Formulation and evaluation of antibacterial and antioxidant herbal cream of curry leaves and turmeric extract

Priya Thakur*, Sahil Thakur, Kajal, Shivam Thakur, Mohit Sharma, Kumari Varsha, Sunaina Dhiman and Sunil Kumar

Gautam College of Pharmacy, Hamirpur, Himachal Pradesh, India.

World Journal of Advanced Research and Reviews, 2024, 22(01), 170–184

Publication history: Received on 22 February 2024; revised on 28 March 2024; accepted on 31 March 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.22.1.1011

Abstract

Humanity relies on plants to meet its basic needs, such as food, clothing, and shelter. Both rural and urban civilizations benefit from wild plants for medicinal, craft, and beauty purposes. *Murraya kienigii Linn* (Rutaceae), also known as Meethi Neem or Curry Patta, is a fragrant, usually deciduous shrub or small tree that can grow to be 6 meters tall. It may be found all throughout India and reaches heights of up to 1500 meters. It is cultivated for its fragrant leaves. In traditional medicine, it is used as an antiemetic, antidiarrheal, dysentery, febrifuge, blood purifier, tonic, stomachic, and flavoring agent in curries and chutneys. The essential oil derived from the leaves contains alkaloids such as mahanine, koenidine, koenigine, koenine, girinimibine, girinimbiol, murrayamine, and several more.

Another plant Turmeric (*Curcuma longa L.*) belongs in the ginger family, which is native to Southwest India. Turmeric is a medicinal and fragrant plant that is recognized as one of nature's most valuable resources, with enormous export potential in medicine, personal care, culinary spices, and natural colours. An ethanolic extract of turmeric including curcumin, dimethoxy-curcumin, and bisdemethoxycurcumin has been shown to reduce blood glucose levels in mice and prevent blood glucose from rising. Reduces proteinuria and haematuria when taken orally in people with refractory lupus nephritis. Curcuminoid is the most abundant component in turmeric, along with many other phenolic compounds and mono-, sesqui-terpenes.

Soxhlet extraction combines both percolation and maceration techniques. The extraction is carried out using a particular device known as the Soxhlet apparatus, which was created by Franz von Soxhlet in 1879. It was one of the most popular extraction methods, and it is still commonly used today. The apparatus comprises of an extraction chamber linked to a vapor duct and a siphon tube that continues down to the joint, where a circular bottom shell may be attached. A thimble of filter paper or a cotton plug is put in the extraction chamber to prevent the siphon tube from being blocked when powdered medication material is introduced. In this extraction we will use the Soxhlet extraction method to extract the phytoconstituents of the respective plants.

Keywords: *Murraya Koenigii*; *Curcuma longa L.*; Anti- bacterial; Anti-oxidant; Herbal cream.

1. Introduction

1.1. Curry Leaves (*Murraya Koenigii*)

Humanity uses plants in a variety of ways to satisfy its fundamental requirements, including food, clothing, and shelter. Wild plants provide medicines, crafts, and cosmetics to both rural and urban cultures. Wild plants provide revenue and job opportunities in rural regions [1]. Herbal items include spices, herbal teas, functional food components, medical raw

* Corresponding author: Shivam Thakur

materials, aromatic plants, essential oils, flavouring, fragrant products, and nutritional supplements. Plants have been utilized as remedies for thousands of years around the world. According to WHO estimates, 80% of the population, primarily in underdeveloped countries, continues to rely on plant-based medications for basic care (1978). The plants utilized were referred to as medicinal herbs. India is a country with an abundance of natural resources and a long history of traditional medicine [2]. Medicinal plants include a variety of biologically active substances that can assist improve one's health and treat diseases. Compounds include carbohydrates, proteins, enzymes, lipids, oils, terpenoids, flavonoids, sterols, and simple phenolic compounds, among others. Natural goods are the source of both synthetic and traditional herbal medicine, and they remain the major health-care system. The existence of numerous life-sustaining elements in plants prompted scientists to examine their potential in treating some infectious illnesses and managing chronic wounds [3].

Murraya koenigii Commonly known as Meethi neem, Curry Patta, Linn (Rutaceae) is a fragrant, mostly deciduous shrub or small tree that may grow up to 6 meters in height. It can be found all throughout India and can reach elevations of up to 1500 meters. It is grown for its aromatic leaves [4].

Figure 1 *Murraya koenngii* plant

It is used as an antiemetic, antidiarrheal, dysentery, febrifuge, blood purifier, tonic, stomachic, and flavouring ingredient in curries and chutneys in the conventional medical system. The oil is applied externally for blisters, eruptions, and in the fragrance and soap industries [5]. Thus far, alkaloids such as mahanine, koenidine, koenigine, koenine[6], girinimibine, girinimbiol [7], O-methyl murrayamine with koenimbine A, bismahanine, bispyrayafoline, isomahanine, and O-methyl mahanine [8] and other phytoconstituents include murrayanine, scopotin, and coumarin glycoside [9] have been isolated from the leaves as phytoconstituents [10]. Diα-phellandrene, D-sabinene, D-α-pinene, dipentene, D-α-terpinol, and caryophyllene were all found in the essential oil extracted from leaves [11]. According to reports, it has antihypertensive, hypoglycemic, anti-lipid peroxidative, antibacterial, antifungal, larvicidal, anticarcinogenic, and antioxidant properties [12]. Additionally, it is said to include β-sitosterol, 1-al, 3[6', 6' dimethyl 5-hexene] carbazole, and 5,8-dimethyl furanocoumarin [13].

