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Anti-Bacterial Herbal Gel

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ABSTRACT:
Ayurveda is nowdays considered to provide the best treatment for any kind of disease conditions as it does not have any of side effects. Herbal medicine has become an item of global importance both medicinal and economical. Due to rapidly developing antibiotic resistance for various bacterial and fungal infections in the body, a strong and effective solution was required to tackle this problem. Geographically a variety of herbs are available showing the anti-bacterial properties. The present review article has been undertaken with the aim to study the antibacterial activities of gel formulation prepared from herbal plants.

Keywords: Bacteria, Infection, Diseases, Anti-biotics, Herbal gel.

I. INTRODUCTION:

Bacteria are the living microorganisms which are very small in size and are unicellular in nature. While observing under a microscope it was found to be rod shaped, spiral shaped as well as in the spherical shape such as balls. Most bacterial species are either spherical, called cocci , or rod shaped, called bacilli. Some bacteria, called vibrio, are shaped like slightly curved rods or comma shaped; others can be spiral shaped, called spirilla, or tightly coiled, called spirochaetes. A small number of other unusual shapes have been described, such as star-shaped bacteria.The vast majority of bacteria are harmless to people and some strains are even beneficial. In the human gastrointestinal tract, good bacteria aid in digestion and produce vitamins. They also help with developing immunity, making the body less hospitable to bad bacteria and other harmful pathogens. When considering all the strains of bacteria that exist, relatively few are capable of making people sick. The Bacteria plays animportant role in ourdayto-day life, as bacteria are mainly involved in the GIT of the humans as well as other living organisms which helps in the process of digestion and also the other biochemical processes and reactions in our body. Only a small percentage of the world's bacteria can cause infections leading to disease.Those bacterial infections have a large impact on public health. Those infectious diseases are mainly caused by viruses and parasites, however, the bacterial resistance to antimicrobials is a rapidly growing problem with potentially devastating consequences.

BACTERIAL INFECTIONS:

A bacterial infection is a proliferation of a harmful strain of bacteria on or inside the body. Bacteria can infect any area of the body. Pneumonia, meningitis, and food poisoning are just a few illnesses that may be caused by harmful bacteria. Bacteria come in three basic shapes: rod-shaped (bacilli), spherical (cocci), or helical (spirilla). Bacteria may also be classified as gram-positive or gram-negative. Gram-positive bacteria have a thick cell wall while gram-negative bacteria do not. Gram staining, bacterial culture with antibiotic sensitivity determination, and other tests like genetic analysis are used to identify bacterial strains and help determine the appropriate course of treatment. Bacterial infections are very common, but not all of those infection are same. There are many types of bacteria which can each have different effects on the body.Bacteria and viruses are different types of pathogens, organisms that can cause disease. Bacteria are

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larger than viruses and are capable of reproducing on their own. Viruses are much smaller than bacteria and cannot reproduce on their own. Instead, viruses reproduce by infecting a host and using the host's DNA repair and replication systems to make copies of itself. The symptoms of a bacterial or viral infection depend on the area of the body that is affected. Sometimes the symptoms of the two can be very similar. For example, runny nose, cough, headache, and fatigue can occur with the common cold (virus) and with a sinus infection (bacteria). A doctor may use the presence of other symptoms (such as fever or body aches), the length of the illness, and certain lab tests to determine if an illness is due to a virus, bacteria, or some other pathogen or disease process.

Symptoms Of Bacterial Infections:

Children and adults of any age can develop a bacterial infection. Bacteria can infect every area of the body, including your:

- Bladder
- Brain
- Intestines
- Lungs
- Skin

A bacterial infection can also spread throughout the blood, triggering a potentially life-threatening blood infection called septicemia. That, in turn, can lead to sepsis, a condition that happens when your body has a severe response to an infection.

You can feel generalized symptoms as a result of a bacterial infection. Generalized symptoms affect the whole body and include fevers, chills, and fatigue.

Localized Symptoms

You can also experience localized symptoms (local effects) of a bacterial infection.

