INTRODUCTION
Ointments are topical formulations that offer better patient compliance and hence become more acceptable to patients. It is a semisolid dosage form that contains < 20% water and volatiles and > 50% hydrocarbons, waxes or polyethylene glycols as the vehicle for external application to the skin. Ointments are used topically for several purposes, e.g., as protectant, antiseptics, emollients, antipruritic, kerotolytic, and astringents. Plants had been used for medicinal purposes long before recorded history. According to survey report by WHO, about 25 per cent of prescribed human medicines are derived from plants and 80 per cent people still depend on traditional system of medicines. The World Health Organization (WHO) has appreciated the importance of medicinal plants for public health care in developing nations and has evolved guidelines to support the member states in their efforts to formulate national policies on traditional medicine and to study their potential usefulness including evaluation, safety, and efficacy.

Figure 1: Leaf of Moringa oleifera
Herbal medicine, also called botanical medicine or phytomedicine, refers to the use of any plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. Long practiced outside of conventional medicine, herbalism is becoming more main stream an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial Share Alike 4.0 License which permits unrestricted non commercial use, provided the original work is properly cited
up-to-date analysis and research shows their value in the treatment and prevention of disease\textsuperscript{6}.

**Figure 2: Moringa oleifera leaf powder**

*Moringa oleifera* is one of the vegetables of the Brassica order and belongs to the family Moringaceae. *Moringa* trees have been used to combat malnutrition, especially among infants and nursing mothers\textsuperscript{7}. *Moringa oleifera* is a small native tree of the sub-Himalayan regions of North West India, which is now indigenous to many regions in West India, Africa, Arabia, South East Asia, Islands and South America\textsuperscript{8}. Traditionally, besides being a daily used vegetable among people of these regions, the Moringa is also widely known as ‘the miracle tree’ and used for its abilities for various ailments and even some chronic diseases including anaemia, skin infections, blackheads, anxiety, bronchitis, catarrh, chest congestion, asthma, blood impurities, cholera, glandular, swelling, headaches, conjunctivitis, cough, diarrhea, eye and ear infections, fever, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation, diabetes and pregnancy\textsuperscript{9}. The healing properties of Moringa oil have been documented by ancient cultures. Moringa oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. Moringa oil has been used in skin preparations and ointments since Egyptian times. Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce. They contain high amount of vitamin C, vitamin A, calcium, potassium, and proteins, the basic building blocks of all our body cells. Another important point is that *Moringa oleifera* leaves contain all of the essential amino acids in a good proportion, which are the building blocks of proteins\textsuperscript{10}. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Leaves were also used for food fortification. Spoonful of the powder can then be added to baby food, soups, and vegetables, adding nutrition but not changing the taste.

The delivery of drug through the skin has long been a promising concept because of the ease of access, large surface area, vast exposure to the circulatory and lymphatic networks and non-invasive nature of the treatment. In present study four different ointment formulations of *Moringa oleifera* were prepared and evaluated for different parameters\textsuperscript{11}.

**MATERIALS AND METHODS**

Fresh leaves of *Moringa oleifera* was collected from local Area Buldana, Maharashtra, India and transported to laboratory, authenticated from Center for Biodiversity Jijamata Mahavidyalaya, Buldana, Maharashtra, India.

**Extraction of Plant Material**

Collected leaves are washed in running tap water till the removal of dirt. After this leaves are soaked in 1% saline solution (NaCl) for 5 minutes to remove microbes. Leaves are further washed with 70 % ethanol followed by twice washing with distilled water. This step plays a substantial role in removal of dust, pathogens as well as microbes present on the leave surface. The excess water can be removed by spreading the leaves in sunlight for a brief period till the removal of water present on the leaf surface\textsuperscript{12-15}. The leaves (1 kg) were crushed with little amount of water to obtain the leaf juice. The leaf juice was filtered through a muslin cloth and later through Whatman filter paper to obtain a greenish brown juice. The juice was shade dried and a little amount of absolute alcohol was added to the juice to prevent the growth of microorganisms. The dried leaf juice was collected as a brown colored powder (about 30 g). It was refluxed at 50°C for 5-6 hours with absolute alcohol. The alcohol fraction was separated from the residue and dried to obtain the alcoholic fraction of *Moringa oleifera* leaf juice.