Figure 2 *Murraya koenngii* leaves

1.2. Morphological factors

A little spreading shrub that grows to a height of about 2.5 meters; its main stem is 16 centimeters in girth and has many spots on it. The bark may be peeled off lengthwise to reveal the white wood below. The main stem is dark green to brownish. The leaves are exstipulate, bipinnately compound, 30 cm long, and have reticulate venation. Each leaflet has 24 lanceolate leaves that are 4.9 cm long, 1.8 cm wide, and have a 0.5-cm-long petiole [14]. Bisexual, white, funnel-shaped, sweetly scented, stalked, complete, ebracteate, regular, actinomorphic, pentamerous, and hypogynous flowers with an average diameter of 1.12 cm; inflorescence, a terminal cyme, each bearing 60 to 90 flowers; calyx, 5-lobed, persistent, inferior, green; corolla, white, polypetalous, inferior, with 5 petals, lanceolate, length, 5 mm; androecium, polyandrous, inferior, with 10 stamens, dorsifixed, arranged into circles of five each; gynoecium, 5 to 6 mm long; stigma, bright, sticky; style, short; ovary, superior [15]. When completely ripe, the round to oblong fruits have a shiny, black surface and measure 1.4 to 1.6 cm in length and 1 to 1.2 cm in diameter. A single, spinach-green, 11 mm length by 8 mm wide seed is present in every fruit. Fruiting and flowering take place from December to July. In warm, humid conditions, this suckering plant may reach a height of 6 m as a tree, but it can also be cultivated to a much lower size in a pot with great success [14-16]. If it is grown outside of its typical climatic zone, it will usually be smaller [16, 17]. Taxonomy of plant [2]

Table 1 Morphological factors

Kingdom	**Planate**
Sub- Kingdom	Tracheobionta
Super division	Spermatophyta
Division:	Magnoliophyta
Class:	Magnoliospida
Sub class:	Rosidae
Order:	Sapindales
Family:	Rutaceae
Genus:	Murraya Koenigii L. Spreng
Species:	Murraya J. Koenig ex L

1.3. Pharmacological activities

1.3.1. Antifungal activity

It has been stated that the leaves' essential oil has antifungal properties [18]. The stem bark of *M. koenigii* contains bioactive substances such as girinimbine, murrayanine, marmesin-1′-O-beta-D'galactopyranoside, mahanine, murrayacine, mukoeic acid, murrayazolinine, girinimbilol, pyrafoline-D, and murrafoline-I. Notable antifungal action is exhibited by girinimbine, murrayanine, and marmesin-1′-O-beta-D'galactopyranoside [19, 20].

1.3.2. Antibacterial activity

Extracts from *M. koenigii* have shown antibacterial activity against a range of microbes. It was discovered that M. koenigii leaf extracts in ethanol and methanol were efficient against specific bacterial strains [21]. *M. koenigii* leaves have the potential to be effectively utilized as a home treatment in regular meals to avoid various bacterial diseases [21, 22].

1.3.3. Hepatoprotective Effect

M. koenigii extract of carbazole alkaloids and tannin were shown to have hepatoprotective action against ethanol-induced hepatotoxicity in a HepG2 cell line paradigm. They displayed outstanding hepatoprotective effect, preserving the enzymatic and non-enzymatic antioxidant levels at a near normal range, as well as maintaining the cell integrity [23].

1.3.4. Anti-inflammatory activity

Tissue injury, cell damage, pathogen infections, and metabolic changes all contribute to the biological reaction known as inflammation [24]. *M. koenigii* leaf extract has anti-inflammatory properties due to bioactive compounds such as murrayakonine A, O-methylmurrayamine A, and mukolidine, which have been shown to inhibit TNF-α and IL-6 release in LPS-induced inflammation in human PBMCs [25].

1.3.5. Nephroprotective Activity

M. koenigii's protective effect has been demonstrated to cause considerable dose-dependent reductions in blood urea and creatinine levels, as well as notable improvements in plasma antioxidant capacity. More importantly, the histological integrity of the kidneys demonstrated similar tissue regeneration mediated by the aqueous extract [26].

1.3.6. Antidiabetic activity

Alkaloids found in the leaves of *M. koenigii* have been found to inhibit the aldose reductase enzyme, glucose consumption, and other enzyme systems, potentially prolonging anti-diabetic benefits [27, 28].

1.3.7. Anti-Cancer activity

M. koenigii has potential secondary metabolites that might be turned into anticancer medicines. It is reported that, the extracts were found to be potently cytotoxic in HeLa carcinoma cells [29]. There are other reports of histological data indicated that *M. koenigii* extract therapy created a decrease in neoplasms in the colon [30].

1.3.8. Neuroprotective activity

Supplementation with *M. koenigii* leaf extracts has been documented in the therapy of a wide range of neurological disorders, including Alzheimer's, Parkinson's, and others [31-35]. *M. koenigii* has neuroprotective properties against orofacial dyskinesia caused by resperine. It also stabilizes levels of protective antioxidant enzymes such as SOD, catalase (CAT), and GSH, as well as inhibiting LPO in reserpine-treated rats' forebrains. Similarly, treatment with *M. koenigii* dramatically restored the levels of protective antioxidant enzymes (SOD, CAT, and GSH) and prevented LPO in the forebrain area as compared to reserpine, as well as catalepsy produced by haloperidol [36]. The findings indicated that M. koenigii leaves enhanced memory and learning deficits. *M. koenigii* leaf extracts somewhat enhanced memory in rats with chronic partial global cerebral ischemia [37].

1.3.9. Wound healing activity

M. koenigii leaves promote wound healing by considerably increasing wound contraction and decreasing epithelialization, which supports collagen production as demonstrated in histopathological investigations [38].