These symptoms affect the specific area or areas of the body that are infected. Pain, swelling, redness, and problems with organ function are typical localized symptoms.

Pain is common with bacterial infections. You can experience skin pain with a bacterial skin infection. A lung infection can cause pain when breathing. And you can feel abdominal (stomach) pain with an intestinal (or bowel) infection.

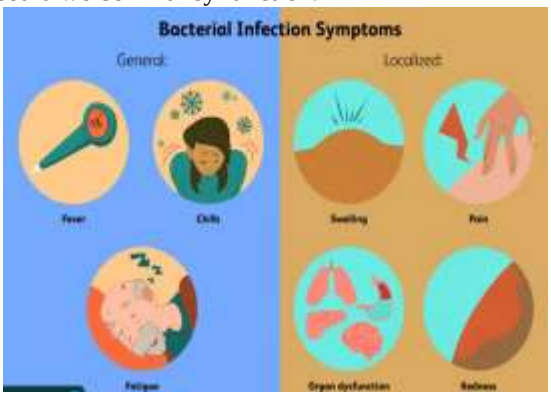
You can easily notice redness or swelling on parts of the body that you can see, such as the skin, throat, or ears.

Internal organs can become inflamed and swollen when you have a bacterial infection, too. While you can't see it, you may feel pain or other effects in these areas.[1]

Consider a bacterial infection of the respiratory tract that can affect your throat, bronchi, or lungs. As a result, you might develop a productive (wet) cough with thick mucus.

Bacterial infections can reduce or alter the affected body part's ability to function.

For instance, meningitis (an infection surrounding the brain) can impair your concentration. Pyelonephritis (a kidney infection) could worsen kidney function.



Bacterial Skin Infections:

Bacterial skin infections are mainly caused by gram-positive strains of Staphylococcus and Streptococcus or other organisms. Commonly bacterial skin infections include:

- **Cellulitis** causes a painful, red infection that is usually warm to the touch. Cellulitis occurs most often on the legs, but it can appear anywhere on the body.
- **Folliculitis** is an infection of the hair follicles that causes red, swollen bumps that look like pimples. Improperly treated pools or hot tubs can harbor bacteria that cause folliculitis.
- **Impetigo** causes oozing sores, usually in preschool-aged children. The bullous form of impetigo causes large blisters while the non-bullous form has a yellow, crusted appearance.
- **Boils** are deep skin infections that start in hair follicles. Boils are firm, red, tender bumps that progress until pus accumulates underneath the skin.

Bacterial skin infections are treated with oral or topical antibiotics depending on the strain causing the infection.

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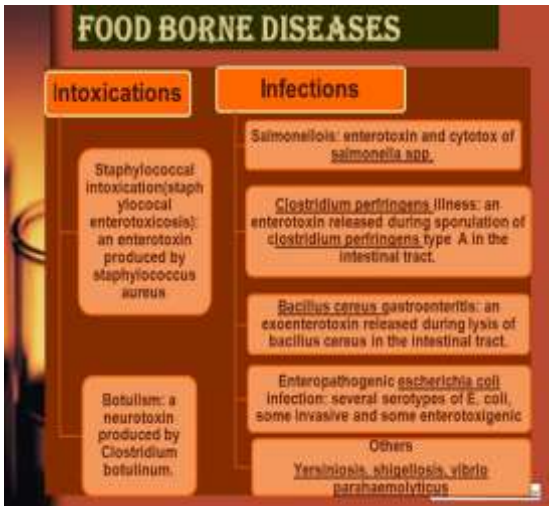
oodborne Bacterial Infections

Bacterial infections are one cause of foodborne illness. Nausea, vomiting, diarrhea, fever, chills, and abdominal pain are common symptoms of food poisoning. Raw meat, fish, eggs, poultry, and unpasteurized dairy products may harbor harmful bacteria that can cause illness. Unsanitary food preparation and handling can also encourage bacterial growth. Bacteria that cause food poisoning include:

