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Herbal Gel: A Review on Formulation and Evaluation of Polyherbal Anti-Acne Gel

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Abstract: *Acne vulgaris is a long-standing inflammatory condition of the hair follicle and its oil gland. It is seen most often in teenagers and young adults, but it can start or persist at almost any age. The condition develops when several things happen together: too much sebum, follicles clogged by dead cells, overgrowth of skin bacteria and inflammation around the follicle. Standard treatments such as topical antibiotics, retinoids and benzoyl peroxide do help, yet they can leave the skin dry and irritated, they are not always affordable, and repeated antibiotic use encourages resistant bacteria. For these reasons, plant-based preparations are being looked at as gentler options. This review gathers published work on four herbs, neem (Azadirachta indica), green tea (Camellia sinensis), aloe vera (Aloe barbadensis Miller) and licorice (Glycyrrhiza glabra), which have anti-inflammatory, antioxidant, antibacterial and skin-healing properties relevant to acne. It also outlines how the extracts can be prepared and built into a Carbopol 940 gel, and how such a gel is checked for physical quality, safety, stability and antimicrobial activity. The evidence so far suggests that the combination is a sensible candidate for development, but standardised extracts, tests of synergy and controlled clinical trials are still missing.*

Keywords: anti-acne formulation, polyherbal gel, neem, green tea, aloe vera, licorice, Carbopol 940, anti-inflammatory activity, antibacterial activity

I. INTRODUCTION

Acne vulgaris is among the commonest skin complaints in the world. It mostly appears on the face, but the back, chest and shoulders are also frequent sites, because these areas carry a high density of sebaceous glands [9]. Although acne is not dangerous to life, it should not be dismissed as trivial. Visible lesions can dent self-confidence and mood, and long-standing or badly handled acne may leave scars and dark marks that last far longer than the pimples themselves [9,11].

Hormonal changes, especially around puberty, increase the output of sebum. At the same time, the cells lining the follicle shed abnormally and stick together, so the pore become blocked. Trapped oil then feeds Cutibacterium acnes (formerly Propionibacterium acnes), and the immune response to this bacterial growth produces redness, swelling and pus [9].

Modern treatments are effective but have drawbacks. Benzoyl peroxide and retinoids commonly cause burning, peeling and dryness, topical antibiotics can lose their effect as resistant strains emerge, and the cost of long courses puts some products out of reach [9,11]. Herbal medicines have a long history of use in skin disease [5], and a number of recent papers have tried to turn that tradition into measurable formulations [1-4,16,17]. A gel is an attractive form for oily, acne-prone skin because it is light, non-greasy, spreads easily and washes off cleanly [2,6].

Types of acne

Acne lesions are usually grouped by how deep they sit and how inflamed they are:

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• Whiteheads (closed comedones): small white or skin-coloured bumps formed when oil and dead cells plug a pore that then stays closed at the surface. They are small and usually painless.
• Blackheads (open comedones): tiny dark spots, common on the nose, forehead and chin. The pore remains open and the plug darkens on contact with air. The colour is due to oxidation, not dirt.
• Papules: red or pink raised bumps that are tender to touch and have no visible white or black centre. Many papules together usually point to moderate or severe acne.
• Pustules: inflamed pimples with a visible yellowish, pus-filled tip, surrounded by a red base.
• Nodules: large, firm and painful lumps that lie deep under the skin and may heal with scarring.
• Cysts: deep, soft, pus-filled lesions. They are the most severe form and carry the highest risk of permanent scars.

Herbal ingredients

1. Neem

Neem leaves contain limonoids and flavonoids that show antibacterial and anti-inflammatory activity in laboratory work [15]. In a neem-extract gel, the agar-diffusion zones increased with extract strength, and a small human trial reported clearing of pimples within a few weeks [7]. These results are encouraging, but they come from limited data.

2. Green tea

The polyphenols of green tea, especially EGCG, are strong antioxidants and also dampen inflammatory signalling. A systematic review and meta-analysis of randomised trials concluded that green tea, particularly when applied to the skin, improved acne lesions [10]. Of the four herbs, it therefore has the strongest human evidence at present. Catechins are, however, sensitive to light, heat and oxidation, which is a practical challenge for the stability of the final gel.

3. Aloe vera

The clear inner gel of the aloe leaf is rich in polysaccharides and has been used for centuries on burns and wounds [12,18]. In an acne gel it offers moisture, a cooling feel and support for skin repair, which may offset the dryness caused by other ingredients. Gels containing aloe have also shown good extrudability and acceptable spreading [2].

4. Licorice

Licorice root contains glycyrrhizin and several flavonoids, including glabridin, with documented anti-inflammatory and antimicrobial actions [13,14]. Its added value in acne is the possible lightening of the dark marks that remain after pimples have healed.