1.3.10. Chemoprotective and Radioprotective activity

A methanolic extract of *M. koenigii* was shown to buffer chromosomal damage from radiation and cyclophasphamide. Radiation causes an increase in all forms of aberrations, including chromatid fragmentation and chromosomal breakage, rings, and dicentrics. Treatment with a methanolic extract of *M. koenigii* prior to radiation considerably decreased the aberrations. M. koenigii can provide considerable bone marrow protection against radiation and cyclophosphamide [39].

1.4. Turmeric (Curcuma longa)

Turmeric is an amazing plant. Its botanical name is *Curcuma longa L.* and it's part of the ginger family. Turmeric is native to Southwest India, which is where its roots come from. Those roots give turmeric its bright yellow colour - people use turmeric both as a spice and to make dye[40]. Curcumin is a yellow polyphenolic compound [41]. The utilization of turmeric rhizome and other botanical derivatives which produce yellow-coloured dyes has been growing in replacing synthetic additives within natural compounds [42].

Turmeric rhizome is widely utilized in the food industry, in particular as a colouring agent in processed foods and sauces. Turmeric is an important medicinal and aromatic plant which is regarded as one of nature's golden resources with immense export potential in the fields of medicine, personal care, culinary spices, and natural dyes.

Turmeric rhizome has long been harvested and internationally traded due to its diverse applications and health-supporting properties. Its distinctive yellow-orange hue and robust flavour profile have allowed turmeric to play a key role in global food supply chains and marketplace opportunities [43].

Figure 3 Turmeric rhizome

Figure 4 Turmeric powder

Administration of turmeric orally decreased proteinuria and haematuria in individuals with refractory lupus nephritis [45].

Curcumin demonstrated immunomodulatory and regulatory impacts on the serum levels of interleukin (IL)-10, vascular endothelial growth factor, and IL-1β in obese individuals [46]. Curcumin offers favourable outcomes for individuals with Alzheimer's disease [47, 48]. In patients with non-alcoholic fatty liver disease, it decreased liver fat [49]. Curcumin is a good cancer fighter for carcinoma of squamous cells of the head and neck region [50].

It is helpful in reducing the development of breast, colon, and cancers of the abdomen [51]. *Curcuma Longa* has a capacity to stop malignancies of the liver triggered by smoking tobacco products [52]. Curcumin the Nano-formulations have been utilized employed in chemotherapy for cancer [53, 54].

Curcumin has been demonstrated to have protective properties against UV B ray damage and to have radioprotective effects on normal cells [55-57]. Even when taken orally in humans at a level of 12 g/day, curcumin has a low bioavailability. The serum curcumin content at this dosage is 51.2 ng/ml [58, 59]. Yet curcumin's liquid micellar and micronized powder boosted oral bioavailability [60].

Studies on curcumin have revealed that this polyphenol substance's chemical structure demonstrates anti-inflammatory, antibacterial, antioxidant, antimutagenic, and antiplatelet aggregation qualities [61, 62]. Curcumin is said to provide preventative and preventive effects against a number of diseases, including cancer, autoimmune, neurological, metabolic, lung, liver, and cardiovascular conditions [63]. Polyphenol compounds have gained significant attention recently because of their impact on cancer and other degenerative disorders [64]

1.4.1. Classification of Curcuma longa

Table 2 Classification of *Curcuma longa* [65, 66]

Rank	**Scientific Name and Common Name**
Kingdom	Plantae-Plants
Sub-kingdom	*Tracheobionta* - Vascular plants
Super-division	*Spermatophyta* - Seed plants
Division	*Magnoliophyta* - Flowering plants
Class	*Liliopsida* – Monocotyledons
Sub-Class	*Zingiberidae*
Order	*Zingiberales*

Family	*Zingiberaceae* Martinov - Ginger family
Genus	*Curcuma* L. – curcuma
Species	*Curcuma longa* L. - common turmeric

1.4.2. Curcumin's physical and chemical composition

Turmeric's constituents are minerals (3.5%), fat (5.1%), protein (6.3%), carbohydrates (69.4%), and moisture (13.1%) (Figure1) [61]. Curcuminoids contains curcumin

(77%), demethoxycurcumin (DMC; 17%), and bidemethoxycurcumin

(BDMC; 3%) (Figure 6) [67].