- Campylobacter jejuni (C. jejuni) is a diarrheal illness often accompanied by cramps and fever.
- Clostridium botulinum (C. botulinum) is a potentially life-threatening bacterium that produces powerful neurotoxins.
- Escherichia coli (E. coli) O157:H7 is a diarrheal (often bloody) illness that may be accompanied by nausea, vomiting, fever, and abdominal cramps.
- Listeria monocytogenes (L. monocytogenes) causes fever, muscle aches, and diarrhea. Pregnant women, elderly individuals, infants, and those with weakened immune systems are most at risk for acquiring this infection.
- Salmonella causes fever, diarrhea, and abdominal cramps. Symptoms typically last between 4 and 7 days.
- Vibrio causes diarrhea when ingested, but it can also cause severe skin infections when it comes in contact with an open wound.



Sexually Transmitted Bacterial Infections

Many sexually transmitted diseases (STDs) are caused by harmful bacteria. Sometimes, these infections aren't associated with any symptoms but can still cause serious damage to the reproductive system. Common STDs caused by bacterial infections include:

- Chlamydia is an infection in men and women caused by an organism called Chlamydia trachomatis. Chlamydia increases the risk of pelvic inflammatory disease (PID) in women.
- Gonorrhea, also known as "clap" and "the drip," is caused by Neisseria gonorrhoeae. Men and women can be infected. Gonorrhea also increases the risk of pelvic inflammatory disease (PID) in women.
- Syphilis can affect men and women and is caused by the bacteria Treponema pallidum. Untreated, syphilis is potentially very dangerous and can even be fatal.
- Bacterial vaginosis, which causes an overgrowth of pathogenic bacteria in the vagina (the CDC does not consider this a STD.

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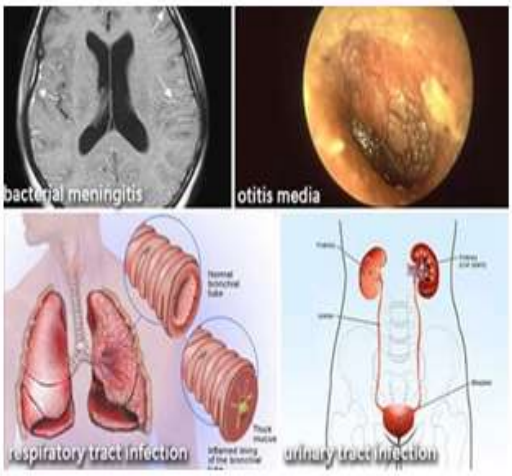
Other Bacterial Infections

Harmful bacteria can affect almost any area of the body. Other types of bacterial infections include the following:

- Bacterial meningitis is a severe infection of the meninges, the lining of the brain.
- Otitis media is the official name for an infection or inflammation of the middle ear. Both bacteria and viruses can cause ear infections, which commonly occur in babies and small children.
- Urinary tract infection (UTI) is a bacterial infection of the bladder, urethra, kidneys, or ureters.
- Respiratory tract infections include sore throat, bronchitis, sinusitis, and pneumonia. Bacteria or viruses may be responsible for respiratory tract infections. Tuberculosis is a type of bacterial lower respiratory tract infection.



➢ **Bacterial Skin Infections:**

- **Cellulitis-**

Cellulitis is an skin infection which is very painful as compared to the other ones. Firstly the infection may appear as a discoloured or swelling in the skin area which feels hot to touch and can cause severe infections as it spreads rapidly. The Cellulitis caused on light skin may appear red or pink colour and on the dark skin , it mainly appears in dark brown or purple colour. Feet or lower legs are mainly affected by Cellulitis infection also the infection may spread to any of the body part or the face. Staphylococcus and Streptococcus bacteria are the root cause of this infection. The interference of any of this bacteria in the body/skin can cause skin injuries like surgical wounds, cuts and bug bites which may lead to Cellulitis.

