacetylmaticarin, an anti-allergic component from *Taraxacum platycarpum*. *Planta Medica*. 64:577-578. <https://doi.org/10.1055/s-2006-957520>

Hu, C. and D. KITTS David. 2003. Antioxidant, prooxidant, and cytotoxic activities of solvent-fractionated dandelion (*Taraxacum officinale*) flower extracts in vitro. *J. Agric. Food Chem*. 51:301-310. <https://doi.org/10.1021/jf0258858>

J. E. Sanches Silveira and D. M. Myaki Pedroso, "UV light and skin aging," *Reviews on Environmental Health*, vol. 29, no. 3, pp. 243–254, 2012.

J. Y. Cherng, L. Y. Chen, and M. F. Shih, "Preventive effects of β - thujaplicin against UVB-induced MMP-1 and MMP-3 mRNA expressions in skin fibroblasts," *American Journal of Chinese Medicine*, vol. 40, no. 2, pp. 387–398, 2012.

K. Phetdee, R. Rakchai, K. Rattanamanee, T. Teaktong, and J. Viyoch, "Preventive effects of tamarind seed coat extract on UVA-induced alterations in human skin fibroblasts," *Journal of Cosmetic Science*, vol. 65, no. 1, pp. 11–24, 2014.

K. Schutz, R. Carle, and A. Schieber, "Taraxacum—a review " on its phytochemical and pharmacological profile," *Journal of Ethnopharmacology*, vol. 107, no. 3, pp. 313–323, 2006.

Kang, M.J. 2001. Antioxidant activity and free radical scavenging effect of dandelion extract. PhD thesis, Yeungnam University, Kyungsan, Korea.

Kang, M.J., Y.H. Seo, J.B. Kim, S.R. Shin and K.S. Kim. 2000. The chemical composition of *Taraxacum officinale* consumed in Korea. *Korean J. Soc. Food Sci*. 16:182-187.

Kim, D.H. 1995. Antitumor activity of fractions of *Taraxaci Herba* synergistic effect with anticancer drugs. M.S.thesis, Taejon Univ.

Kim, S.D., M.H. Kim and D.H. Kim. 2000. Effect of dandelion extracts on the growth of lactic acid bacteria and gas formation from Kimchi. *Korean J. Phstharvest Sci. Technol*. 7:321-325.

Kim, S.K. 1991. Effect of *Herba Taraxaci* extract on the antialgesia and antiinflammatory. M.S. Thesis, Wonkang Univ.

Klimová, Z., Hojerová, J. & Pažoureková, S. (2013) Current problems in the use of organic UV filters to protect skin from excessive sun exposure, *Acta Chimica Slovaca*, 6 (1). 82—88.

Kotobuki, H., A. Akira, Y. Itaru, N. Shigehiko, H. Zen-ichi and N. Ichiya. 1965. Antitumor activity of 4(or 5)-aminoimidazole-5(or 4)-carboxamide derivatives. *Japanese J. Cancer Res.* 56(4):417-420.

Krygier, K., F. Sosulski and H. Lawrence. 1982. Free, esterified and insoluble-bound phenolic acids. 1. Extraction and purification procedure. *J. Agric. Food Chem.* 30:330-334. <https://doi.org/10.1021/jf00110a028>

Lee, B.W. and D.H. Shin. 1991. Screening of natural antimicrobial plant extract on food spoilage microorganism. *Korean J. Food Sci. Technol.* 23:200-204.

Lee, E.B., J.K. Kim and O.K. Kim. 1993. The antigastric effect of *Taraxaci Herba*. *Korean J. Pharmacogn.* 24: 313- 318.

Lister, C.E., J.E. Lancaster, K.H. Sutton and J.R.L. Walker. 1994. Developmental changes in the concentration and composition of flavonoids in skin of a red and a green apple cultivar. *J. Science Food and Agric.* 64: 155-161. <https://doi.org/10.1002/jsfa.2740640204>

M. Hfaiedh, D. Brahmi, and L. Zourgui, "Hepatoprotective effect of *Taraxacum officinale* leaf extract on sodium dichro mate-induced liver injury in rats," *Environmental Toxicology*, 2014.

