



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

FORMULATION AND EVALUATION OF HERBAL HAIR GEL BY USING FLAXSEED AND CHIA SEED EXTRACT

M. Mamta*¹, Farswan A.S², Patil S.M³

Student B Pharm IV Year, Shree Dev Bhoomi Institute of Education Science and Technology Dehradun, Uttarakhand, India.

Associate Professor, Shree Dev Bhoomi Institute of Education Science and Technology Dehradun, Uttarakhand, India.

Director, Shree Dev Bhoomi Institute of Education Science and Technology Dehradun, Uttarakhand, India.

Corresponding Address- M. Mamta,

Student B Pharm IV Year,

Shree Dev Bhoomi Institute of Education Science ,
And Technology Dehradun, Uttarakhand, India.

ABSTRACT

India is known for its traditional system of medicines like ayurveda, yoga, unani & siddha. Herbal plants and their cosmetics preparations are used to enhance the human appearance. Now a days these herbal plants and their preparations having higher demand in the world trade, because the usage of these herbal plants having higher efficacy, quality & safety. The aim of this research work was to formulate and evaluate the herbal hair gel of flaxseed and chiaseed that promotes hair growth and health while providing effective styling. The gel was formulated using a combination of ingredients known for their beneficial properties on the hair, such as the omega-3 fatty acids found in flaxseed and chia seed extracts, the antioxidant effect of vitamin E, and the soothing effect of lavender oil. Flaxseed and chia seed extracts were prepared by cold water extraction method. Five distinct kinds of gel formulations were created and tested, each with various amounts of flaxseed and chia seed extracts. A variety of characteristics, including physical appearance, pH, homogeneity, spreadability, viscosity, extrudability, and stability tests were used to evaluate each of the formulations (F1 to F4). The results showed that among the five formulations, F4 & F5 had good spreadability, viscosity, homogeneity, pH, physical appearance and was stable for long period of time and was effective in styling hair without causing any damage. The use of natural ingredients resulted in a hair gel that was gentle on the hair and scalp, making it suitable for everyday use. The formulation results suggest the hair gel can be used as a natural alternative in the cosmetic industry. Further research can explore the inclusion of additional plant extracts to enhance the properties of the hair gel.

Keywords:-Herbal hair gel, flaxseed, chia seed, vitamin E, & antioxidants.

INTRODUCTION

Topical formulations come in a variety of forms, including oils, creams, pastes, ointments, and gels. Gels are becoming more and more common these days since they are more stable and capable of regulated release than other semisolid preparations. The bioavailability of the medicine can be increased by using gel formulations since they have superior absorption properties [1]. Gels are semisolid systems with a constrained liquid phase inside a three-dimensional polymeric matrix consisting of organic or inorganic components that have undergone intensive physical or chemical cross-linking [2]. A network of colloidal solid particles is used to capture larger volumes of aqueous hydroalcoholic liquids to create the relatively new class of dosage forms known as gels. These particles may be made of inorganic substances like aluminum salts or organic polymers that are either natural or manmade [3]. The majority of topical gels are made with organic polymers, such as carbopol 940, which give the goods an appealing, clear, glittering look. These gels are often removed from the skin with water.

Hair gel is an essential hairstyling product that is used to add shine, hold, and manageability to hair. Many hair gels available in the market today contain harsh chemicals such as silicones and alcohol that can damage hair by making it dry and brittle over time. To avoid these harmful effects, many people are turning towards natural and herbal hair gels made from plant extracts that are gentle on hair, provide a natural hold, and enrich hair texture and shine.

This article focuses on the formulation of an herbal hair gel using flaxseed and chia seed extract, with carbopol 940, methylparaben, glycerin, propylene glycol, triethanolamine, and water creates a flexible and nourishing hair gel that can improve hair health and appearance. Flaxseed and chia seed extract are excellent sources of omega-3 fatty acids, which have been shown to nourish and strengthen hair follicles, leading to healthier and stronger hair growth [4]. These seeds are also high in antioxidants, which protect hair and scalp from environmental damage and oxidative stress caused by free radicals, that can lead to hair breakage and thinning [5].