**Preparation of Ointment**

Four topical ointment formulations were prepared by means of different ingredients as shown in Table 1. The constituents of the base were placed together in a melting pan and allowed to melt together at 70°C. After melting, the ingredients were stirred gently maintaining temperature of 70°C for about 5 minutes and then cooled with continuous stirring. Formulation of ointment was done by incorporating 10 % w/w of the semisolid extract of *Moringa oleifera* into the various bases by triturating in a ceramic mortar with a pestle to obtain 100g of herbal ointments containing 10 % w/w of *Moringa oleifera*. The prepared herbal ointments were put in ointment jars, labelled and were stored at room temperature pending the evaluation\textsuperscript{16-18}.

| Table 1: Composition of *Moringa oleifera* ointment formulations |
|---------------------------------------------------------------|
| Ingredients (% w/w) | Formulation code |
|----------------------|------------------|
| Extract              | F1   | F2   | F3   | F4   |
| Cetostearyl alcohol  | 5    | 5    | -    | -    |
| Chlororesol          | -    | -    | 5    | 5    |
| Wool fat             | -    | 5    | 5    | -    |
| Liquid Paraffin      | 20   | 20   | -    | -    |
| Hard Paraffin        | 5    | -    | -    | 5    |

**EVALUATION OF FORMULATIONS**

Prepared *Moringa oleifera* ointment formulations were evaluated for the following parameters.

1. Organoleptic Parameters

*Moringa oleifera* ointment formulations were evaluated based on their appearance, texture and consistency.
Texture was determined on the basis of grittiness/smoothness. Texture was found to be smooth; it can be spreadable and washable easily.

2. **pH**
Total 2.5gm *Moringa oleifera* ointment formulations of each batch was taken in 100 ml dry beaker, 50 ml water was added to it. Beaker was heated on water bath maintained at about 60°C to 70°C for 10 minutes, cooled to room temperature, and then centrifuged at 3000 rpm for 10 minutes. The pH of water extract was measured using pH meter. The pH measurements were done by using a digital type pH meter by dipping the glass electrode into the ointment formulation.

3. **Spreadability**
The spreadability is expressed in terms of time in seconds taken by two slides to slip off from ointment, placed in between two slides under the direction of certain load. Lesser the time taken for separation of two slides, better the spreadability of ointment. Spreadability of *Moringa oleifera* ointment formulations was determined by using the formula:

\[ S = \frac{M \times t}{L} \]

Where S = spreadability, M = Weight tied to upper slide, L = Length of glass slides and T = Time taken to separate the slides.

4. **Viscosity**
The measurement of viscosity of prepared ointments was carried out with Brookfield Viscometer (model LV-DV-II, Helipath spindle type S-96). The values of each *Moringa oleifera* ointment formulation were done in triplicate.

5. **Extrudability**
Extrudability test is the measure of the force required to extrude the material from a collapsible tube when certain amount of force has been applied on it in the form of weight. In the present study the quantity in percentage of ointment extruded from the tube on application of certain load was determined. The extrudability of prepared *Moringa oleifera* ointment formulations was calculated by using following formula:

\[ \text{Ext.} = \frac{\text{Amount of ointment extruded from the tube} \times 100}{\text{Total amount of ointment filled in the tube}} \]

6. **Loss on drying**
The loss in weight, in the sample so tested, principally is due to loss of water and small amount of other volatile material from it. Loss on drying was determined by placing the 1gm of *Moringa oleifera* ointment formulations of different batches in a petri dish on a water bath and dried until constant weight was obtained.

7. **Centrifugation**
It is believed to be a unique tool for the evaluation of accelerated deterioration of ointments. It was determined by using Remi centrifuge in 10ml graduated cylinder at 10,000 rpm for 10 min.

8. **Washability**
*Moringa oleifera* ointment formulations were applied on the skin and then ease extend of washing with water was checked. Washability was checked by keeping applied skin area under the tap water for about 10 min.

9. **Stability study**
*Moringa oleifera* ointment formulations were evaluated for their stability at an ambient condition of pressure and temperature for two weeks. Formulations were observed for phase separation and particle agglomeration.

10. **Acute skin irritation study**
This test was performed on albino rats weighing between 150-200g. The animals were given standard animal feed and had free access to water ad libitum. The total mass was separated into four groups, each batch containing five animals. Dorsal hair at the back of the rats were removed one day prior to the commencement of the study and kept individually in cages to avoid contact with the other rats. Two groups of each were used for control and standard irritant. Other two groups were used as test. The 50mg of *Moringa oleifera* ointment formulations were applied over one square centimeter area of whole and abraded skin to different animals. Aqueous solution of 0.8 % formalin was used as standard irritant. The animals were observed for seven days for any signs of oedema and erythema.

**RESULTS AND DISCUSSION**

Four different ointment formulations were prepared using *Moringa oleifera* extract in different ratio (Table 1). All formulations were found to be free of grittiness, homogeneous, without phase separation with green colour with a smooth homogeneous texture and glossy appearance (Table 2). The mechanical evaluation parameters are important tests to evaluate pharmaceutical ointment formulations. Formulations complied with the physical evaluation parameters like pH, physical stability, centrifugation, viscosity, spreadability, extrudability was found to be acceptable.

