



“HIBISCUS FLOWER EXTRACT AS A NATURAL HAIR GROWTH STIMULANT: A COMPREHENSIVE REVIEW OF MECHANISM AND APPLICATION”

Rahul Kumar^[1*], Sunil Chandra Bhatt^[2], Vivek Pandey^[3], Pushkar Rana^[4], Shweta Rawat^[5]

^{1*}Department of Pharmacology, Six sigma institute of technology and science jafarpur- Dineshpur road, Khanpur purab, Rudrapur, Uttarakhand 263153

²Department of Pharmacology, Six sigma institute of technology and science jafarpur- Dineshpur road, Khanpur purab, Rudrapur, Uttarakhand 263153

³Department of Pharmacology, Six sigma institute of technology and science jafarpur- Dineshpur road, Khanpur purab, Rudrapur, Uttarakhand 263153

⁴Department of Pharmacology, Six sigma institute of technology and science jafarpur- Dineshpur road, Khanpur purab, Rudrapur, Uttarakhand 263153

⁵Assistant professor, Six sigma institute of technology and science jafarpur- Dineshpur road, Khanpur purab, Rudrapur, Uttarakhand 263153

ABSTRACT

The phytochemical richness and therapeutic qualities of Hibiscus flower extract (*Hibiscus rosa-sinensis*) have made it a popular natural treatment for hair growth in recent years. The fundamental processes through which hibiscus extracts stimulate the anagen (growth) phase, inhibit the activity of the 5-alpha-reductase enzyme, and increase the proliferation of keratinocytes and dermal papilla cells are all thoroughly examined in this review. Antioxidants and anti-inflammatory properties also protect hair follicles from oxidative stress, and improved blood flow and nutrient delivery to the scalp support healthy hair in general. Hibiscus's potential as a flexible and long-lasting remedy for hair loss issues is demonstrated by its use in both conventional and contemporary formulations, including oils, shampoos, and topical treatments. Further research is necessary to resolve problems with large-scale production, safety, and standardization for its efficiency. Hibiscus flower extract has the potential to be a safe, natural, and scientifically supported technique of stimulating hair growth, as this review highlights.

Keywords : *Hibiscus rosa-sinensis*, hair growth, phytochemicals, 5-alpha-reductase inhibition, keratinocyte proliferation, antioxidants, topical applications, natural hair care

INTRODUCTION

A widely known herb in traditional medicine, hibiscus (*Hibiscus rosa-sinensis*) is well known for its hair care properties. Bioactive substances like flavonoids, anthocyanins, and mucilage [1] are abundant in hibiscus flowers and leaves. These substances nourish the scalp, encourage hair growth, and stop hair loss. Its moisturizing qualities enhance the texture and manageability of hair, and its antimicrobial and antioxidant qualities support the health of the scalp [2]. The herb *Hibiscus rosa-sinensis* Linn belongs to the family Malvaceae is a glabrous shrub widely cultivated in the tropics as an ornamental plant and has several forms with varying colours of flowers [3]. The role of Hibiscus extract in stimulating hair growth by enhancing follicular health and prolonging the anagen (growth) phase of the hair cycle [4]. Hair follicles obtain blood flow to the brain from its flavonoids and saponins, and mucilage protection hair from dehydrating out and splitting. Be that dandruff and other scalp infections can be controlled with the extract's antimicrobial activity [5].



Fig. 1: *Hibiscus sabdariffa*

BOTANICAL CHARACTERISTICS

Vernacular Names

Eng. - Shoe-flower plant, Chinese Hibiscus.

Hindi - Jasut, Jasum, Java, Odhul, Gurhal, Arahul.

Mar. - Jasavanda, Jassvandi.

Sanskrit - Japa, Java, Rudrapuspa [6, 7]

Morphology

The shrub *Hibiscus rosa-sinensis* is bushy and evergreen, grows to a height of 1 to 5 meters [8]. It has simple, lobed, glossy, dark green leaves with marked palmate vascular bundles and sharpened margins. With five petals that are commonly wrinkled or curled, the flowers are big, colorful, and up to 15 centimeters in diameter [9]. The flowers can have a wide range of colors, including pink, yellow, white, and red [10]. Their centers are commonly contrasting.