Symptoms:

Fever
Redness of skin along with inflammation
Rashes on skin, sore skin
Pain on affected portion
Warm feeling on the affected portion
Tightness in skin
Fatigue and dizziness

Treatment:

Cellulitis can be treated easily by oral administration of Antibiotics for about 5 days. Early diagnosed infection can be cured with intravenous infusion of antibiotics.It takes about 7-10 days for the complete treatment of cellulitis using antibiotics.

- **Folliculitis-**

Folliculitis is a common (benign) skin condition where the hair follicles are infected or inflamed which causes or forms a pustule or aerythematous papule of overlying covering on skin with hair. Though it is an non-threatening and less dangerous as compared to others it may cause problematic situations for the immunocompromised patients.[1] Folliculitis is caused mostly by the bacterial infection of the superficial or deep hair follicles, it may be also caused because of various fungal species or viruses.

Superficial Bacterial Folliculitis: Superficial Folliculitis is the most common form of folliculitis and it is caused because of the interference of the bacteria Staphylococcus aureus.The methicillin sensitive as well as methicillin resistant bacteria can caused this infection.[1]

Treatment - Topical Antibiotics are commonly preferred. Mupirocin, Clindamycin are preferred as first line topical antibiotics. In case of oral antibiotics Cephalexin and Dicloxacillin can be used.[2,3]

Gram-Negative Bacterial Folliculitis: It is mainly caused due to the bacteria Pseudomonas aeruginosa and is also known as Hot Tub Folliculitis. Exposure to the contaminated water is the root cause of this infection, it may also increase after the long term use of oral antibiotics.[4,5]

Treatment - Ampicillin, Trimethoprim-Sulfamethoxazole, and Ciprofloxacin are preferred as first-line agents.[6]

Viral Folliculitis: It is commonly caused due to the Herpes Virus, but very rare cases have been observed

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where this infection is caused because of Molluscum contagiosum. The difference between the virally caused folliculitis and the bacterial folliculitis is that instead of postules, plaques or papulovesicles are present.[7]

Treatment - Oral antibiotics -Acyclovir, Valacyclovir, and Famciclovir. Cryotherapy is used for the treatment of Molluscum contagiosum folliculitis and Cantharidin is used as topical antibiotic.[6]

Demodex Folliculitis: It is mainly caused because of the mite Demodex folliculorum. It is observed that among all humans 80-90% of humans carry this mite. As the Demodex mite is present in the pilonidal sebaceous area of skin this folliculitis infection is controversial.[8]

Treatment - Anti-Parasitic agents such are mainly preferred as a choice of treatment for this infection.
Oral- Metronidazole, Ivermectin and topically Permethrin is used. The combined treatment of oral and topical drugs have been found to be much more effective.[9,10]

- **Impetigo-**

Impetigo is a common skin infection mainly caused due to the gram-positive bacteria, in which the superficial layers of epidermis is highly contagious. Childrenresiding in hot humid climates are at a very high risk for this infection. It is present in the form of erythematous plaques which have yellowish crust and maybe painful and itchy.This infection specifically affects the face or may also spread on the other parts of body showing any abrasions, laceration, insects bites or trauma.

Men are most commonly affected by this infection but most commonly it is observed in the children of age about 2-5 years or above it. Bullous impetigo is most common among infants.[11,12,13]

Treatment- Topical Antibiotics are preferred mainly but can also be given in combination with systemic antibiotics.

For non-bullous and localized impetigo, topical antibiotics such as Mupirocin, Retapamulin and fusidic acid.
For bullous impetigo, systemic antibiotics are mainly preferred. B-lactamase inhibitors such as Cephalosporins,Amoxicillin-clavulanate, Dicloxacillin. Cephalexin is commonly used.
Trimethoprim-sulfamethoxazole are effective against MRSA.[14,15,16]

- **Boils-**

Boils is a skin infection which gradually starts in the hair follicles or oil glands, in which firstly redness is observed on the infected skin area followed with development of a tender lump. Within a period of 4-7 days the pus starts collecting under the skin which turns the lump from red to white.