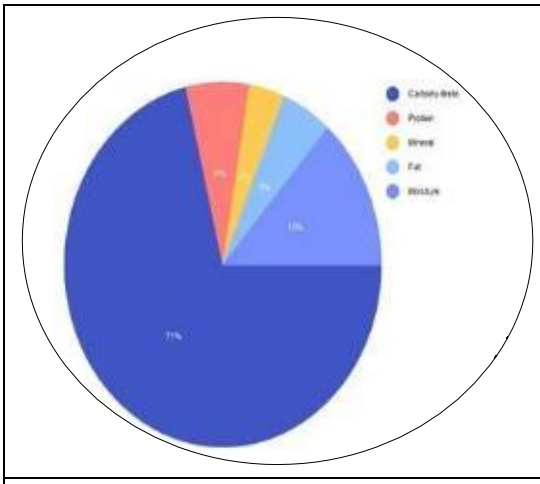

Figure 5 Turmeric Constituents

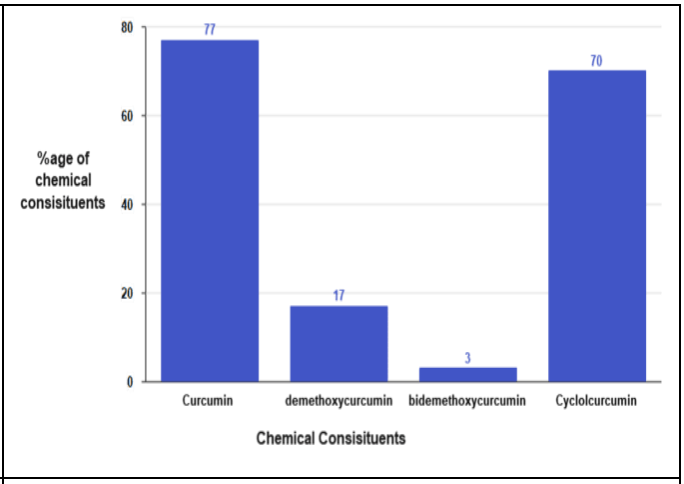

Figure 6 Percentage (%) of Major Chemical Constituents

1.4.3. Chemical Constituents in Curcuma longa

Curcumin, dimethoxy-curcumin and bisdemethoxycurcumin called as curcuminoids (3-6%) are major compounds in turmeric rhizomes [68].The major colouring principle of turmeric rhizome was isolated in 19th century and named as 'Curcumin'. Its chemical structure was determined by Roughley and Whiting (1973). The principle constituents present here is Curcuminoid, with several other phenolic compounds as 1-hydroxy-1, 7-bis (4-hydroxy-3- methoxyphenyl) -(6E)-6-heptene-3, 5-dione, 6-heptadiene-3, 5-dione and 1, 7-bis (4-hydroxyphenyl)-1, 4, 6-heptatrien-3-one. The pale yellow to orange-yellow volatile oil (4-6%) obtained from turmeric consists of a number of mono- and sesquiterpenes. The sesquiterpenes were named as curcumenone; dehydrocurdione; (4 S, 5 S)-germacrone 4, 5-epoxide; bisabola 3, 10-diene 2-one; arturmerone bisacumol; bisacurone; curcumenol; isoprocurcumenol; zedoaronediol; procurcumenol; epipro-curcumenol; germacrone-13-al; 4- hydroxybisabola-2, 10-diene-9-one; 4, 5- dihydrobisabola-2, 10-diene; 4-methoxy5-hydroxybisabola-2, 10-diene-9-one; 2, 5-dihydroxybisabola-3, 10-diene and procurcumadiol [69].

1.4.4. Activites of Turmeric: [70]

Curcuma longa commonly called as turmeric belongs to the family of Zingiberaceae and it is derived from the rhizomes. It is well known that curcumin has a good anti-bacterial and anti-inflammatory properties and a protective effect on the skin. Traditionally, curcumin is incorporated in many natural herbal remedies to treat skin infections and inflammation.

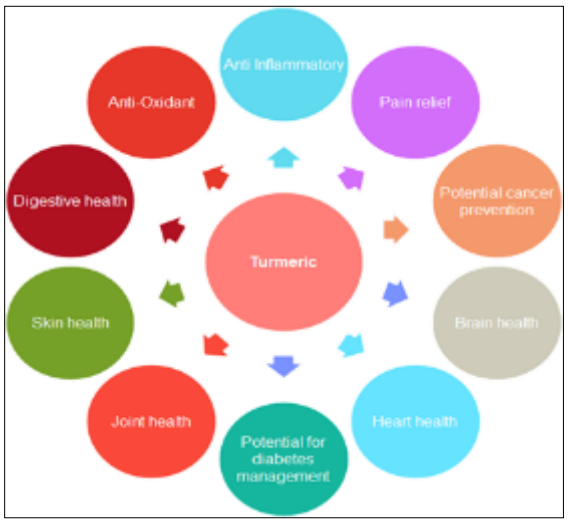

Figure 7 Activities of Turmeric

There is an increase in demand for plant-based medicine, cosmetic, food product, food supplement and various pharmaceutical products cream is o/w type of emulsion. The preparation and evaluation parameter both are influenced by the methods of preparation. The natural content in the botanical does not causes any side effects on the human body instead enrich the body with nutrient and other useful minerals. To formulate and evaluate herbal cream using turmeric to give glowing and cooling effect. The cream was prepared by using the cream base that is bee wax, liquid paraffin, borax, distilled water, cetyl alcohol and rose water. This formulation can be evaluated by using various evaluation parameters like pH, viscosity, irritancy, spreadiability.

1.5. Aim

To formulate and evaluate antibacterial herbal cream using curry leaves and turmeric extract to give multipurpose effect. The aim of the present study to prepare the herbal cream for the use of moistening, nourishing and cure of various disease of the skin.

1.6. Objective

Formulation of antibacterial cream using extracts

- To nourish and beautify the skin.
- To reduce the rate of premature ageing
- Preparation of extract with different solvent of leaves of two different identified plants.
- Preliminary phytochemical investigation of different extract of the plants.

2. Methodology

2.1. Collection of Plant

- Plant A: *Murraya Koenigii*
- Plant B: *Curcuma longa*

For this project, both the plants *Murray Koenigii and Curcuma longa* were collected from different areas of district Hamirpur, Himachal Pradesh, India.

2.2. Authentication

The authentication was done by the office of Director of College of Horticulture & Forestry, Neri, District- Hamirpur.

2.2.1. Washing and drying of the plant material

After the plants were collected from their natural habitats, they were carefully washed to remove any dirt, debris, or contaminants that may have been present on the surface. Fresh rhizomes were cleaned, washed with deionized water, sliced and dried in the sun for one week and dried again at 50ºC in a hot air oven for six hours.