The earliest plant cultivated by humans is flax (*Linum usitatissimum* L.), a member of the Linaceae family. It is indigenous to the Mediterranean and Central Asian regions. About 40% of flaxseeds are oil, which contains a lot of α -linolenic acid, which can make up as much as 52% of all fatty acids. About 30% and 20%, respectively, of dietary fibre and high-quality proteins may be found in flaxseeds. This plant also has considerable amounts of vitamins (B1 and A), minerals (Mg, P, Mn, Se, and Zn), and lignans that are responsible for its antioxidant properties [6].



Fig.1: (a) Flaxseed plant.



(b) Brown flaxseed.

Salvia hispanica L. (family Lamiaceae) is an annual herbaceous plant that originates from Mexico and Guatemala, and it is currently known by the popular name of chia; it has been part of human food for about 5500 years. The seeds were historically utilised by the Aztecs and Mayas to make food, paintings, and folk remedies. It was the secondary crop in prehistoric Columbian communities, behind beans. Chia seeds, both whole and crushed, and their oil were used in prehistoric Aztec cultures as nourishment, ancient cosmetics, and a component of sacred rites [7].

In addition to being a powerhouse of omega-3 fatty acids, *S. Hispanica* is derived from the Spanish word "chian," which describes substances related to oil. It also contains other nutrients, such as proteins, dietary fibres, vitamins, and minerals, as well as a variety of polyphenolic antioxidants that are primarily used to prevent the catabolism of chia seed [8]. Chia seed is an oilseed having significant amounts of vitamins and minerals, as well as proteins (15–24%), lipids (40–60% omega-3 fatty acids), dietary fibres (18–30%), and carbs (26–41%) [9]. The omega-3 fatty acids found in chia seeds are yet another great source. They also

contain B vitamins, antioxidants, and minerals such as calcium and magnesium, which all contribute to healthy hair growth. Chia seeds have been shown to improve hair thickness, promote shine, and decrease hair breakage [10].



Fig. 2: (a) Chia seed plant.



(b) Chia seed.

Vitamin E is a powerful antioxidant that can help to promote healthy hair growth by reducing oxidative stress and inflammation in the scalp. It has been shown to improve the circulation of blood to the scalp, which can promote hair growth [11]. Vitamin E is also known to help prevent hair loss and improve hair thickness [12]. Lavender oil is well known for its antimicrobial and anti-inflammatory properties, which can help to soothe the scalp and reduce inflammation. It is also believed to improve hair growth and thickness by promoting blood flow and stimulating hair follicles [13].

Carbopol 940 is a synthetic polymer that is commonly used in cosmetic formulations as a thickener and stabilizer. It helps to create a gel-like consistency in the hair gel, allowing it to hold its shape and provide a flexible hold. Methylparaben is a preservative that is commonly used in cosmetic formulations to prevent the growth of bacteria and mold. Glycerin is a natural humectant that can moisturize and hydrate hair, while PVP is a film-forming polymer that can help to hold the hair in place [14]. Propylene glycol is a humectant and solvent commonly used in cosmetic formulations to moisturize and condition hair [15]. Triethanolamine is a pH adjuster that is commonly used in cosmetic formulations to maintain a stable pH [16].

MATERIAL AND METHODS

MATERIAL USED

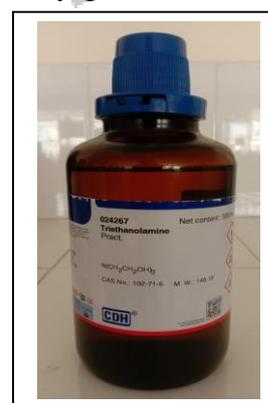
All the plant material (flaxseed, chia seed, lavender oil) was collected from the local market in Dehradun district, Uttarakhand. Carbopol 940, PEG 600, methylparaben, triethanolamine, and glycerin were procured from the laboratory of Shree Dev Bhoomi Institute Of Education Science And Technology, Dehradun. And all other chemicals and reagents used were of either analytical or laboratory-grade.



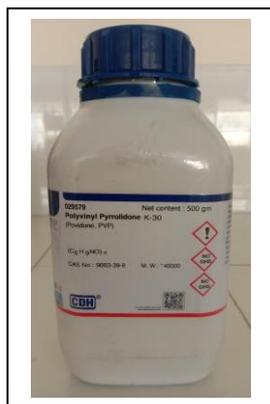
a) Carbopol



b) Methylparaben



c) Triethanolamine



d) PVP



e) PEG

Figure no.3: Chemicals used in herbal hair gel formulations.**Table no.1:** List of materials used.