Boils commonly appears on neck, face, armpits, shoulders and buttocks. Sty is the kind of boil infection which mainly forms on the eye lids. The most severe case in the boils is carbuncle, skin infection in which boils appear in a group.
Boils are mainly caused because of the bacteria Staphylococcus aureus. Commonly it is present on the skin or in the inner lining of the nostrils. Boils is commonly caused in the people with weak immune system, thus people suffering from various medical conditions, diabetes, severe infections or cancer are more prompt to this skin infection.

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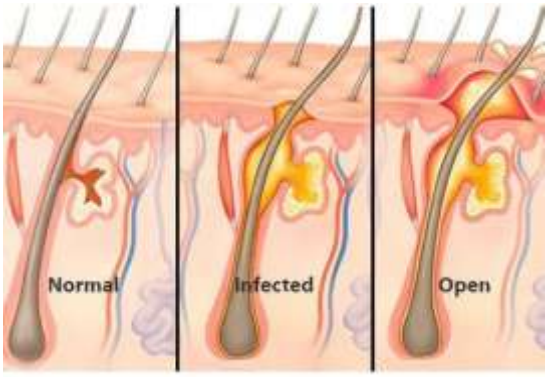

Treatment: Treatment for boils involves mainly the opening of the pus-filled abscess by giving a small cut on it which drains out the pus. As per medical professionals the boils should never be squeezed as this may cause more infection.
Ointment known as "Drawing Slave" is also used, but in severe infections it recommended to prefer antibiotics prescribed by doctors.[17]

As per the information provided above it is observed that most off the skin infections are mainly treated using the various antibiotics which is considered to be the most preferable and safer mode of treatment. The antibiotics can be administered orally through the tablets or capsule type of dosage form.
Though oral antibiotics may have better bioavailability than any other dosage form, it takes time for the drug to reach the site of action.

Skin infections can be treated with the topical antibiotics in the form of creams, ointments, lotions, liniments or gels.

In the time being the gel formulations are mainly preferred over any other topical antibiotics as they are easy to apply and shows very least side effects.Thusin case of skin infections topical antibiotics are most preferable one especially the gels.

Gels:

The gels are semisolid systems containing either suspensions made up of small inorganic particles, or large organic molecules which are interpenetrated by a liquid. As the gel contains various small particles they are classified as:

a. Two Phase System – In two phase system the particle size is mostly larger, so the gel mass can be known as magma.
b. Single Phase System- It mainly consist of organic macromolecules which are uniformly distributed in the liquid such that the apparent boundaries between the macromolecules and the liquid does not occur.

Characteristics Of Gel[18]:

A) Swelling- When the gel comes in the contact of a liquid medium the swelling agents present in it are capable of swelling. Its swelling properties are mainly dependent on the gelling agents used in the formulation.
B) Syneresis- When the gels are stored for longer period of time, some of them release water or liquid and this phenomenon of releasing of fluid is termed as syneresis. It indicates that the quantity of the gelling agent used is not sufficient. An ideal gel should be Syneresis free.
C) Structure- The rigidity of the gel is dependent on the gelling agent use. The gelling agents are responsible for the viscosity of gel as well as the bonding between the particle and medium(liquid) used the formulation.
D) pH – The changes/variations in the pH may cause skin irritations. The pH of the gels should be isotonic.
E) Spreadability- The surface area to be covered by the gel on application is determined by the spreadability. The spreadabiltyshould always be excellent.

Properties of Gels:

Various Properties of Gels are Following:

A) Physical Properties[25,26,27]
- Gels are elegant in appearance and have a smooth texture.

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- They are non-dehydrating and non-greasy.
- Gels are semisolid in nature.
- Gels are translucent and transparent.

B) Physiological Properties[25]

- Gels are mostly non-irritating in nature.
- They are miscible with the skin secretions.
- Gels have low sensitization index and does not alter the skin functioning.

C) Application Properties[25]

- They are applicable easily with a good drug release efficiency.
- The gels have a very aqueous washability.