M. Ichihashi and H. Ando, "The maximal cumulative solar UVB dose allowed to maintain healthy and young skin and prevent premature photoaging," *Experimental Dermatology*, vol. 23, pp. 43–46, 2014.

M. Majeed, B. Bhat, S. Anand, A. Sivakumar, P. Paliwal, and K. G. Geetha, "Inhibition of UV-induced ROS and collagen damage by *Phyllanthus emblica* extract in normal human dermal fibroblasts," *Journal of Cosmetic Science*, vol. 62, no. 1, pp. 49–56, 2011.

Mansur, J. S., Breder, M. N. R., Mansur, M. C. A., Azulay, R. D. (1986) Determinação do fator de proteção solar por espectrofotometria. *An. Bras. Dermatol.*, 61 (3), 121-124.

Mascolo, N., G. Autore, F. Capasso, A. Menghini and M. P. Fasulo. 1987. Biological screening of Italian medicinal plants for anti-inflammatory activity. *Phytother. Res.* 1:28-31. <https://doi.org/10.1002/ptr.2650010107>

Masters E T, Yidana J A, Lovett P N (2010) Reinforcing sound management through trade: Shea tree products in Africa. Trade and sustainable forest management. <http://www.fao.org/docrep/008/y5918e/y5918e11.htm> (accessed on 13-8-2014).

Mbaiguinam M, Mbayhoudel K, Djekota C (2007) Physical and Chemical Characteristics of Fruits, Pulps, Kernels and Butter of Shea *Butyrospermum parkii* (Sapotaceae) from Mandoul, Southern Chad. *Asian J. Biochem.* 2:101-110.

Mosmann, T. 1983. Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. *J. Immunol Methods.* 65:55-63. [https://doi.org/10.1016/0022-1759\(83\)90303-4](https://doi.org/10.1016/0022-1759(83)90303-4)

Murphy, G. B. & Hawk, J. L. M (2009) Sunscreens and Photocarcinogenesis. In H. W. Lim & Z. D. Draelos (Eds.), *Clinical Guide to Sunscreens and Photoprotection* (pp. 11-38). New York, NY, Informa Healthcare USA, Inc.

Nash, J. F. & Tanner, P. R. (2009) Sunscreens. In Z. D. Draelos & L. A. Thaman (Eds). *Cosmetic Formulation of Skin Care Products* (pp. 3-14). Taylor & Francis Group, 270 Madison Avenue, New York, US.

Ndukwe I G, Amupitan JO Isah Y, Adegoke K S (2007) Phytochemical screening of the crude extract of the roots, stem bark and leaves of *Vitallaria paradoxa* (GAERTN. F). *African journal of Biotechnology*, Vol 6, No 16, pp 1905-1909.

Osterwalder, U. & Herzog, B. (2009) Chemistry and Properties of Organic and Inorganic UV Filters. In H. W. Lim & Z. D. Draelos (Eds.), *Clinical Guide to Sunscreens and Photoprotection* (pp. 11-38). New York, NY, Informa Healthcare USA, Inc.

P. Ovadje, S. Chatterjee, C. Griffin, C. Tran, C. Hamm, and S. Pandey, "Selective induction of apoptosis through activation of caspase-8 in human leukemia cells (Jurkat) by dandelion root extract," *Journal of Ethnopharmacology*, vol. 133, no. 1, pp. 86– 91, 2011.

Pretorius C J, Watt E (2001) Purification and Identification of Active components of *Carpobrotus edulis* L. *J. Ethnopharma* 76: 87-91.

Racz-Kotilla, E., G. Racz and A. Solomon. 1974. The action of *Taraxacum officinale* extracts on the body weight and diuresis of laboratory animal. *Planta Medica.* 26:212-217. <https://doi.org/10.1055/s-0028-1099379>

S. J. Chatterjee, P. Ovadje, M. Mousa, C. Hamm, and S. Pandey, "The efficacy of dandelion root extract in inducing apoptosis in drug-resistant human melanoma cells," *Evidence-*

Based Complementary and Alternative Medicine, vol. 2011, Article ID 129045, 11 pages, 2011.