2.3. Extraction

Murraya koenigii was extracted by using Soxhlet extraction method. Fresh leaves were cleaned, washed with deionized water, sliced and dried in the sun for one week and dried again at 50ºC in a hot air oven for six hours. These Dried leaves were crushed into powder form by mortar pestle. 10 gm of sample were taken into a thimble and placed in a Soxhlet apparatus170 ml of solvent was added and extracted according to their boiling point for six hours. The solvents used were acetone(120ml) + (50ml) water. After completion of extraction the dark brown extract was then cooled, crude dried extract which was turning dark green in colour.

For *Curcuma longa,* the Curcuminoid was extracted by using Soxhlet extraction method. These Dried rhizomes were cut in small pieces, powdered by mortar pestle. 8 gm of sample were taken into a thimble and placed in a Soxhlet apparatus; 170 ml of solvent was added and extracted according to their boiling point for six hours. The solvents used were ethanol (120ml) + (50ml) water.

Figure 8 Soxhlet apparatus

2.4. Evaluation of extract

After completion of extraction the dark brown extract was then cooled, this crude dried extract which was turning black orange in colour.

2.5. Formulation of cream

Take the liquid paraffin and bee wax in a borosilicate glass breaker at 75°C and maintain that heating temperatures (Oil phase). In other beaker, dissolve borax and methyl paraben in distilled water by maintaining temperatures 75°C with water bath. Stir the solution with glass rod until all solid particles get dissolve. Then gently add heated aqueous phase in heated oily phase with continue stirring. After mixing both phases, immediately add turmeric extract and add *Murraya koenigii* into it with continues mixing by glass rod until it forms a smooth cream. When cream is formed, then add rose oil as fragrance. Put this cream on the slab and add few drops of distilled water if necessary and mix the cream in a geometric manner on the slab to give a smooth texture to the cream and to mix all the ingredients properly. This method is called as slab technique or extemporaneous method of preparation of cream.

Table 3 Formula

S.no	Ingredient	Quantity taken	Uses
1	Turmeric extract	2.0g	Skin lighting agent/ anti-inflammatory
2	Curry leaves	0.5g	Dark spot reduction
3	Cetyl alcohol	1.6g	Emollient
4	Glycerin	1.5ml	Humectant
5	Methyl paraben	0.8g	Preservative
6	Ascorbic acid	1.5g	Prevent Sun damage
7	Liquid paraffin	5g	Lock moisture
8	Bees wax	20g	Stiffening agent
9	Borax	5.0g	Emulsifying agent
10	Purified water	20ml	Vehicle & solvent
11	Rose water	0.2ml	Reduce skin redness

2.5.1. Evaluation of crème

pH of the cream

The pH meter was calibrated using standard buffer solution. About 19 of cream was weighted and dissolve in 100 ml of distilled water and check the pH of the cream.

Consistency

The consistency was checked by application on the skin.

Determination of emollience

The emollient test was preferred to check the amount of residue test after the application of specific quantity of cream.

5.4 Determination of spreadibility: Spread ability may be expressed by the extent of the area to which the topical application spread when applied to the affected part on the skin. The therapeutics efficiency of the formulation also depends upon its spreading value. The spread ability (s) can be calculated using formula.

S= m * L/T

Where,

S = Spread ability

M= weight tied to upper glass slide-length moved on a glass slide

T = time taken

U=The determination was carried out in triplicate and average of three reading was recorded.

2.6. Removal

The easy of removal of the cream applied was examined by washing the applied part with tap water.

- **Irritancy:** Test mark an area (15 q.cm) on the left-hand dorsal surface. The cream was applied to the specified area and time was noted, irritancy, erythema, edema was checked if any for regular intervals up to 24 hr and reported.
- **Physical evaluation:** Formulated herbal cream was further evaluated by using the following physical parameter, colour, odour, consistency and state of the formulation.
- **Colour:** The colour of the cream was observed by visual examination. The result was shown in the table.
- **Odour:** The odour of cream was observed by the visual examination.
- **State:** The state of cream was examined by rubbing visually. The cream having a semisolid state.

3. Result

Prepared formulation was pale odour and slightly smooth texture

Table 4 Formulation

Sr. No.	Parameter	Result
1	Colour	Slightly green
2	Odour	Characteristic Aroma
3	pH	5.5
4	Spreadibility	11.4g.cm/sec
5	Consistency	Slightly smooth
6	Appearance	Semi solid

Figure 9 Final product

The formulated cream showed good consistency, and spreadibility, homogeneity. Form the results it is consider, pH, no phase separation during study period of research. So, the values of herbs in the cosmetic has been extensively improved in personal care system and to than synthetic ones. From the above study it can be calculated that the polyherbal cold cream is safe to use as it is developed from herbal extract. Natural remedies are more acceptable in the belief that they are safer with fewer side effect than the synthetic ones. So, the values of herbs in the cosmetics have been extensively improved in personal care system & there is greater demand for the herbal cosmetics nowadays. So, this formulation will be beneficial for both the parties i.e. on industrial scale and consumer scale. Further modifications need to be done on a higher scale for the betterment of the product.

4. Conclusion

The formulated cream showed good consistency, and spreadibility, homogeneity. Form the results it is consider, pH, no phase separation during study period of research. So, the values of herbs in the cosmetic has been extensively improved in personal care system and to than synthetic ones. From the above study it can be calculated that the polyherbal cold cream is safe to us.

Compliance with ethical standards

Acknowledgments

Behind every success there are lot many efforts, but efforts are fruitful due to hands making the passage smoother. I express my deep sense of gratitude for hands, people Extended to me during my work.

I would like to give my sincere thanks to the whole management of Gautam Group of colleges, Hamirpur, and Mr. Jagdish, Gautam Chairman College of Pharmacy, Hamirpur.