D) Rheololgical Properties[28]

- Gels does not flow at low shear stress, but undergoes reversible deformation like the elastic solids.
- The gel flows like liquid if the yield value or the yield stress exceeds more than that of normal.

Classification of Gels:

A) Controlled release gels
B) Organogels
C) Extended-releasegels
D) Amphiphilic gels
E) Hydrophilic gels
F) Non aqueous gels
G) Bio-adhesive gels
H) Thermosensitive sol-gel reversible hydrogels
I) Complexation gels
J) Hydrogels

Methods For Preparation of Gels:

1. Fusion Method:

In the Fusion method the vehicles, additives, gelling agents and drug are blended together at a high temperature until a semisolid texture is formed.[19]

2. Cold Method:

In the Cold method, all of the components excluding drug or API are heated and blended simultaneously. After lowering temperature of the formulation drug or API is added and blending process is started until the formation of gel.[19]

3. Dispersion Method:

In Dispersion Method,the gelling agent is added in water and stir continuously until the gelling agent is swelle up. The drug dissolved in the medium (liquid) is then incorporate into it.
Buffer solution is added for the adjustment of pH.[19]

Gelling Agents:Gelling agents are the polymers which provides texture to the gels.

- Natural Polymers- Gelatin, Xanthine, Cassia Tora, collagen, pectin and Guar gum etc.
- Synthetic Polymers- Carbopol 940, Carbopol 934, Polyvinyl alcohol.
- Semi-Synthetic Polymers- Hydroxyl propyl methyl cellulose, Carboxyl methyl cellulose, Hydroxy ethyl cellulose.

Additives Used in Gel Formulation:

- Preservatives: Preservatives are used to preserve the gel for longer time period and avoid any kind of spoiling in it.

E.g.- Methyl Paraben, Propyl Paraben, etc.

- Drug solubilizer:Solubilizers are used to increase the solubility of the drugs. The solubility of the drugs having poor solubility can be increased with solubilizers.

E.g., Triethyl-o-amine and PVP, etc.

- Stabilizers: Stabilizers are used to stabilize the heavy metals and other agents in the gel by using the chelating agents.

E.g. E.D.T.A.

Advantages of Gels:[20,21,22]

1. The first pass effect can be avoided, i.e. the initial passage of the drug substance through body.
2. Systemic and portal circulation can be avoided following the absorption in GIT.
3. They are non-invasive and are have localized effect with minimum side effects.
4. Difficulties in the GIT due to its pH can be avoided easily.
5. Drug food interaction and other enzymatic activities can be avoided.
6. Gels are used in the cutaneous and percutaneous drug delivery, and also they shows prolonged and slow absorption on topical application.

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Dis-Advantages of Gels:[21,23,24]

1. Some drugs have poor absorption through the skin, thus drugs with larger particle size cannot be absorbed easily.
2. The gels which are to be applied into body cavities or eyes should be sterilised properly, as they may cause allergic reactions or side effects.
3. The enzymes present in the epidermis may denature the drugs in the skin.

Anti-Bacterial Gel:

Anti-bacterial gel are the gels which shows anti-microbial/ antibacterial properties by inhibiting or preventing the growth of bacteria on the skin. Those gels also help to maintain a moist environment around the wound, which is conductive to healing either by absorbing the wound extrudate or by providing moisture while delivering the antibacterial drugs. Antibacterial gels inhibitthe growth of bacteria such as Staphylococcus aureus, Pseudomonas aeruginosa, E.coli,Vancomycin resistant Enterococcusfaecalis(VRE), Methicillin resistant Staphylococcus aureus(MRSA),etc

Anti-Bacterial Herbal Gel:

Herbal antibacterial gels are same as that of the other pharmaceutical gels, but are mainly prepared from herbal plants, ayurvedic products, or other plant extracts which shows medicinal properties.

Herbal products/gel has less side effects and are more effective against skin infection.

Aloe vera gel is the most common gel used in today's time. It shows various properties such as antibacterial, anti-viral , antiseptic. The aloe vera gel is also used as a moisturiser, helps in healing properties, protective effects.