Taxonomical classification

Table 1: Taxonomical classification of *Hibiscus rosa-sinensis*

Botanical name	<i>Hibiscus rosa sinensis</i> Linn.
Kingdom	Plantae
Subkingdom	Trachibionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Malvales
Family	Malvaceae
Genus	<i>Hibiscus</i>
Species	<i>rosa sinensis</i>

[11, 12, 13, 14, 15]

Geographical source

Hibiscus rosa sinensis, originating in East Asia [16], *Hibiscus rosa sinensis* is cultivated for decorative purpose and has become widely distributed in tropical and subtropical areas because of its ability to survive warm temperatures [17]. It is a warm-climate plant that was introduced to the southern United States [18]. Because of its hardiness and colorful flowers, it is also a popular ornamental shrub in Australia and is widely used in African herbal traditions [19]. It is grown from sea level to a height of 500 meters. Fertile, well-drained soil with a high amount of organic matter is ideal for growing [20].

PHYTOCHEMISTRY

Table 2: Phytochemical composition of *Hibiscus rosa-sinensis*

Phytochemical	Plant Part	Biological Effect	References
Flavonoids (Quercetin, Kaempferol)	Flowers	Antioxidant, anti-inflammatory	[21], [22], [23]
Anthocyanins (Cyanidin derivatives)	Petals	Colorant, antioxidant	[24], [25]
Saponins	Leaves, Flowers	Antimicrobial, immunomodulatory	[26], [27]
Phenols	Leaves, Flowers	Antioxidant, antibacterial	[26], [28]
Tannins	Leaves, Flowers	Antimicrobial, astringent	[29], [30]
Alkaloids	Roots, Leaves	Analgesic, anti-inflammatory	[31]

Fatty Acids	Seeds	Emollient, skin-nourishing	[27], [30]
Glycosides	Leaves, Flowers	Cardioprotective, antimicrobial	[32], [33]
Proteins	Flowers	Nutritional, skin-conditioning agent	[34]
Vitamin C	Flowers	Antioxidant, promotes collagen synthesis	[30], [32]

MECHANISMS OF ACTION IN HAIR GROWTH STIMULATION

Hibiscus rosa-sinensis's active ingredients, flavonoids and tannins, enhance the anagen phase of the hair growth cycle [35]. Strengthening hair follicle cell proliferation, promoting hair strand elongation, and increasing follicular activity are the methods used to achieve the above [36]. Hibiscus rosa-sinensis contains compounds that block 5-alpha-reductase, an enzyme that changes testosterone into dihydrotestosterone (DHT). Particularly in androgenetic alopecia, high DHT levels are linked to hair follicle shrinkage and hair loss [37]. Hibiscus rosa-sinensis extracts exhibit strong antioxidant and anti-inflammatory effects [38]. These characteristics promote a healthier scalp environment that supports hair growth by protecting hair follicles from oxidative stress and inflammatory damage [39]. The extracts from the flowers and leaves increase the scalp's microcirculation, which ensures that hair follicles receive the best potential nutrition and oxygen. Stronger and thicker hair strands are supported by this stimulation of follicular activity [40]. Extracts from Hibiscus rosa-sinensis promote the growth of keratinocytes and dermal papilla cells [41], which are essential for the formation of hair shafts and for securing hair in follicles. Hair strength and density are increased as a result of these effects [42].

THERAPEUTIC PROPERTIES OF HIBISCUS ROSA-SINENSIS SUPPORTING HAIR HEALTH

Antioxidant Activity

Hibiscus rosa-sinensis contains many beneficial components. Antioxidant-rich flavonoids and polyphenols, such as quercetin and anthocyanins, are rich in it [43]. They are helpful in the fight against free radicals and inflammation. This is important because it protects hair follicles from damage and stress [44], which can lead to aging and hair loss. Researchers are considering using hibiscus for hair and scalp care because of these advantages [45].

Antimicrobial Effects:

The antibacterial qualities of saponins, flavonoids, and tannins are part of hibiscus' phytochemical composition [46]. These substances support a healthy scalp environment and fight against microorganisms that cause dandruff. Hibiscus is a useful component for avoiding scalp infections because studies have shown how well it reduces microbial activity [47].

Anti-Inflammatory Properties:

The antibacterial qualities of saponins, flavonoids, and tannins are part of hibiscus' phytochemical composition [46]. These substances support a healthy scalp environment and fight against microorganisms that cause dandruff. Hibiscus is a useful component for avoiding scalp infections because studies have shown how well it reduces microbial activity [47].