S.NO.	MATERIAL	SOURCE
1.	Flaxseed extract	Local Market
2.	Chia seed extract	Local Market
3.	Lavender oil	Local Market
4.	Vitamin E capsule	Local Market
5.	Carbopol 940 (gm)	Chemical store
6.	Methyl paraben (mg)	Chemical store
7.	Glycerin (ml)	Chemical store
8.	PEG 600 (ml)	Chemical store
9.	Triethanolamine (ml)	Chemical store
10.	PVP (ml)	Chemical store
11.	Water (ml)	Chemical store

METHODOLOGY

Preparation of flaxseed extract

The flaxseed extract was prepared by cold water extraction method in which about 20gm of flaxseed were weighed and ground into a fine powder by using a coffee grinder or a mortar and pestle. Add the powdered seeds to a beaker and pour in 200 ml of distilled water. Stir the mixture well & cover the beaker with a foil paper. Place the beaker at room temperature or lower temperature for at least 24 hours. After that, strain the mixture through a cheese cloth or fine mesh strainer into a clean beaker. Store the extract in a clean, airtight container in a cool place.

Preparation of Chia seed extract

The chia seed extract was prepared by cold water extraction method in which about 20gm of chia seed was weighed and ground into a fine powder by using a coffee grinder or a mortar and pestle. Add the powdered seeds to a beaker and pour in 200 ml of distilled water. Stir the mixture well & cover the beaker with foil paper. Place the beaker at room temperature or lower temperature for at least 24 hours. After that, strain the mixture through a cheesecloth or fine mesh strainer into a clean beaker. Store the extract in a clean, airtight container in a cool place.

Table No.2: Formulation of herbal hair gel

S.NO.	FORMULATON CODE	F1	F2	F3	F4	F5
1.	Flaxseed extract %	4.5	8.5	12.5	16.5	20.5
2.	Chia seed extract %	20.5	16.5	12.5	8.5	4.5
3.	Lavender oil %	0.3	0.3	0.3	0.3	0.3
4.	Vitamin E capsule %	0.1	0.1	0.1	0.1	0.1
5.	Carbopol 940 (gm)	2	2	2	2	2
6.	Methyl praben (mg)	75	75	75	75	75
7.	Glycerin (ml)	3	3	3	3	3
8.	PEG (ml)	6.25	6.25	6.25	6.25	6.25
9.	Triethanolamine (ml)	0.5	0.5	0.5	0.5	0.5
10.	Water (ml)	35	35	35	35	35

Preparation of herbal hair gel

The flaxseed and chia seed extract were prepared separately through the cold water extraction method by using distilled water (About 200ml) which is poured on 20gm of weighed flaxseed or chia seed (In a powdered form) in a beaker, then close the lid tightly and shaken well to mix. Place the beaker at room temperature or lower temperature for at least 24 hours. After that, strain the mixture through a cheesecloth or fine mesh strainer into a clean beaker. Store the extract in a clean, airtight container in a cool place for further use [23].

Five distinct herbal hair gel formulations were made using a carbopol gel basis and a straight forward gel manufacturing process. In a beaker, 35 ml of water were used to dissolve a weighed amount of polyethylene glycol, glycerin, and methylparaben. Then the mixture was stirred at high speed using a mechanical stirrer. 2gm of carbopol 940 was added slowly to the beaker containing the above mixture of liquid while continuously stirring. Once a gel structure was achieved, triethanolamine was added gradually while the beaker was continuously stirred. Finally, varying concentrations of aqueous extract of flaxseed and chia seed (4.5%, 8.5%, 12.5%, 16.5% & 20.5%) were incorporated into carbopol gel and stirred for about 1 hour to obtain F1, F2, F3, F4 & F5 containing 4.5%, 8.5%, 12.5%, 16.5% and 20.5% flaxseed & chia seed extract in carbopol gel formulation. The generated herbal gel compositions were kept at room temperature until further assessment.



Figure no.4: Prepared herbal hair gel

EVALUATION OF HERBAL HAIR GEL FORMULATIONS

Physical appearance/ Visual inspection

The formulated herbal hair gel was evaluated for color, transparency, odor, visual appearance, and foreign particles [24]. In Table 3, the outcomes are summarised.

Determination of pH

The digital pH metre was used to calculate the pH of different hair gel compositions. In 100ml of distilled water, one gram of gel was dissolved and allowed to stand for two hours. The pH of the hair gel formulations was measured after fully submerging the electrodes [25]. In Table 3, the outcomes are summarised.

