

Formulation and Evaluation of Topical Hydrogel formulation From Aloe vera Extract

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Abstract: *The goal of this research was to create and evaluate a topical hydrogel containing Aloe vera extract for prospective skin-healing and moisturizing properties. Aloe vera is a well-known medicinal plant having anti-inflammatory, antibacterial, antioxidant, and wound-healing qualities because it includes active substances such vitamins, enzymes, polysaccharides, anthraquinones, and amino acids. Using propylene glycol, glycerine, methyl paraben, triethanolamine, and Carbopol 934 as the gelling agent, a number of hydrogel formulations (F1–F6) were created in this work. Among the physicochemical properties evaluated for the produced formulations were physical appearance, pH, Spreadability, viscosity, and percentage moisture content.*

Formulation F4 fared better than the others in terms of consistency, stability, and skin compatibility, with pH 5.89, Spreadability 1.97, viscosity 4469 cp, and moisture content 95.90%. The resulting hydrogel's exceptional semisolid qualities, smooth texture, and appealing appearance made it suitable for topical application. The results of the study indicate that Aloe vera-based hydrogel has significant pharmacological and therapeutic potential and might be a useful herbal topical formulation..

Keywords: *Aloe vera*

I. INTRODUCTION

The botanical name of Aloe vera is “Aloe Barbadosensis miller”. It belongs to Asphodelaceae (Liliaceae) family, and is a shrubby or arborescent, perennial, xerophytic, succulent colony. It grows mainly in the dry regions of Africa, Asia, Europe and America. In India, it is found in Rajasthan, Andhra Aloe is also widely used in Ayurvedic and traditional Chinese medicine. Aloe is used topically to treat psoriasis or dermatitis, frequently in conjunction with liquorice root, and ingested as a laxative, anthelmintic, hemorrhoid treatment, and uterine stimulant in Ayurvedic medicine, the traditional Indian medical system. The fresh gel is used in Arabian medicine to treat conjunctivitis, wound healing, and disinfection. It is also applied to the forehead to relieve headaches and to the body to cool it down in cases of fever. Vitamins, enzymes, minerals, carbohydrates, lignin, saponins, salicylic acids, and amino acids are among the 75 potentially active ingredients found in aloe vera. And it is found in Himachal Pradesh, Gujarat, Maharashtra.





Figure 1: Aloe vera.

History of Aloe vera:

The historical significance of Aloe vera is profound. Egyptians revered the plant, using it in burial rituals and as a vital component of their medicinal practices, while Greek physicians like Hippocrates praised it for its therapeutic properties. In Chinese medicine, Aloe vera has been employed for its cooling effects and benefits for digestive health. This longstanding tradition of use has paved the way for modern research that seeks to understand the scientific basis behind Aloe vera's myriad health benefits. Aloe vera was used to treat skin ailments, according to Egyptian texts around 550 BC. In addition to being used as a laxative and insect repellent, aloe vera was utilized to cure eczema.

Botany of Aloe vera:

Medicinal species:

A. vulgaris, *A. arborescens*, *A. ferox* (Cape aloe), *A. barbadensis* (Barbados aloe), *A. perryi* (Socotrine or Zanzibar aloe), and Aloe vera. The majority of the more than 300 species of aloe are indigenous to Madagascar, South Africa, and Arabia. The active component concentrations in the various species vary slightly.

Description of Aloe vera:

Aloe vera is known by its botanical name, "Aloe barbadensis miller". Succulent, pea-green, perennial, xerophytic, shrubby, or arborescent, it is a member of the Asphodelaceae (Liliaceae) family. The triangular, fleshy leaves of the aloe plant are up to 20 inches long and 5 inches wide, with spikes on the margins. The clear, fresh parenchymal gel from the leaf's centre is occasionally dried to make Aloe vera concentrate or diluted with water to make aloe juice products. Laxative anthraquinones are produced by the yellowish green pericyclic tubules that line the leaf which is where the sticky latex liquid originates. The flowers (which are not utilized in medicine) are yellow. Aloe is indigenous to South Africa and South America, but are now cultivated worldwide except in tundra, deserts and rain forests. It takes approximately four years to reach maturity and has a life span of about 12 years.