Hydration and Conditioning:

As a natural conditioner, hibiscus mucilage helps hydrate hair, making it softer and shinier [50]. When added to shampoo and conditioner formulations, studies have demonstrated its efficacy in enhancing hair texture and moisture retention [51, 52].

SAFETY AND TOXICITY ASPECTS OF HIBISCUS EXTRACTS

Commonly made from Hibiscus sabdariffa, hibiscus extracts are generally accepted to be safe when used in moderation. Hibiscus calyx extracts have been shown in animal experiments to have minimal acute and sub-acute toxicity profiles [53]. Rats' long-term toxicity tests have revealed no appreciable negative effects, indicating its general safety for use in food and medicine [54]. There aren't many worries about hypersensitivity or allergic reactions when hibiscus extracts are applied topically for scalp and hair care [55]. Nonetheless, certain occurrences of allergic contact dermatitis have been documented in people who are susceptible to the plant's flavonoids or anthocyanins [56]. For users with known plant allergies, patch testing and close observation are advised [57]. According to studies, in order to prevent irritation and attain the intended effectiveness, topical formulations containing hibiscus should maintain ideal concentrations of 2-5% of active extracts [58]. Sensitive people may get irritated by higher amounts, particularly if they are administered frequently without adequate formulation balancing [59].

CONCLUSION

Because of its many different modes of action, hibiscus flower extract (Hibiscus rosa-sinensis) has immense potential as a natural hair growth stimulator. The extract's effectiveness in treating hair loss and encouraging regeneration is supported by its capacity to induce the anagen phase, suppress 5-alpha-reductase activity, and increase keratinocyte and dermal papilla cell proliferation. Hair follicles are additionally shielded from oxidative stress and inflammatory damage by their strong antioxidant and anti-inflammatory qualities, which promote healthy hair development. Hibiscus extract's applicability in both conventional and contemporary hair care systems is highlighted by its versatility in a range of formulations, such

as oils, shampoos, and serums. Notwithstanding its many advantages, there are still issues, such as inconsistent active component concentrations, a lack of extensive clinical trials, and the standardization of extraction procedures. The optimal usage of hibiscus extract in hair care products will be made possible by filling in these gaps with more research and regulatory frameworks. This thorough analysis encourages more research into the uses of hibiscus flower extract in dermatology and cosmetology by highlighting its potential as a natural, sustainable, and efficient substitute for treating hair loss and improving hair health.