Homogeneity

All created hair gels were checked for homogeneity by visual examination after the gel compositions were put within the container. They underwent examinations to check for lumps, flocculates, or aggregates as well as for visual appearance [26]. In Table 3, the outcomes are summarised.

Spreadability

The spreadability of gel formulations was calculated on a glass slide, the gel is fixed between the two slides, a 20gm load is planted on the slide, the time to squeeze the sample to uniform thickness, and the time to separate the two slides (seconds) was calculated. Measures were taken for spreadability [27]. In Table 3, the outcomes are summarised.

$$S = M.L/T$$

Where,

S=Spreadability (g.cm/sec),

M=Weight on the upper slide (gm),

Length of a glass slide (cm),

T=Time taken to separate the slide from one another (sec).

Viscosity

The Brookfield viscometer was used for the measurement of the viscosity of the prepared gel. The Brookfield viscometer was spun at 100 rpm, spindle no. 6. After the sample reached equilibrium at the end of the first two minutes, each reading was taken [28]. Table 3 presents the findings.

Extrudability

Metal tubes with foldable ends were filled with the hair gel formulas. The material was forced through the tubes, and the formulations extrudability was evaluated [29]. The formulations' ability to be extruded was examined. The formulations extrudability was assessed by calculating the weight in grams needed to extrude a 0.5 cm gel ribbon in 10 seconds. In Table 3, the outcomes are summarised.

Stability studies

The formulated gel was filled within the collapsible tubes and stored at room temperature and 40°C at 75% RH. The three-month stability assessment was carried out. The parameters like appearance, pH, homogeneity, viscosity, and spreadability were tested every month [30]. Table 4 includes a summary of the outcomes.

QUALITATIVE PHYTOCHEMICAL ANALYSIS

The extract of flaxseed and chia seeds obtained were subsequently subjected to qualitative tests for the detection of diverse plant constituents like alkaloids, steroids, carbohydrates, proteins, tannins, etc. The reagents prepared for this test were based on the research of Kopperundevi. R et al. (2017) [31].

Preparation of the sample extract (flaxseed or chia seed)

Around 10gm of dried sample was gently soaked in 100ml of ethanol in a beaker. Then, stir the mixture continuously with a glass rod and cover it with a foil paper properly. Stored at room temperature for at least 24 to 48 hours in a cool and dark place. And filter the extract through whatman filter paper no.42. Then, preserved it in an airtight container in a cool and dark place.

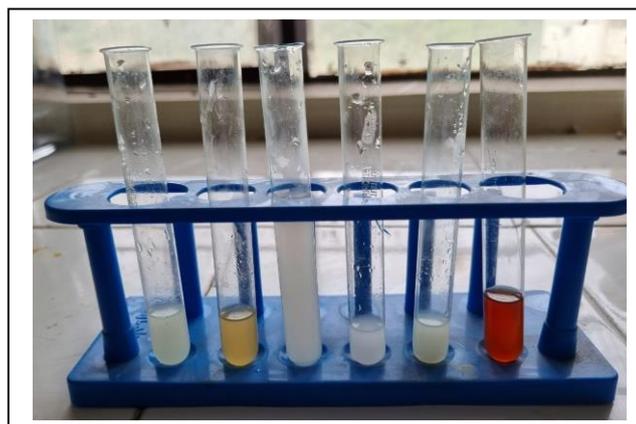
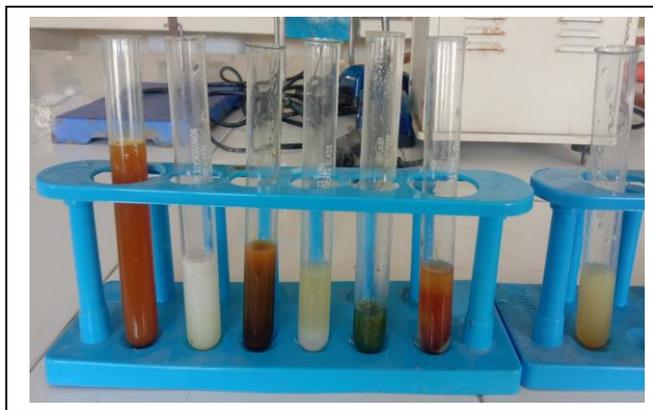


Figure no.5: Qualitative phytochemical testing of flaxseed & chia seed extract.