Aloe vera Constituents and Its Properties:

Aloe gel is 99% water with a pH of 4.5 and is a common ingredient in many non-prescription skin salves. The gel contains an emollient polysaccharide, glucomannan. It is a good moisturizer, which accounts for its use in many cosmetics. Acemannan, the major carbohydrate fraction in the gel, is a water-soluble long chain mannose polymer which accelerates wound healing, modulates immune function (particularly macrophage activation and production of cytokines) and demonstrates antineoplastic and antiviral effects. The gel also contains bradykininase, an anti-inflammatory, magnesium lactate, which helps prevent itching, and salicylic acid and other antiprostaglandin compounds which relieve inflammation. Whole leaf components are proposed to have direct antibacterial properties include anthraquinones and saponins, while polysaccharides have been attributed within direct bacterial activity through the stimulation of phagocytic leucocytes to destroy bacteria. Pryocatechol is a hydroxylated phenol, known to be toxic to micro-organisms.

The site and number of hydroxyl groups on the phenol group are thought to be related to their relative toxicity to microorganisms and the increase in hydroxylation. The phenolics group present in Aloe vera extracts act by denaturing



the proteins and cell membranes. They act as disinfectant and are effective in presence of organic matter and remain active even long after application. Numerous aloe species around the world are used for conditions ranging from dermatitis to cancer. There is growing experimental evidence for its use as an antiviral, an ulcer remedy and an adjuvant cancer treatment due to its immune modulating effects.

Active Components and Its Functions:

Aloe vera contains 75 potentially active constituents: vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids and amino acids.

Vitamins: It contains vitamin A (betacarotene) C and E, which are antioxidants. It also contains vitamin B12, folic acid and choline.

Enzymes: It contains 8 enzymes: alliasse, alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulose, lipase and peroxidase. Bradykinase helps to reduce excessive inflammation when applied to the skin topically.

Minerals: It provides calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc. They are essential for the proper functioning of various enzyme systems in different metabolic pathways and few are antioxidants.

Sugars: It provides monosaccharides (glucose and fructose) and polysaccharides (glucomannans/polymannose). These are derived from the mucilage layer of the plant and are known as mucopolysaccharides. The most common polysaccharides are called glucomannans (beta -1,4 acetylated mannan) A glycoprotein with antiallergic properties, called alprogen and novel anti-inflammatory compound, Cglucosylchromone, has been isolated from Aloe vera gel

Anthraquinones: It provides 12 anthraquinones, which are phenolic compounds traditionally known as laxatives. Aloin and emodin act as analgesics, antibacterials and antivirals.

Fatty acids: It provides four plant steroids, cholesterol, campesterol, β -sisosterol and lupeol. All these have anti-inflammatory action and lopesol also possess antiseptic and analgesic properties.

Hormones: Auxins and gibberellins that help in wound healing and have anti-inflammatory action.

Others: It provides 20 of the 22 human required amino acids and 7 of the 8 essential amino acids. It also contains salicylic acid that possesses anti-inflammatory and anti- bacterial. Lignin, an inert substance, when included in topical preparations enhances penetrative effect of the other ingredients into the skin.

Biological Properties of Aloe vera:

Healing Properties:

Various researchers reported that the effective components for wound healing may be tannic acid and a type of polysaccharide. Other researcher have also reported that glucomannan, a mannose-rich polysaccharide and gibberellin a growth hormone interacts with growth factor receptors on the fibroblast thereby stimulating its activity and proliferation which in turn significantly increase collagen synthesis after topical and oral aloe vera .Aloe gel not only increased collagen content of the wound but also changed collagen composition and increased the degree of collagen cross linking .Due to this, it accelerated wound contraction and increased the breaking strength of resulting scar tissue.