REFERENCES

1. Adhirajan N, Kumar TR, Shanmugasundaram N, Babu M. In vivo and in vitro evaluation of hair growth potential of *Hibiscus rosa-sinensis* Linn. *Journal of Ethnopharmacology* [Internet]. 2003 Sep 3;88(2–3):235–9.
2. Missoum A. An update review on *Hibiscus rosa sinensis* phytochemistry and medicinal uses. *Journal of Ayurvedic and Herbal Medicine* [Internet]. 2018;3–3:135–46.
3. Jadhav VM, Thorat RM, Kadam VJ, Sathe NS. *Hibiscus rosa sinensis* Linn– “Rudrapuspa”: a review. *J Pharm Res*. 2009 Jul;2(7):1168–73.
4. L. C. Tapsell, I. Hemphill, L. Cobiac, C. S. Patch, D. R. Sullivan, M. Fenech, S. Roodenrys, J. B. Keogh, P. M. Clifton, P. G. Williams and V. A. Fazio, Health benefits of herbs and spices: the past, the present, the future, *Med. J. Aust.* 185(4) (2006), S4-24.
5. P. K. Lai and J. Roy, Antimicrobial and chemopreventive properties of herbs and spices, *Current Medicinal Chemistry* 11(11) (2004), 1451-1460.
6. Joshi, S. G., *Medicinal Plants*, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi; 2004, 255.
7. Gupta, A. K., Tandon, N., Sharma, M., *Quality Standards of Indian Medicinal Plants, Vol-2*, Indian Council of Medical Research, New Delhi, 2005, 130.
8. El-Kader, M. A., Elabbasy, M., Adeboye, A. A., Zeairya, M. G., & Menazea, A. (2021). Morphological, structural and antibacterial behavior of eco-friendly ZnO/TiO₂ nanocomposite synthesized via *Hibiscus rosa-sinensis* extract. *Journal of Materials Research and Technology*, 15, 2213–2220.
9. Chin Hoong Fong, “Introduction,” in *The Hibiscus: Queen of Tropical Flowers* (Kuala Lumpur: Tropical Press, 1986), 2–3. (Call no. RCLOS 635.93317 CHI)
10. Kim MS, Kim JK, Kim HJ, Moon SR, Shin BC, Park KW, Yang HO, Kim SM, Park R. Hibiscus extract inhibits the lipid droplet accumulation and adipogenic transcription factors expression of 3T3-L1 preadipocytes. *The Journal of Alternative & Complementary Medicine*. 2003 Aug 1;9(4):499-504.
11. Gilman, E. F. (1999). *Hibiscus rosa-sinensis: Tropical Hibiscus*. Available on University of Florida's IFAS Extension
12. Tapkir, S. A. & Dattakala shikshan Sanstha's, institute of pharmaceutical science and research (for girls), Swami chincholi (Bhigwan), Daund, Pune- 413202. (2022). *Hibiscus Rosa sinensis: A review of Morphology of H. Rosa sinensis plant, its nutrients and pharmacological properties* [Journal-article]. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 9(2), a327–a331.
13. Slamet, A. (2018). The diversity of *Hibiscus rosa-sinensis* Based on Morphological Approach. *Scientiae Educatia*, 7(1), 32.
14. Tropicos Database (2024). Taxonomical details on *Hibiscus* species.
15. SDA Plants Database (2024). Classification of *Hibiscus rosa-sinensis*.
16. Devi, K., & Isaac, K. J. (2022). A review on *Hibiscus rosa-sinensis* leaf extraction, phytochemical screening and thin layer chromatography. *International Journal of Pharmacognosy and Pharmaceutical Sciences*, 4(1), 38–43.
17. Rasane S, Bhalsing M, Bhusari V, Daspute G, Ghortale A. A REVIEW OF COMPREHENSIVE STUDY ON *HIBISCUS ROSA SINENSIS* [Internet]. IJRAR23B1954 *International Journal of Research and Analytical Reviews (IJRAR)*. 2023 [cited 2024 Nov 20] p. 741.
18. People: Thulaja, Naidu Rantala & National Library Board Singapore. (n.d.). *Hibiscus (Hibiscus rosa-sinensis)*.
19. Ali, B. H., Al Wabel, N., & Blunden, G. (2005). Phytochemical, pharmacological and toxicological aspects of *Hibiscus sabdariffa* L.: a review. *Phytotherapy Research*, 19(5), 369–375.
20. Melzer MJ, Simbajon N, Carillo J, Borth WB, Freitas-Astúa J, Kitajima EW, et al. A cilevirus infects ornamental hibiscus in Hawaii. *Archives of Virology*. 2013;158(11):2421–2424.
21. Mejía JJ, Sierra LJ, Ceballos JG, Martínez JR, Stashenko EE. Color, Antioxidant Capacity and Flavonoid Composition in *Hibiscus rosa-sinensis* Cultivars. *Molecules* [Internet]. 2023 Jan 1;28(4):1779
22. Shen H, Zheng Y, Chen R, Huang X, Shi G. Neuroprotective effects of quercetin 3-O-sophoroside from *Hibiscus rosa-sinensis* Linn. on scopolamine-induced amnesia in mice. *Journal of Functional Foods*. 2021 Jan 1; 76:104291.
23. Roriz CL, Barros L, Carvalho AM, Santos-Buelga C, Ferreira IC. *Pterospartum tridentatum*, *Gomphrena globosa* and *Cymbopogon citratus*: A phytochemical study focused on antioxidant compounds. *Food research international*. 2014 Aug 1; 62:684-93.
24. Khare, C. P., *Encyclopedia of Indian Medicinal Plants*, SpringerVerlag Berlin Heidelberg, New York, 2004, 248-249.
25. Salem MZ, Olivares-Pérez J, Salem AZ. Studies on biological activities and phytochemicals composition of *Hibiscus* species-A review. *Life Science Journal*. 2014;11(5):1-8.
26. dos Santos Nascimento LB, Gori A, Raffaelli A, Ferrini F, Brunetti C. Phenolic compounds from leaves and flowers of *Hibiscus roseus*: Potential skin cosmetic applications of an under-investigated species. *Plants*. 2021 Mar 10;10(3):522.
27. Ross, I. A., *Medicinal Plants of the World*, 2nd edition Vol-I, Library of Congress Cataloging in Publication data, America, 253-266.
28. Li AN, Li S, Li HB, Xu DP, Xu XR, Chen F. Total phenolic contents and antioxidant capacities of 51 edible and wildflowers. *Journal of functional foods*. 2014 Jan 1; 6:319-30.