DETECTION OF ALKALOIDS

Dragendroff's Test

The powder/extract was dissolved in 5ml of distilled water, add 5ml of 2M HCL. Then 1ml of Dragendroff's reagent was added and examined for an immediate formation of an orange-red precipitate.

Mayer's Test

The powder/extract was mixed with a little amount of oil. HCL and Mayer's reagent and examined for the formation of a white precipitate.

Wagner's Test

The powder/extract was mixed with Wagner's reagent and examined for the formation of a reddish-brown precipitate.

DETECTION OF STEROIDS

Alkaline reagent test

Drops of sodium hydroxide solution should be added to the test solution. Flavonoids can be detected by the creation of a strong yellow hue that becomes colourless when a few drops of diluted acid are added.

DETECTION OF CARBOHYDRATES

Molish's Test

To 1ml of the extract, 2ml of Molish's reagent was added, a reddish brown ring indicates the presence of carbohydrates.

Fehling's Test

The test solution was mixed with Fehling's I & II, heated, and examined for the presence of red coloration for the presence of sugar.

DETECTION OF PROTEINS

Biuret Test

The sample solution was treated with 5-8 drops of 1% w/w copper sulfate solution and 1 ml of 5% sodium hydroxide. If a violet color is formed, It indicates the presence of proteins.

DETECTION OF PHENOL

Ferric chloride Test

A small quantity of powdered drug/extract was dissolved in 2ml distilled water and a few drops of 10% aqueous ferric chloride solution was added and observed for the appearance of blue or green color.

DETECTION OF TANNINS

Lead acetate Test

The test solution was mixed with a basic lead acetate solution and examined for the formation of a white precipitate.

DETECTION OF SAPONINS

To the sample, a drop of sodium bicarbonate solution was added and the mixture was shaken vigorously and left for 3 minutes. The development of any honeycomb like froth was examined.

DETECTION OF FLAVONOIDS

A few drops of ammonia solution were added to the sample, and further concentrated hydrochloric acid was layered, the appearance of yellow color shows the presence of flavonoids.

RESULT & DISCUSSION

1) Physicochemical evaluation of formulated hair gel containing flaxseed and chiaseed extract with vitamin E & lavender oil.

Table No.3: Evaluation of prepared herbal hair gel

S.no.	Parameters	F1	F2	F3	F4	F5
1.	Physical appearance	Translucent, slightly yellow and smooth				
2.	pH	6.8	6.7	6.9	7.0	7.2
3.	Homogeneity	Good	Good	Good	Good	Good
4.	Spreadability	13.75	14.44	15.14	16.25	15.11
5.	Viscosity	14860	14220	14680	13280	13780
6.	Extrudability	++	++	++	+++	+++

++: Good, +++: Excellent

Physical appearance

All of the herbal gel formulations F1, F2, F3, F4, & F5 were determined to have a colourless appearance due to a transparent presence that was designed to be seamless when applied.

Determination of pH

All herbal formulations have a pH that is suitable for hair, ranging from 6.8 to 7.2, which makes the herbal gel formulation for hair compatible.

Homogeneity

The homogeneity of each formed gel was evaluated visually for the presence of any lumps, flocculates, or aggregates. All formulas' consistency was deemed to be satisfactory.

Spreadability

Patient compliance is greatly influenced by the gel's spreadability, which also aids in consistent gel application. A good gel takes less duration to spread and will have excellent spreadability.

Viscosity

Viscosity is an essential requirement for distinguishing the gels as it influences the spreadability & release of the drug. The viscosity of all the formulations was in the range of cps.

Extrudability

When extruded from the metal collapsible tube, all formulas (F1 to F5) shown acceptable extrudability. Comparatively, F4 and F5 had excellent extrudability than F1, F2 & F3.

Stability studies

The stability studies were conducted for all the formulations for 3 months. No appreciable changes were found for the proven limits like physical appearance, pH, odor, homogeneity & spreadability at room temperature.

Table No.4: Stability studies of herbal hair gel formulations.

S.no.	Parameters	Initial	1 st Month	2 nd Month	3 rd Month
1.	Physical appearance	Translucent slightly yellow & smooth			
2.	Odour	Characteristic	Characteristic	Characteristic	Characteristic
3.	pH	6.8	6.9	7.0	7.2
4.	Homogeneity	Homogeneous, smooth & no aggregates			
5.	Spreadability	15.14	15.14	15.14	15.14

2) Qualitative phytochemical evaluation of flaxseed & chia seed extract.