Immune modulation:

Immunostimulant and anti- inflammatory in a case study of 14 HIV-1+ patients who were prescribed 800 mg/day of acemannan, there was a significant increase in the number of circulating monocyte and macrophages which mirrored clinical improvement. Alprogen inhibit calcium influx into mast cells, thereby inhibiting the antigen-antibody-mediated release of histamine and leukotriene from mast cells. In a study on mice that had previously been implanted with murine sarcoma cells, acemannan stimulates the synthesis and release of interleukin -1(IL1) and tumor necrosis factor from macrophages in mice, which in turn intitiated an immune attack that resulted in necrosis and regression of the cancerous cells. Several low-molecular-weight compounds are also capable of inhibiting the release of reactive oxygen free radicals from activated.



Antimicrobial:

Aloe vera contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamic acid, phenols and sulphur. They all have inhibitory action on fungi, bacteria and viruses. Aloe extract treatment of guinea pig feet that had been infected with *Trichophyton mentagrophytes* resulted in a 70% growth inhibition compared with untreated animals. In recent studies, a polysaccharide fraction has shown to inhibit the binding of benzopyrene to primary rat hepatocytes, thereby preventing the formation of potentially cancer-initiating benzopyrene- DNA adducts. An induction of glutathione S-transferase and an inhibition of the tumorpromoting effects of phorbol myristic acetate has also been reported which suggest a possible benefit of using aloe gel in cancer chemo prevention.

Skin and mucus membranes:

Despite the conflicting research, some dentists and otolaryngologists use aloe gel to promote healing in injured tissues in the mouth, nose, sinuses and ear. Aloe gel has most often been used as a topical treatment for burn wound. Aloe gel has most often been used as a topical treatment for burn wounds. In a study of 27 adults with partial thickness burns, those treated with aloe healed an average of six days faster than those treated with Vaseline. Psoriasis remedy in a 1995 double-blind, placebo- controlled study of aloe's effect on 60 patients with psoriasis vulgaris, an aloe vera extract (0.5%) in a hydrophilic cream resulted in a significant clearing of the psoriatic plaques in 83.3% of the aloe-treated patients versus 6.6% of the placebo group. The aloe treatment was well tolerated with no adverse drug-related side effects.

Effects on Skin Exposure to UV and Gamma Radiation:

Aloe vera gel has been reported to have a protective effect against damage to skin. In a study on streptozotocin-induced diabetic rats oral administration of Aloe vera gel (alcohol insoluble residue extract) significantly reduced the fasting blood glucose, hepatic transaminases, plasma and tissue cholesterol, triglycerides, free fatty acids and phospholipids and in addition also significantly increased plasma insulin levels. The decreased plasma levels of high-density lipoprotein cholesterol and increased levels of low-density lipoprotein cholesterol in the streptozotocin-induced rats were restored to normal after treatment with gel extract. From the findings of another study on streptozotocin-induced diabetic rats, it was suggested that the mechanism of action of Aloe vera extracts to reduced blood glucose levels is by enhancing glucose metabolism. It was further proposed that the glucose lowering effect could be explained by an antioxidant mechanism because it attenuated oxidative damage in the brains of streptozotocin-induced mice and reduced peroxidation levels in the kidneys of streptozotocin-induced diabetic rats.

Human Skin:

The skin serves both the body's protective covering and a bustling interface between the environment and the human body. It not only stops radiation and harmful foreign substances from penetrating, manages the loss of important fluids, and protects against mechanical shock, but it also controls heat loss and transduces incoming sensations. The skin is made up of a continuous layer that covers the whole body. The epidermis and dermis are its two primary layers.

Epidermis:

The epidermis is the skin's outermost layer. The epidermis's cells create a barrier and a multilayered system. The epidermis is made up of five different layers. The horny layer is called stratum corneum, the refractile layer is called stratum lucidum, the granular layer is called stratum granulosum, the spiny layer is called stratum spinosum, and the base layer is called stratum basale.