![Figure 3: Moringa oleifera ointment formulation of batch F1](Image)

The pH of the formulations was in the range of 5.5 to 6.5, which lies in the normal pH range of the skin and would not produce any skin irritation. There was no significant change in pH values as a function of time for all formulations. Loss on drying was determined by placing the 1gm of *Moringa oleifera* ointment formulations was found to be in the range of 20-38%. The results of viscosity gives an idea about measurement of strength and the result of spreadability denote the extent of area to which the prepared formulations readily spreads on application to skin or affected part and homogeneity confirms no lumps. Viscosity of the ointment formulations was in the range of 32.21±0.51 to 35.3±0.4.
As per results of spreadability studies, the spreading area was found to decrease with increase in viscosity, as spreadability and viscosity are inversely proportional. All the formulations did not produce any skin irritation, i.e. erythema and oedema for about a week when applied over the skin. All formulations were found to be safe for clinical practice. No phase separation was observed during centrifugation among all ointment formulations. Formulations were found to be stable at different temperature i.e. 20°C, 25°C, 37°C.

Table 2: Evaluation of Formulation

| Parameters         | F1            | F2            | F3            | F4            |
|--------------------|---------------|---------------|---------------|---------------|
| Colour             | Green         | Green         | Green         | Green         |
| Odour              | Characteristic| Characteristic| Characteristic| Characteristic|
| Consistency        | Soft semisolid| Soft semisolid| Soft semisolid| Soft semisolid|
| Viscosity (cps)    | 34.5±0.8      | 35.3±0.4      | 33.5±0.21     | 32.21±0.51    |
| pH                 | 5.5           | 6.5           | 5.0           | 5.6           |
| Spreadability (sec)| 9             | 10            | 8             | 7             |
| Extrudability (gm) | 0.5           | 0.4           | 0.9           | 0.8           |
| Centrifugation     | No phase      | No phase      | No phase      | No phase      |
| Loss on drying     | 20%           | 35%           | 38%           | 25%           |
| Washability        | Good          | Good          | Good          | Good          |
| Non irritancy      | Non irritant  | Non irritant  | Non irritant  | Non irritant  |
| Stability study    | Stable        | Stable        | Stable        | Stable        |

CONCLUSION

Since ancient time, herbs plays major role in the treatment because of less side effects, low cost and easy availability. The Morenga oleifera leaves extract was used to formulate four different ointment formulations with different bases like cetostearyl alcohol, hard paraffin, and liquid paraffin. Formulations evaluated for physical parameters and standardize as per pharmacopoeial standards. The results of the physical evaluation of ointment preparations with extract of Morenga oleifera leaves indicated the suitability of method for the production of ointments. Further investigations are necessary to determine the therapeutic efficiency of the prepared Morenga oleifera ointment formulations.

AUTHOR'S CONTRIBUTION

The manuscript was carried out, written, and approved in collaboration with all authors.

CONFLICT OF INTEREST

No conflict of interest is associated with this work.

REFERENCES

1. Rajasree PH, Vishwanad V, Cherian M, Eldhose J, Singh R. Int J Pharm Life Sci 2012; 3(10):2021-31. https://doi.org/10.3126/kaset.v6i1.3317

2. Khandelwal KR, Sethi V. Practical Pharmacognosy, Techniques and experiments, 23rd Edition, Publisher: Nirali Prakashan, New Delhi; 2013. 3:1.5-3.5.

3. Elsaied HE, Dawaba HM, Ibrahim EA, Afouna MI. Investigation of proniosomes gel as a promising carrier for transdermal delivery of Glimepiride, Univ J Pharm Res. 2016; 1(2): 1-18. https://doi.org/10.22270/ajpr.v1i2.81

4. Verma AR, Vijayakumar M, Mathela CS. In-vitro and in-vivo antioxidant properties of different fraction of Moringa oleifera leaves. Food and Chem Toxicol 2009; 47: 2196-201. https://doi.org/10.1016/j.fct.2009.06.005

5. Mishra SP, Singh P, Singh S. Nutritional and medicinal value of Moringa oleifera leaves: Potential and Prospects. Forestry Bulletin 2011; 11(1):46-58.