Table No.5: Qualitative phytochemical screening of flaxseed & chia seed

S.no.	Plant constituents	Ethanollic extract of flaxseed	Ethanollic extract of chiaseed
1.	Alkaloids	+++	+++
2.	Steroids	++	++
3.	Carbohydrates	+++	+++
4.	Proteins	++	++
5.	Phenols	+	++
6.	Tannins	++	++
7.	Saponins	++	+
8.	Flavonoids	+++	++

+++ : Strongly indicated, ++ : Moderately indicated, + : Present, - : Absent

CONCLUSION

With the understanding that natural medicines are less likely to have negative effects than synthetic and semi-synthetic ones, they are more accepted. Herbal hair gels assist in repairing the numerous harms produced by chemical agents in a variety of commercially available products. The hair gels that contains flaxseed and chia seed which are both rich in omega-3 fatty acids and antioxidants, they may promote healthy hair growth and reduce hair damage. Vitamin E is also known for its hair-nourishing properties, while lavender oil is believed to have soothing and anti-inflammatory effects on the scalp. It's an attempt made to work out the herbal hair gel that containing various concentration of herbal extract. The formulated herbal hair gel is employed for the purpose of moisturizing & nourishing the hair and preventing the hair fall. The formulation results suggest the hair gel can be used as a natural alternative in the cosmetic industry. Further research can explore the inclusion of additional plant extracts to enhance the properties of the hair gel.

ACKNOWLEDGMENT

The principal and management of the Shree Dev Bhoomi Institute of Education, Science, and Technology in Dehradun, Uttarakhand, are to be thanked by the authors for allowing us to conduct the current research.

REFERENCES:

1. PreetKaur and Tarun Kumar Guleri. Topical Gel. A recent approach for novel drug delivery. Asian J Biomed pharma Sci. 2013;3(17):1-5.
2. ShaikArifBhasha, Syed Abdul Khalid, Duraivel S, DebjitBhowmik and Sampath Kumar KP. Recent trends in usage of polymers in the formulation of dermatological gels. Indian J Res Pharm Biotech. 2013;1(2):161-168.
3. Shelke J, Shinkar DM and Saudagar RB. Topical gel. A novel approach for development of topical drug delivery
4. Bouayed J, Bohn T. Exogenous antioxidants—double-edged swords in cellular redox state: health beneficial effects at physiologic doses versus deleterious effects at high doses. Oxidative medicine and cellular longevity. 2010 Jul 1;3(4):228-37.
5. Gopalan A, Reuben SC, Ahmed S, Darvesh AS, Hohmann J, Bishayee A. The health benefits of blackcurrants. Food & function. 2012;3(8):795-809.
6. Kosiorowska A, Pietrzyk S, Pająk P, Socha R. The effect of the addition of gold flax (*Linum usitatissimum* L.) and chia seeds (*Salvia hispanica* L.) on the physicochemical and antioxidant properties of cranberry jams. European Food Research and Technology. 2022 Nov;248(11):2865-76.
7. Ullah R, Nadeem M, Khalique A, Imran M, Mehmood S, Javid A, Hussain J. Nutritional and therapeutic perspectives of Chia (*Salvia hispanica* L.): a review. Journal of food science and technology. 2016 Apr;53(4):1750-8.
8. Capitani ME, Spotorno V, Nolasco SM, Tomás MC. Physicochemical and functional characterization of by-products from chia (*Salvia hispanica* L.) seeds of Argentina. LWT-Food Science and Technology. 2012 Jan 1;45(1):94-102.
9. Din ZU, Alam M, Ullah H, Shi D, Xu B, Li H, Xiao C. Nutritional, phytochemical and therapeutic potential of chia seed (*Salvia hispanica* L.). A mini-review. Food Hydrocolloids for Health. 2021 Jan 1;1:100010.
10. Guzmán, C., Choquevilca, V., Bazán, E., & Guzmán, J. (2019). Chia (*Salvia hispanica* L.) oil extraction: A review. Journal of the American Oil Chemists' Society, 96(5), 507-520.
11. Finner AM. Nutrition and hair: deficiencies and supplements. Dermatologic clinics. 2013 Jan 1;31(1):167-72.
12. Park H, Kim CW, Kim SS, Park CW. The therapeutic effect and the changed serum zinc level after zinc supplementation in alopecia areata patients who had a low serum zinc level. Annals of dermatology. 2009 May 1;21(2):142-6.
13. Lee BH, Lee JS, Kim YC. Hair growth-promoting effects of lavender oil in C57BL/6 mice. Toxicological research. 2016 Apr;32:103-8.
14. Carbopol® 940 Polymer Technical Data Sheet. [Online] Available at: <https://www.lubrizol.com/Personal-Care/Formulation/PC-Products/Carbopol/Carbopol-940-Polymer> [Accessed 26 Apr. 2023]. (carbopol 940, methyl paraben, glycerin, PVP)
15. Propylene Glycol Technical Data Sheet. [Online] Available at: <https://www.dow.com/en-us/pdp/propylene-glycol.us-pharma.000373z.xhtml> [Accessed 26 Apr. 2023]. (propylene glycol)
16. Triethanolamine Technical Data Sheet. [Online] Available at: <https://www.chemtradeasia.com/en/triethanolamine-tea-99-1514> [Accessed 26 Apr. 2023]. (triethanolamine)
17. Roohi TF, Wal A. phytochemical evaluation and standardization of polyherbal ethyl acetate extract and its gel-based formulation obtained from berries and flaxseed (EAPEG-BF).