29. Hernández AC, Sanchez DH, Gómez-Vázquez A, Govea-Luciano A, Pinos-Rodríguez JM, Chay-Canul A, Izquierdo AC, Vega HB. Tannin concentration and degradation rate in vitro of *Morus alba* and *Hibiscus rosa-sinensis*. *Acta Universitaria*. 2019 Oct 9; 29:1-6.
30. Srivastava, D. N., Bhatt, S. K. and Udupa, K. N., Gas chromatographic identification of fatty acids, fatty alcohols and hydrocarbons of *Hibiscus rosa sinensis* leaves, *J. Amer. Oil Chem Soc*; 53: 1976, 607.
31. Falade OS, Aderogba MA, Kehinde O, Akinpelu BA, Oyedapo BO, Adewusi SR. Studies on the chemical constituents, antioxidants and membrane stability activities of *Hibiscus rosa sinensis*. *Niger J. Nat. Prod. Med*. 2009; 13:58-64.
32. Al-Snafi AE. Chemical constituents, pharmacological effects and therapeutic importance of *Hibiscus rosa-sinensis*-A review. *IOSR Journal of Pharmacy*. 2018;8(7):101-19.
33. Patel R, Patel A, Desai S, Nagee A. Study of secondary metabolites and antioxidant properties of leaves, stem and root among *Hibiscus rosa-sinensis* cultivars. *Asian J Exp Biol Sci*. 2012 Oct;3(4):719-25.
34. Udo IJ, Ben MG, Etuk CU, Tiomthy AI. Phytochemical, proximate and antibacterial properties of *Hibiscus rosa-sinensis* L. Leaf. *Journal of Medicinal Plants Studies*. 2016;4(5):193-5.
35. Bala R, Kaur R, Kaur B, Kaur P. *Hibiscus Rosa Sinensis* Linn.: A phytochemical and pharmacological review. *International Journal of Health Sciences*. 2022; 6:5165-93.
36. Amtaghri S, Qabouche A, Slaoui M, Eddouks M. A comprehensive overview of *Hibiscus rosa-sinensis* L.: Its ethnobotanical uses, phytochemistry, therapeutic uses, pharmacological activities, and toxicology. *Endocrine, Metabolic & Immune Disorders-Drug Targets (Formerly Current Drug Targets-Immune, Endocrine & Metabolic Disorders)*. 2024 Jan 1;24(1):86-115.
37. Chakraborty A, Bhattacharjee A, Mondal B, Chakraborty M, Mukhopadhyay G. 5 α -reductase inhibitory potential of *Hibiscus rosa sinensis*: effective for the management of alopecia.
38. Raduan SZ, Abdul Aziz MW, Roslida AH, Zakaria ZA, Zuraini A, Hakim MN. Anti-inflammatory effects of *Hibiscus rosa-sinensis* L. and *Hibiscus rosa-sinensis* var. *alba* ethanol extracts. *Int J Pharm Pharm Sci*. 2013 May;5(4):754-62.
39. Singh KG, Sonia S, Konsoor N. In-vitro and ex-vivo studies on the antioxidant, anti-inflammatory and antiarthritic properties of *Camellia sinensis*, *Hibiscus rosa sinensis*, *Matricaria chamomilla*, *Rosa SP.*, *Zingiber officinale* tea extracts. *inflammation*. 2018; 49:50.
40. Lailiyah M. Hair Growth Cream Formulation from Shoe Flower Leaf Ethanol Extract (*Hibiscus rosa-sinensis* L.) As a Hair Grower in Rabbit (*Oryctolagus cuniculus*). *Jurnal eduhealth*. 2023 Jun 3;14(02):720-8.
41. Kim E, Choi S, Kim SY, Jang SJ, Lee S, Kim H, hyeon Jang J, Seo HH, Lee JH, Choi SS, Moh SH. Wound healing effect of polydeoxyribonucleotide derived from *Hibiscus sabdariffa* callus via Nrf2 signaling in human keratinocytes. *Biochemical and Biophysical Research Communications*. 2024 Oct 8; 728:150335.
42. Upadhyay SM, Upadhyay P, Ghosh AK, Singh V, Dixit VK. Effect of ethanolic extract of *Hibiscus rosa sinensis* L., flowers on hair growth in female wistar rats. *Der Pharmacia Lettre*. 2011 Sep 28;3(4):258-63.