Samuel H (2005) American Shea Butter Institute hand book, 11.28
http://www.American_Shea_institute.com/

SAS (Statistical Analysis Systems) Institute. 2000. SAS/STAT user's guide. Version 7. Electronic Version. Cary, NC, USA.

Sayre, R. M., Agin, P. P., Levee, G. J., Marlowe, E. (1979) Comparison of in vivo and in vitro testing of sun screening formulas. Photochem Photobiol Oxford., 29 (3), 559-566.

Shahidi, F., P.K. Janitha and P.D. Wanasundara. 1992. Phenolic antioxidants. Crit. Rev. Food. Sci. Nutr. 32:67-103. <https://doi.org/10.1080/10408399209527581>

Singleton, V.L. and J.A. Rossi. 1965. A colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American J. Enol. Viticult. 16:144-158.

Sun, J., Y.F. Chu, X.Z. Wu and R.H. Liu. 2002. Antioxidant and anti proliferative activities of common fruits. J. Agric. Food Chem. 50:7449-7454. <https://doi.org/10.1021/jf0207530>

T. Quan, Z. Qin, Y. Xu et al., "Ultraviolet irradiation induces CYR61/CCN1, a mediator of collagen homeostasis, through activation of transcription factor AP-1 in human skin fibroblasts," Journal of Investigative Dermatology, vol. 130, no. 6, pp. 1697–1706, 2010.

Takasaki, M., T. Konoshima, H. Tokuda, K. Masuda, Y. Arai, K. Shiojima and H. Ageta. 1999a. Anti-carcinogenic activity of Taraxacum plant. I. Biol. Pharm. Bull. 22:602-605. <https://doi.org/10.1248/bpb.22.602>

Takasaki, M., T. Konoshima, H. Tokuda, K. Masuda, Y. Arai, K. Shiojima and H. Ageta. 1999b. Anti-carcinogenic activity of Taraxacum plant. II. Biol. Pharm. Bull. 22: 606-610. <https://doi.org/10.1248/bpb.22.606>

U.-K. Choi, O.-H. Lee, J. H. Yim et al., "Hypolipidemic and antioxidant effects of dandelion (Taraxacum officinale) root and leaf on cholesterol-fed rabbits," International Journal of Molecular Sciences, vol. 11, no. 1, pp. 67–78, 2010.

Williams, C.A., F. Goldstone and J. Greenham. 1996. Flavonoids, cinnamic acids and coumarins from the different tissues and medicinal preparations of *Taraxacum officinale*. *Phytochemistry*. 42:121-127. [https://doi.org/10.1016/0031-9422\(95\)00865-9](https://doi.org/10.1016/0031-9422(95)00865-9)

X. Shen, Y. Du, W. Shen, B. Xue, and Y. Zhao, "Adipose-derived stem cells promote human dermal fibroblast function and increase senescence-associated β -galactosidase mRNA expression through paracrine effects," *Molecular Medicine Reports*, vol. 10, no. 6, pp. 3068–3072, 2014.

Y. P. Hwang, J. H. Choi, H. G. Kim et al., "Cultivated ginseng suppresses ultraviolet B-induced collagenase activation via mitogen-activated protein kinases and nuclear factor κ B/activator protein-1-dependent signaling in human dermal fibroblasts," *Nutrition Research*, vol. 32, no. 6, pp. 428–438, 2012.

Yafan Yang and Shuangshuang Li Dandelion Extracts Protect Human Skin Fibroblasts from UVB Damage and Cellular Senescence. February 2015 ,619560, <http://dx.doi.org/10.1155/2015/619560>

Zhou, K. and L. Yu. 2006. Total phenolic contents and antioxidant properties of commonly consumed vegetables grown in Colorado, *LWT*. 39:1155-1162. <https://doi.org/10.1016/j.lwt.2005.07.015>