18. Núñez-González, M. A., Guevara-Arauza, J. C., & Vázquez-Sánchez, A. Y. (2019). Characterization of Hair Gel Produced from *Salvia hispanica* L. Mucilage. *International Journal of Polymer Science*, 2019, 3240369.
19. Coelho, D. S., Policarpi, P. B., de Souza, P. M., & Coutinho, H. D. (2019). Natural products from plants as source of potential hair growth promoters: A review. *International Journal of Trichology*, 11(2), 54-61.
20. Manjula D, Jenita JJ, Premakumari KB, Shanaz B. Formulation and evaluation of flaxseed hair gel: a natural hair tamer. *International Journal of Research in Pharmacy and Chemistry*. 2018;8(3):487-91.
21. Aguilar-Pérez, A., Zapata-Morales, J. R., & Juárez-Onofre, J. E. (2018). Comparative Study of the Antioxidant and Antibacterial Activity of Flaxseed and Chia Seed Extracts. *Journal of Agricultural and Food Chemistry*, 66(19), 4845-4853.
22. Azizi, H., Najafi, M. N., Ghassemi, M. R., & Ardakani, M. R. (2014). The Potential Use of Flaxseed Gel as a Natural Hair Gel. *Journal of cosmetic science*, 65(2), 127-135.
23. Kajla P, Sharma A, Sood DR. Flaxseed—a potential functional food source. *Journal of food science and technology*. 2015 Apr;52:1857-71.
24. Regupathi T, Chitra K, Ruckmani K, Lalitha KG, Kumar M. Formulation and evaluation of herbal hair gel for hair growth potential. *Journal of Pharmacology & Clinical Research*. 2017;2(2):1-8.
25. Kaur LP, Garg R, Gupta GD. Development and evaluation of topical gel of minoxidil from different polymer bases in application of alopecia. *Int J Pharmacy and Pharm Sci*. 2010;2(3):43-7.
26. Choudhari A, Biyani KR. design, development and characterization of novel herbal hair styling preparation. *International Journal of Pharmaceutical, Chemical & Biological Sciences*. 2014 Jul 1;4(3).
27. Richa S, Sagar B, Manoj KM. *Int. J. Drug Dev.*, 2020; 12 (2): 1-7
28. Sharma M. *Int. J. Pharm. Res. Scholars.*, 2013;2(4): 33-41.
29. Sharma M, Bhowmick M, Pandey GK, Joshi A and Dubey B. Formulation and evaluation of hair gel for the treatment of chronic inflammatory disorder seborrheic dermatitis. *Int J Pharma Res Sch*. 2013;2(1-4):277-7873.
30. Chauhan K, Tyagi B, Singh B and Agarwal S. Accelerated stability studies of polyherbal preparation (Ezmov) capsule. 1999;18(3&4):210-217.
31. Kopperundevi R. *Development and Standardisation of Poly Herbal Gel and Clinical Evaluation of Its Hair Growth Stimulation* (Doctoral dissertation, Madras Medical College, Chennai)