43. Ghaffar FR, El-Elaimy IA. In vitro, antioxidant and scavenging activities of *Hibiscus rosa sinensis* crude extract. *Journal of applied pharmaceutical science*. 2012 Feb 27:51-8.
44. Rengarajan S, Melanathuru V, Govindasamy C, Chinnadurai V, Elsadek MF. Antioxidant activity of flavonoid compounds isolated from the petals of *Hibiscus rosa sinensis*. *Journal of King Saud University-Science*. 2020 Apr 1;32(3):2236-42.
45. Garg D, Shaikh A, Muley A, Marar T. In-vitro antioxidant activity and phytochemical analysis in extracts of *Hibiscus rosa-sinensis* stem and leaves. *Free Radicals and Antioxidants*. 2012 Jul 1;2(3):41-6.
46. Vijayakumar SA, Yabesh JM, Arulmozhi P, Praseetha PK. Identification and isolation of antimicrobial compounds from the flower extract of *Hibiscus rosa-sinensis* L: In silico and in vitro approaches. *Microbial pathogenesis*. 2018 Oct 1; 123:527-35.
47. Arullappan S, Zakaria Z, Basri DF. Preliminary screening of antibacterial activity using crude extracts of *Hibiscus rosa sinensis*. *Tropical life sciences research*. 2009 Dec;20(2):109.
48. Raduan SZ, Abdul Aziz MW, Roslida AH, Zakaria ZA, Zuraini A, Hakim MN. Anti-inflammatory effects of *Hibiscus rosa-sinensis* L. and *Hibiscus rosa-sinensis* var. *alba* ethanol extracts. *Int J Pharm Pharm Sci*. 2013 May;5(4):754-62.
49. Geeganage JR, Gunathilaka MD. Mechanistic Insight into Anti-inflammatory Potential of *Hibiscus rosa-sinensis* Flower Extract as an Herbal Remedy: A Systematic Review. *Journal of Herbal Medicine*. 2024 Jun 1; 45:100884.
50. Pandit KR, Bhadange SS, Sapnar SM, Gaikwad SB, Wakade RS. Research on the Formulation and Evaluation of Shampoo Using *Hibiscus*. *International Journal of Research Publication and Reviews [Internet]*. 2024 Aug;5(8):1404–11.
51. Sawidis T, Papadopoulou A, Voulgaropoulou M. Effect of zinc on nectar secretion of *Hibiscus rosa-sinensis* L. *Protoplasma*. 2014 May; 251:575-89.
52. Goutam M, Prabir DK, Pranjal D, Akhsay S, Shymodip K, Pintu S, Debasmita M, Argha S, Tarique N, Chandan K, Sangita RC. Authentication and photochemical screening of *Hibiscus rosa sinensis*. *International Journal of Research and Analytical Reviews*. 2018;5(4).
53. Acute Toxicity and Genotoxic Activity of *Hibiscus rosa sinensis* Flower Extract [Internet]. *American Journal of Phytomedicine and Clinical Therapeutics*. 2014 p. 524–9.
54. Murthy DR, Reddy CM, Patil SB. Effect of benzene extract of *Hibiscus rosa sinensis* on the estrous cycle and ovarian activity in albino mice. *Biol Pharm Bull*. 1997; 20:756- 8.
55. Singh N, Nath R, Agarwal AK, Kohli RP. A pharmacological investigation of some indigenous drugs of plant origin for evaluation of their antipyretic, analgesic and anti-inflammatory activities. *J. Res. Indian Med. Yoga Homeopathy* 1978; 13: 58–62.
56. Masaki HS, Sakaki S, Atsumi T, Sakurai H. Active oxygen scavenging activity of plant extracts. *Biol. Pharmacol. Bulletin* 1995; 18: 162–166.
57. Basu K. *Bharatiya, Ousadhabalir Sankhpta, Bhaisajya Tattwa*. Hahnemann Publishing Company: Calcutta; 1946; p. 56.

58. OECD. OECD Guidelines for the Testing of Chemicals, Acute Oral Toxicity- up-and-down-procedure (UDP). 425. 2008:27. Adopted 2008 Oct 03.
59. Rhiouani H, El-Hilaly J, Israili ZH, Lyoussi B. Acute and sub-chronic toxicity of an aqueous extract of the leaves of *Herniaria glabra* in rodents. *J Ethnopharmacol.* 2008; 118:378–86. doi: 10.1016/j.jep.2008.05.009.