I am thankful to Dr. J.S Badhan, Principal at Gautam College of Pharmacy, Hamirpur (H.P), for their support and encouragement.

I express my sincere thanks to my collogues: Mr. Sunil Kumar, Assistant Professor in Pharmacology at Gautam college of pharmacy, Hamirpur (H.P).

Mrs. Sunaina Dhiman, Assistant Professor in Pharmacology at Gautam college of pharmacy, Hamirpur (H.P).

I am thankful to Dr. Sanjay Kumar, Associate Professor at Laureate College of Pharmacy, Kathog (H.P), for their support and encouragement.

I wish to thanks all the faculty members and my students.

I acknowledge the help and support of Ms. Samiksha Sharma, lab attender at Gautam College of Pharmacy, Hamirpur. Thanks! is a small word to God, my beloved parents and family. I pay tribute to my parent's thanks for their love, trust, patience, support and bearing all kinds of stress to make me what I am. It is indeed a difficult task to acknowledge the services of all those gentle people who have extended their valuable their valuable suggestion and support directly or indirectly whose names have been unable to mention as they are like the countless stars in the numerous galaxies.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Reference

[1] Kokwaro, J.O., *Medicinal plants of east Africa*. 1976: East African Literature Bureau.

[2] Handral, H.K., A. Pandith, and S. Shruthi, *A review on Murraya koenigii: multipotential medicinal plant.* Asian Journal of pharmaceutical and clinical research, 2012. 5(4): p. 5-14.

[3] Nayak, S., *Influence of Ethanol Extract of Vinca rosea on Wound Healing in Diabetic Rats.* OnLine Journal of Biological Sciences, 2006. 6(2).

[4] Scientific, C.o. and I. Research, *The Wealth of India: a dictionary of Indian raw materials and industrial products*. Vol. 9. 1972.

[5] Prajapati ND, P.S., Sharma AK, Kumar T. , *A Handbook of Medicinal Plants.* . 2003, Jodhpur: Agrobios.

[6] Narasimhan, N., M. Paradkar, and S. Kelkar, *Alkaloids of Murraya koenigii: structures of mahanine, koenine, koenigine and koenidine.* Indian Journal of Chemistry, 1970. 8: p. 473-4.

[7] Adebajo, A., et al., *Anti-trichomonal, biochemical and toxicological activities of methanolic extract and some carbazole alkaloids isolated from the leaves of Murraya koenigii growing in Nigeria.* Phytomedicine, 2006. 13(4): p. 246-254.

[8] Tachibana, Y., et al., *Comparison of Antioxidative Properties of Carbazole Alkaloids from Murraya koenigii Leaves.* Journal of agricultural and food chemistry, 2003. 51: p. 6461-7.

[9] Adebajo, A.C. and J. Reisch, *Minor furocoumarins of Murraya koenigii.* Fitoterapia, 2000. 71(3): p. 334-337.

[10] Ajay, S., et al., *Comprehensive review: Murraya koenigii Linn.* Asian J Pharm Life Sci, 2011. 2231: p. 4423.

[11] Gopalan, C., B. Rama Sastri, and S. Balasubramanian, *Nutritive value of Indian foods.* (No Title), 1971.

[12] Iyer, D. and U. Devi, *Phyto-pharmacology of Murraya koenigii (L.).* Pharmacognosy Reviews, 2008. 2(3): p. 180.

[13] Sumit, G., P.M. Paarakh, and G. Usha, *Isolation of phytoconstituents from the leaves of Murraya koenigii Linn.* Journal of Pharmacy research, 2009. 2(8): p. 1313-1314.

[14] Das Roy, M., *Taxonomy, distribution and morphology of two indigenous drugs Murraya paniculata and Murraya koenigii.* Spreng, Nagarjun, 1977. 20(9): p. 15.

[15] Khosa, R. and S. Prasad, *Pharmacognostical studies of leaf of Murraya koenigii and Murraya paniculata.* J. Res. Indian Med, 1972. 7(3): p. 78.

[16] Khosa, R. and S. Prasad, *Pharmacognosy of roots of Murraya koenigii and Murraya paniculata.* J. Res. Indian Med, 1974. 9(3): p. 105.

[17] Khosa, R., S. Sen, and S. Dixit, *Studies on Murraya paniculata.* Indian Journal of Pharmacy, 1970. 32(3): p. 65-66.

[18] Goutam, M. and R. Purohit, *Antimicrobial activity of the essential oil of the leaves of Murraya koenigii (Linn) Spreng (Indian curry leaf).* 1974.

[19] Bonde, S., et al., *Murraya koenigii (Curry leaf): Ethnobotany, phytochemistry and pharmacology-A review.* International Journal of Pharmaceutical and Phytopharmacological Research, 2011. 1(1): p. 23.

[20] Kumar, N.S., et al., *Acetylcholinesterase inhibitory potential of a carbazole alkaloid, mahanimbine, from Murraya koenigii.* Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 2010. 24(4): p. 629-631.

[21] Qais, F.A., et al., *Antibacterial effect of silver nanoparticles synthesized using Murraya koenigii (L.) against multidrug-resistant pathogens.* Bioinorganic chemistry and applications, 2019. 2019.

[22] Joshi, T., et al., *Pyranocarbazoles from Murraya koenigii (L.) Spreng. as antimicrobial agents.* Natural Product Research, 2018. 32(4): p. 430-434.

[23] Sathaye, S., et al., *Hepatoprotective effects of aqueous leaf extract and crude isolates of Murraya koenigii against in vitro ethanol-induced hepatotoxicity model.* Experimental and Toxicologic Pathology, 2011. 63(6): p. 587-591.