Dermis:

Blood arteries, nerve endings, hair follicles, and sweat glands are all found in the dermis, a thick layer of strong, viscoelastic tissue that lies under the epidermis. The dermis is made up of a comparatively limited number of cells that are encased in an amorphous "jelly" known as ground substance and situated inside a network of protein fibers. Fibroblasts are the main cells that make up the dermis. These cells produce the two primary fibrous protein types, collagen and elastin.



Hydrogel:

Hydrogel, sometimes known as aqua gel, is a mixture of insoluble polymer chains that is sometimes observed as a colloidal gel consisting of water acting as the scattering medium. Hydrogels are created using natural or synthetic polymers that are superabsorbent—that is, able to hold over 99 percent of water. Because hydrogels include a large amount of water, they also have an elasticity that is quite similar to that of real tissue.

Properties of Hydrogel:

The gelling operator should ideally be safe, inert, and unable to react with other formulation fixes.

The presence of a suitable antimicrobial operator is required.

The topical hydrogel must not be sticky.

You must use sterile eye gel.

The mechanical properties of the strong state are demonstrated.

Throughout the system, every component stays the same.

When the gels are standing, they do not settle easily and stay uniform due to the solid partiality between the fluid medium and the scattered stage.

Material and Methodology:

Collection of Plant Material:

Leaves of Aloe vera are collected from the local area of Himachal Pradesh near Abhilashi university; Mandi. The chemicals required for study is provided by Abhilashi university school of Pharmacy Chail Chowk.

Preparation of Extract:

Decoction method:

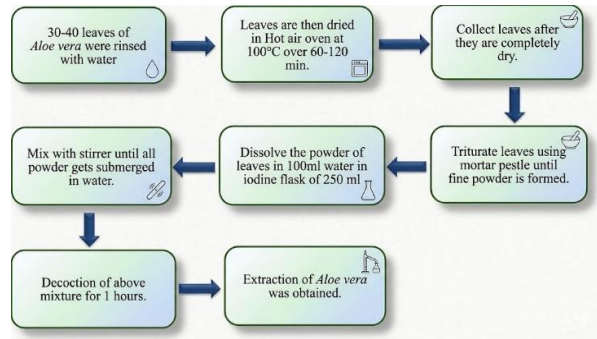


Figure 2: Decoction Process.

Sr. no.	Ingredient	F1	F2	F3	F4	F5	F6
1	Extract of aloe vera (ml)	20	20	20	20	20	20
2	Carbopol 934(mg)	180	180	195	195	205	205
3	PropyleneGlycol400(ml)	3	5	5	7	5	7
4	Glycerine (ml)	1	1	1	1	1	1
5	Methylparaben (mg)	305	305	305	305	305	305
6	Triethanolamine (ml)	1	1	1	1	1	1
7	Distilled water (ml)	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.

Table 1: Material and Quantity used.

Preparation of Gel:

180 mg of carbopol-934 was dispersed in 50 ml of distilled water with continuous stirring.

2 ml of distilled water was mixed with methyl paraben and propyl paraben.



They were dissolved on a water bath with continuous stirring. The solution was cooled and propylene glycol 400 was added gradually to form a homogenous mass.

Further extract of Aloe vera was mixed to the above mixture.

All the ingredients were mixed properly with Carbopol 934 to form a smooth gel.

Triethanolamine was added drop wise to the formulation for the adjustment of required pH of about 6.8-7, to form a gel of required consistency.

Further different formulations were prepared with herbal extract.

Evaluation of Gel:

The prepared gel was evaluated on the basis of following parameters like: Physical evaluation, measurement of pH, spread ability, viscosity, skin irritation, extrudability etc.

Physical Evaluation:

Physical parameters such as colour and appearance will be checked.

Measurement of pH:

pH of gel was measured with the help of pH meter.