6. Duke JA. Moringaceae: Horseradish-tree, benzolive-tree, drumstick-tree, sohnja. Moringa, murunga-kai, malunggay.. 19-28. In: M. Benge (ed.) Moringa: A multipurpose vegetable and tree that purifies water. Sci Tech Environ and Natural Resources Agro-Forestation Tech. Ser. 27. US AID, Washington, D.C., 1987

7. Fuglie LJ. The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. Church World Service, Dakar. 68.; revised in 2001 and published as The Miracle Tree: The Multiple Attributes of Moringa. 1999, 172.

8. Manzoor M, Anwar F, Iqba T, Bhanger MI. Physico-chemical characterization of Moringa concanensis seeds and seed oil. J Am Oil Chem. Soc. 2007; 84: 413-419. https://doi.org/10.1007/s11746-007-2155-3

9. Morton JF. The Horseradish tree, Moringa pterygosperma (Moringaceae)- A boon to arid lands. Econ Bot 1991; 45: 318-333.

10. Tende JA, Ezekiel I, Dikko AAU. Effect of ethanolic leaves extract of Moringa oleifera on blood glucose levels of streptozocin-induced diabetics and normoglycemic Wistar rats. British J Pharmacol Toxicol 2011; 2:1-4.

11. Purwal L, Pathak AK, Jain UK. In vivo anticancer activity of the leaves and fruits of Moringa oleifera on mouse melanoma. Pharmacologyonline 2010; 1: 655-665. https://doi.org/10.1155/2018/1071243

12. Dangi S, Jolly C, Narayanani S. Antihypertensive activity of total alkaloids from the leaves of Moringa oleifera. Pharm Biol 2002; 40:144-50. https://doi.org/10.1076/phbi.40.2.144.5847

13. Ghani S, Nwobodo E, Ofili JO. Hypcholesteremic effects of crude extract of leaf of Moringa oleifera Lamn in high fat diet fed Wister rats. J Ethnopharmacol 2000; 69:21-5. https://doi.org/10.1016/s0378-8741(99)00106-3

14. Groenwegen WA, Hepstinstall S. A comparison of the effects of an extract of feverfew and parthenolide, a component of feverfew, on human platelet activity in vitro. J Pharm Pharmacol 1990; 42:553-7. https://doi.org/10.1111/j.1366-0475.1990.tb07057.x

15. Asian livestock. Review of traditional veterinary medicines vol. VI (4): 33 summarized report RAPA 43. A preliminary study on traditional system of veterinary medicine, 1980. https://doi.org/10.2875/501044

16. Steinhaus KH, Pederson CS, Nellis LF, Cullen RE. Hand book of indigenous fermented foods. Marcel Dekar inc. New York, 1995.
17. Chatterjee A, Pakrgshi CA. The Treatise on Indian Medicinal plants, 1994;1,98.
18. Kritikar KR, Basu BD, Indian Medicinal plants, 2nd ed. 1993; vol. 1, 66.
19. Burd A, Huang L. Carbohydrates and cutaneous wound healing. Carbo. Chem. 2008; 17:253-27. PMID: 19274069
20. Saifullahi U, Onyekachi MK. Development and evaluation of transdermal gel of Lornoxicam. Univ J Pharm Res 2017; 2(1): 17-20. https://doi.org/10.22270/ujpr.v2i1.R4
21. Mehta NJ, Patadiya ND, Patel J. Development and Evaluation of Antiarthritic Herbal Ointment. Res J Pharm, Biol Chem Sci 2013; 4(1), 221-228. https://doi.org/10.3126/kusett.v6i1.3317
22. Rajasree PH, Vishwanad V. Formulation and evaluation of antiseptic polyherbal ointment. Int J Pharm Life Sci 2012; 3(10), 2021-2031.
23. Mhatre J, Nagaral S, Kulkarni S. Formulation and evaluation of antibacterial activity of herbal ointment prepared from crude extracts of Aegle marmelos, (bael). Int J Pharmacy Pharm Sci 2014; 2:575-579. https://doi.org/10.1155/2016/5754349
24. Majumder P, Majumder S. Preparation and characterization of some herbal ointment formulations with evaluation of antimicrobial property. Indian J Research Pharm Biotech 2013; 1(3), 385-390.
25. Aukunuru J, Bonepally C. Preparation, characterization and optimization of ibuprofen ointment intended for topical and systemic delivery. Trop J Pharm Res 2007; 6(4), 855-860. https://doi.org/10.4314/tjpr.v6i4.14670
26. Rajalakshmi G, Damodharan N. Formulation and evaluation of clotrimazole and ichthammol ointment. Int J Pharm Bio Sciences 2010; 1(4):P7-P15.
27. Nimbekar TP, Bhave PG, Wanjari BE. Formulation and evaluation of some framycetin sulphate ointment. Int J Pharma and Bio Sci 2012; 3(2), 327-332. https://doi.org/10.1.1.588.5359