[24] Bashkatova, V., et al., *Chronic administration of rotenone increases levels of nitric oxide and lipid peroxidation products in rat brain.* Experimental Neurology, 2004. 186(2): p. 235-241.

[25] Nalli, Y., et al., *Four new carbazole alkaloids from Murraya koenigii that display anti-inflammatory and anti-microbial activities.* Organic & Biomolecular Chemistry, 2016. 14(12): p. 3322-3332.

[26] Yankuzo, H., et al., *Beneficial effect of the leaves of Murraya koenigii (Linn.) Spreng (Rutaceae) on diabetes-induced renal damage in vivo.* Journal of Ethnopharmacology, 2011. 135(1): p. 88-94.

[27] Patel, D., et al., *Natural medicines from plant source used for therapy of diabetes mellitus: An overview of its pharmacological aspects.* Asian Pacific Journal of Tropical Disease, 2012. 2(3): p. 239-250.

[28] Balakrishnan, R., et al., *Medicinal profile, phytochemistry, and pharmacological activities of Murraya koenigii and its primary bioactive compounds.* Antioxidants, 2020. 9(2): p. 101.

[29] Amna, U., et al., *Evaluation of cytotoxic activity from Temurui (Murraya koenigii [Linn.] Spreng) leaf extracts against HeLa cell line using MTT assay.* Journal of advanced pharmaceutical technology & research, 2019. 10(2): p. 51.

[30] Iman, V., et al., *Anticancer and anti-inflammatory activities of girinimbine isolated from Murraya koenigii.* Drug design, development and therapy, 2016: p. 103-121.

[31] Mani, V., et al., *Effects of the total alkaloidal extract of Murraya koenigii leaf on oxidative stress and cholinergic transmission in aged mice.* Phytotherapy Research, 2013. 27(1): p. 46-53.

[32] Mani, V., et al., *Protective effects of total alkaloidal extract from Murraya koenigii leaves on experimentally induced dementia.* Food and chemical toxicology, 2012. 50(3-4): p. 1036-1044.

[33] Balakrishnan, R., et al., *Isolongifolene attenuates oxidative stress and behavioral impairment in rotenone-induced rat model of Parkinson's disease.* International Journal of Nutrition, Pharmacology, Neurological Diseases, 2018. 8(2): p. 53-58.

[34] Zang, Y.-D., et al., *Total synthesis and neuroprotective effect of O-methylmurrayamine A and 7-methoxymurrayacine.* Journal of Asian Natural Products Research, 2017. 19(6): p. 623-629.

[35] Sharma, S., et al., *Anti-anxiety and anti-depressant like effects of Murraya koenigii in experimental models of anxiety and depression.* Ancient science of life, 2017. 36(4): p. 215.

[36] Patil, R., et al., *Protective effect of leaves of Murraya koenigii on reserpine-induced orofacial dyskinesia.* Iranian journal of pharmaceutical research: IJPR, 2012. 11(2): p. 635.

[37] Jain, M., et al., *Curry leaf (Murraya koenigii): A spice with medicinal property.* MOJ Biol Med, 2017. 2(3): p. 236-256.

[38] Nagappan, T., et al., *Efficacy of carbazole alkaloids, essential oil and extract of Murraya koenigii in enhancing subcutaneous wound healing in rats.* Molecules, 2012. 17(12): p. 14449-14463.

[39] Iyer, D. and D. Uma, *Effect of Murraya koenigii (L.) on radiation induced rate of lipid peroxidation in Swiss albino mice.* Indian Drugs, 2009. 46(2): p. 160.

[40] Jansen, P., *Curcuma longa L.* PROTA, 2005. 3.

[41] Agarwal, K.A., et al., *Efficacy of turmeric (curcumin) in pain and postoperative fatigue after laparoscopic cholecystectomy: a double-blind, randomized placebo-controlled study.* Surgical endoscopy, 2011. 25: p. 3805-3810.

[42] Ravindran, P., K.N. Babu, and K. Sivaraman, *Turmeric: the genus Curcuma*. 2007: CRC press.

[43] Das, K., *Chapter 95 - Turmeric (Curcuma longa) Oils*, in *Essential Oils in Food Preservation, Flavor and Safety*, V.R. Preedy, Editor. 2016, Academic Press: San Diego. p. 835-841.

[44] Kuroda, M., et al., *Hypoglycemic effects of turmeric (Curcuma longa L. rhizomes) on genetically diabetic KK-Ay mice.* Biological and Pharmaceutical Bulletin, 2005. 28(5): p. 937-939.

[45] Khajehdehi, P., et al., *Oral supplementation of turmeric decreases proteinuria, hematuria, and systolic blood pressure in patients suffering from relapsing or refractory lupus nephritis: a randomized and placebo-controlled study.* Journal of Renal Nutrition, 2012. 22(1): p. 50-57.

[46] Ganjali, S., et al., *Investigation of the effects of curcumin on serum cytokines in obese individuals: a randomized controlled trial.* The Scientific World Journal, 2014. 2014.

[47] Mishra, S. and K. Palanivelu, *The effect of curcumin (turmeric) on Alzheimer's disease: An overview.* Annals of Indian Academy of Neurology, 2008. 11(1): p. 13.

[48] Ringman, J.M., et al., *A potential role of the curry spice curcumin in Alzheimer's disease.* Current Alzheimer Research, 2005. 2(2): p. 131-136.

[49] Rahimnia, A.-R., et al., *Impact of supplementation with curcuminoids on systemic inflammation in patients with knee osteoarthritis: findings from a randomized double-blind placebo-controlled trial.* Drug research, 2014: p. 521-525.