Aloe-vera also shows anti-inflammatory action. Aloe vera is also useful in dental industry.

Preparation of Gel Base:[29]

Carbopol 934 is dissolved slowly in 60 ml of water with continuous stirring, to avoid its agglomeration.

Disodium edetate and Triethanolamine are dissolved in about 10ml of water and stirred for 10 min.

4.83 ml of propylene glycol is mixed with 12 ml of water and stirred for 10 min.

Disodium edetate and triethanolamine are then added to the Carbopol solution and the pH was adjusted to about 7.4 with a continuous stirring for about 10 min.

Propylene glycol solution is then added with a stirring of 10 min, until a clear, consistent gel base is formed.

Preparation of Gel:[29]

Disperse the Carbopol 940 in distilled water to form a polymer dispersion.

A solution containing methyl paraben, propyl paraben and glycerine were mixed together and kept for 24 hrs.

The leaf extract or the herbal drug is mixed with propylene glycol and this solution is then added to the polymer dispersion.

The remaining water is then added to the solution to make up the volume of formulation.

Triethanolamine is used to adjust the pH of the formulation.

Formulation & Evaluation of Herbal Gel:[30]

Twelve different gel formulations (F1 to F12) were prepared using different concentrations (0.5, 1, 1.5, 2, 2.5 and 3% w/w) of methanol extract of the herbal

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drug, with 1.5 % concentration of Carbopol 934 or Carbopol 940 polymer respectively.

Carbopol 934 and Carbopol 940 were used as gelling agent in the formulation as they are biodegradable,bio-adhesive, irritation free and are not absorbed into body

Among the two polymers, Carbopol 934 has more gelling property as compared to Carbopol 940. Thus it is best suitable for the controlled release of the active phytoconstituents in the gel formulation.

After preparing the gel with various concentrations from 0.5-2.5%, the gel formulated with 1.5% of Carbopol was found to be compatible with the requirements of gel formulations.

As per the quality control tests performed, it was concluded that the gel prepared with Carbopol 934 was fund to be more superior then the Carbopol 940.

As per the studies Dimethylsulfoxide and propylene glycol are reported to be the best permeation enhancers. Since DMSO reported to causes skin erosion, both of the permeation enhancers were replaced with propylene in the preparation of the gel formulation. Disodium edetate and triethanolamine were used in the formulation for the adjustment of its pH .

Evaluation Parameters for Gel:

1) pH: The pH value of the gel formulation should be determined to avoid any skin irritation. It is determined using a pH meter. The pH measurement is one after 1,30,60,90 days of the formulation to detect any change in pH of the formulation.
2) Viscosity: The viscosity of gel is determined using Brookfield viscometer. The readings are mostly taken at 100 rpm using the spindle number 7.
3) Spread ability: The spreadability of the gel is mainly determined by measuring the diameter of spreading of 1gm of gel between two horizontal plates for about one minute.
4) Physical Appearance; The physical appearance is studied or observed through the visual observation and inspection.

Benefits of Herbal Gel:

Aloe vera Gel is the most common and one of the safe herbal gel formulation, so we can consider aloe vera gel as a example.

Herbal products are safe and shows more efficacy than the synthetic formulations.

II. CONCLUSION

Herbal gels providea protective barrier from contamination and reducing frequencies of use of anti-bioticbasedgels while also providing sustained desired effect. Indiscriminate use of antibiotics in today's world is one of themajor reasons for the rising emergencies of multi-drug resistant pathogenic strains that do not respond to the usualline of treatment. Therefore, the need to search for new antimicrobial remains unchallenged. Therefore, currentlytrend to look out for the alternative natural or herbal medicine is increasing. The reason is they tend to have fewerside effects or toxicity thanks to their natural sources. Herbal gels are also economically reliant and also can beused by customers and patients of all types without much worry for side effects and adverse drug reactions. Herbalgels can also serve the purpose of different medicinal categories.Therefore herbal gels and also herbal products arethe way for the future.

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