Spreadability:

Spreadability was determined by the apparatus which consist of wooden block, which was provided by the pulley at one end. By this method spreadability was measured on the basis of slip and gel characteristics of gel. An excess of gel (2 gm) was placed on the on the glass slide. The gel was then sandwiched between this glass slide and another glass slide having the dimensions of fixed ground slide and provided with the hook. A 1 gm weighted was placed on the top of the two slides for 5mins to expel air and to provide the uniform film of the gel between two slides. Excess of gel was scrapped off from the edges. The top plate was then subjected to the pull of 80gms. With the help of string attached to the hook and time in seconds required by the top slides to cover a distance of 7.5cm can be noted. A shorter interval indicates better Spreadability

$$S = M \cdot L / T$$

Where,

S= Spreadability, M= Weight of pen tied to the upper slide, T= Time taken (sec) to separated slides completely from each other.

Percentage Moisture Content:

The formulations percentage moisture loss was calculated. Accurate two-gram formulations (F1 to F9) were weighed and stored in a desiccator with anhydrous calcium chloride. The formulas were weighed after three days. The following calculation was used to determine the % moisture loss:

Initial weight- Final Weight / Final Weight x 100.

Viscosity:

The viscosity of the formulation was measured at 25 degrees Celsius using a Brookfield viscometer. The measurement was taken at 25 rpm speed by the L63 spindle.

Results and Discussion:

The physical parameters of formulation were compared on the basis of Physical evaluation, viscosity, pH, Spreadability, Moisture content. These tests were performed and their observations are listed.

Physical Evaluation:

The created hydrogel formulation is semisolid in consistency and has a light white colour, which appearance is good by physical inspection.

Sr.no	Physical evaluation	Inference
1	Colour	Light White
2	Appearance	Good
3	Consistency	Semi-solid

Table 2: Physical Evaluation.



p^H:

The prepared Hydrogel formulation has pH of Formulation 4 is = 5.89

Formulation	F1	F2	F3	F4	F5	F6
pH	4.58	4.77	5.12	5.89	5.96	6.12

Table 3: p^H Results.

Spreadability:

The prepared hydrogel formulation has good Spreadability at Formulation 4 is =1.97.

Formulation	F1	F2	F3	F4	F5	F6
Spreadability	1.79	1.82	1.86	1.97	1.70	1.72

Table 4: Spreadability Evaluation.

Viscosity:

The prepared hydrogel formulation viscosity is Formulation 4 =4469 cp.

Formulation	F1	F2	F3	F4	F5	F6
Viscosity	3884	3990	4150	4469	4552	4648

Table 5: Resulting Viscosity.

Percentage Moisture Content:

The prepared hydrogel formulation of % Moisture Content at Formulation 4 = 95.90 %

Formulation	F1	F2	F3	F4	F5	F6
% Moisture Content	93.74	93.98	94.52	95.90	92.10	92.34

Table 6: Percentage Moisture Content of Aloe Vera Hydrogel.

II. CONCLUSION

The current work successfully produced and evaluated a topical hydrogel comprising Aloe vera extract using Carbopol 934 as the gelling agent. Each created chemical had excellent physical qualities, reasonable homogeneity, and enough stability. Formulation F4 showed the greatest features among the other formulations, making it suitable for topical administration due to its optimum pH, acceptable Spreadability, enough viscosity, and high moisture content. Aloe vera extract provided benefits such wound-healing, antimicrobial, anti-inflammatory, and moisturizing properties. The results show that the developed herbal hydrogel is safe, stable, and efficacious when applied topically. It might be a potential natural product for skin care and wound therapy. Further research, including stability testing and clinical evaluation, can enhance its pharmaceutical usability and therapeutic efficacy.

Ethics:

This study was a primary analysis based on the currently existing data and involve human participation for the preparation of the formulation. Therefore, the ethics approval was not required in this paper.

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Conflict of interest:

The author declares that there is no conflict of interest.



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Data Access:

The data that supports the finding of this study are available from the corresponding author upon reasonable individual request.

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