[50] Allegra, A., et al., *Anticancer activity of curcumin and its analogues: preclinical and clinical studies.* Cancer investigation, 2017. 35(1): p. 1-22.

[51] Khosropanah, M.H., et al., *Analysis of the antiproliferative effects of curcumin and nanocurcumin in MDA-MB231 as a breast cancer cell line.* Iranian journal of pharmaceutical research: IJPR, 2016. 15(1): p. 231.

[52] Liang, Z., et al., *Effects of curcumin on tobacco smoke-induced hepatic MAPK pathway activation and epithelial–mesenchymal transition in vivo.* Phytotherapy Research, 2017. 31(8): p. 1230-1239.

[53] Lee, W.-H., et al., *Recent advances in curcumin nanoformulation for cancer therapy.* Expert opinion on drug delivery, 2014. 11(8): p. 1183-1201.

[54] Davatgaran-Taghipour, Y., et al., *Polyphenol nanoformulations for cancer therapy: experimental evidence and clinical perspective.* International journal of nanomedicine, 2017: p. 2689-2702.

[55] Goel, A. and B.B. Aggarwal, *Curcumin, the golden spice from Indian saffron, is a chemosensitizer and radiosensitizer for tumors and chemoprotector and radioprotector for normal organs.* Nutrition and cancer, 2010. 62(7): p. 919-930.

[56] Inano, H. and M. Onoda, *Radioprotective action of curcumin extracted from Curcuma longa LINN: inhibitory effect on formation of urinary 8-hydroxy-2′-deoxyguanosine, tumorigenesis, but not mortality, induced by γ-ray irradiation.* International Journal of Radiation Oncology* Biology* Physics, 2002. 53(3): p. 735-743.

[57] Li, H., et al., *Protective effect of curcumin against acute ultraviolet B irradiation-induced photo-damage.* Photochemistry and Photobiology, 2016. 92(6): p. 808-815.

[58] Anand, P., et al., *Bioavailability of curcumin: problems and promises.* Molecular pharmaceutics, 2007. 4(6): p. 807-818.

[59] Lao, C.D., et al., *Dose escalation of a curcuminoid formulation.* BMC complementary and alternative medicine, 2006. 6(1): p. 1-4.

[60] Schiborr, C., et al., *The oral bioavailability of curcumin from micronized powder and liquid micelles is significantly increased in healthy humans and differs between sexes.* Molecular nutrition & food research, 2014. 58(3): p. 516-527.

[61] Prasad, S., et al., *Curcumin, a component of golden spice: from bedside to bench and back.* Biotechnology advances, 2014. 32(6): p. 1053-1064.

[62] Patil, B.S., et al., *Bioactive compounds: historical perspectives, opportunities, and challenges.* Journal of agricultural and food chemistry, 2009. 57(18): p. 8142-8160.

[63] Deogade, S.C. and S. Ghate, *Curcumin: therapeutic applications in systemic and oral health.* Int J Biol Pharm Res, 2015. 6(4): p. 281-90.

[64] Gupta, S.C., G. Kismali, and B.B. Aggarwal, *Curcumin, a component of turmeric: from farm to pharmacy.* Biofactors, 2013. 39(1): p. 2-13.

[65] Pratondo, A., E. Elfahmi, and A. Novianty, *Classification of Curcuma longa and Curcuma zanthorrhiza using transfer learning.* PeerJ Computer Science, 2022. 8: p. e1168.

[66] Sirirugsa, P., K. Larsen, and C. Maknoi, *The genus Curcuma L.(Zingiberaceae): distribution and classification with reference to species diversity in Thailand.* Gard Bull Sing, 2007. 59(2): p. 203-220.

[67] Goel, A., A.B. Kunnumakkara, and B.B. Aggarwal, *Curcumin as "Curecumin": from kitchen to clinic.* Biochemical pharmacology, 2008. 75(4): p. 787-809.

[68] Satyavati, G., M. Raina, and M. Sharma, *Medicinal plants of India*. Vol. 2. 1987: Indian Council of Medical Research.

[69] Ravindranath, V. and M. Satyanarayana, *An unsymmetrical diarylheptanoid from Curcuma longa.* Phytochemistry, 1980. 19(9): p. 2031-2032.

[70] Gunnars, K., Proven Health Benefits of Turmeric and Curcumin,". 2021.

Author's short Biography

	**Priya Thakur**, a student of Gautam College of Pharmacy, Hamirpur (H.P.). She played a role in constructing an idea for the research.
	**Sahil Thakur,** a student of Gautam College of Pharmacy, Hamirpur (H.P.). He took the responsibility of data management and reporting.
	**Kajal,** a student of Gautam College of Pharmacy, Hamirpur (H.P.). She was responsible for the experiment execution and data reporting.

	**Shivam Thakur** is a student of Gautam College of Pharmacy, Hamirpur (H.P.). He was responsible for conducting literature search and construction of substantial parts of manuscripts.
	**Mohit Sharma** is a student of Gautam College of Pharmacy, Hamirpur (H.P.). He was in charge of creating significant portions of manuscripts and searching the literature**.**
	**Kumari Varsha** holds the position of Assistant Professor, at Gautam College of Pharmacy, Hamirpur (H.P.). As the designated guide, she was responsible for developing the concept and organizing the steps that would lead to the outcome.
	**Sunaina Dhiman** holds the position of Assistant Professor, at Gautam College of Pharmacy, Hamirpur (H.P.). She was in charge of planning and directing the project's duration as the co-guide.
	**Sunil Kumar** holds the position of Assistant Professor, at Gautam College of Pharmacy, Hamirpur (H.P.). He assumed responsibility for the results' logical interpretation and presentation.