Materials and methods

1.Plant materials

Common name	Botanical name	Part and form used
Green tea	Camellia sinensis	Leaves, dried and powdered
Licorice	Glycyrrhiza glabra	Root, dried and powdered
Aloe vera	Aloe barbadensis Miller	Fresh leaf gel
Neem	Azadirachta indica	Leaves, dried and powdered

2. Excipients and chemicals

Ingredient	Chemical name	Function	Ref.
Carbopol 940	Carbomer 940 (cross-linked polyacrylic acid)	Gelling agent	[2,4,6]
Methylparaben	Methyl 4-hydroxybenzoate	Preservative	[4,6]
Propylparaben	Propyl 4-hydroxybenzoate	Preservative	[2,6]
Triethanolamine	2,2',2''-Nitrilotriethanol	Neutraliser; brings pH into a skin-compatible	[2,4,6]

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		range	
Propylene glycol	Propane-1,2-diol	Humectant; solvent for preservatives and extracts	[4,6]
Sodium lauryl sulfate*	Sodium dodecyl sulfate	Surfactant	[6]
Ethanol (95%)	Ethyl alcohol	Extraction solvent	-
Distilled water	Water	Extraction medium and gel vehicle	-

Equipment

- Mechanical grinder and sieve for powdering the dried plant material.
- Soxhlet extraction apparatus with condenser and heating mantle.
- Rotary evaporator or a distillation set-up for removing solvent and concentrating the extracts.
- Glass beakers, stirring rods and a magnetic stirrer; digital weighing balance.
- Calibrated digital pH meter.
- Collapsible aluminium tubes or airtight containers for the finished gel.

Preparation of the plant extracts

Green tea extract

1. Wash the leaves well to remove dust and dirt.
2. Spread them in a thin layer and dry them in the shade at room temperature for several days, until they are crisp. Direct sunlight should be avoided because it breaks down polyphenols.
3. Crumble the dry leaves and grind them to a fine powder; pass the powder through a fine sieve and keep it in an airtight container.
4. Pack the powder into a Soxhlet thimble and extract with 95% ethanol until the solvent in the siphon tube runs clear.
5. Remove the solvent by distillation or rotary evaporation to obtain a semi-solid extract.

Licorice extract

1. Clean the roots to remove soil and fibrous material.
2. Cut them into thin, even slices so that they dry uniformly and quickly.
3. Dry the slices at low heat in an oven or dehydrator until they snap rather than bend.
4. Grind the slices to a powder and sieve out coarse pieces.
5. Extract the powder with ethanol in a Soxhlet apparatus, as for green tea.
6. Concentrate the extract by distillation and store it in an airtight, light-protected container.

Aloe vera gel

1. Select fresh, mature leaves and wash them to remove surface debris.
2. Cut off the outer rind and scoop out the clear inner gel, taking care to avoid the bitter yellow latex just under the rind.
3. Homogenise the gel to a uniform consistency.
4. If a thicker gel is needed, concentrate it gently at low temperature so that heat does not damage its constituents.
5. Use the gel fresh or mildly concentrated, or keep it in an airtight container until required.

Neem extract

1. Add 20 g of dried neem leaves to 200 mL of distilled water.
2. Heat the mixture at 70-80 °C for 30-40 minutes.
3. Let it cool, then filter through filter paper.
4. Concentrate the filtrate further if required.

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Preparation of the herbal gel

1.Sprinkle the required amount of Carbopol 940 over distilled water and leave it undisturbed so that the polymer swells completely into a lump-free dispersion.

2. In a separate vessel, dissolve methylparaben and propylparaben in a small volume of distilled water with gentle warming on a water bath, then cool to room temperature.

3. Add propylene glycol and sodium lauryl sulfate to the cooled preservative solution and mix until uniform.

4. Mix the neem, green tea, licorice and aloe vera extracts in the chosen proportion and blend them into the preservative-surfactant solution.

5. Add this extract solution gradually to the swollen Carbopol base, stirring continuously at moderate speed so that the extracts are spread evenly through the gel.

6.Continue gentle stirring until trapped air bubbles escape and the gel is homogeneous and free of streaks.

7.Prepare a second batch in the same way, using a higher proportion of the combined extract, so that strengths can be compared.

8.Transfer each batch to clean, labelled collapsible tubes or airtight containers and store at room temperature, away from direct light, until tested.

Before formal testing, each batch should be inspected for uniformity, colour, and the absence of grittiness or phase separation.

Evaluation of herbal anti-acne gels

Evaluation can be split into three groups: physicochemical tests, safety and stability tests, and biological tests. The methods below are those used in the reviewed studies [2,4,6-8].

1.Physicochemical tests

• Appearance and homogeneity: colour, smell, texture, grittiness and any separation are checked by eye and by touch. Lumps or undissolved extract suggest poor mixing [2,4].

• pH: measured with a calibrated pH meter, usually on a diluted gel (for example 1 g in 100 mL of water) [4]. A mildly acidic to neutral value close to that of skin is the aim. Values reported in the reviewed studies are compared in Table 4.

• Viscosity: measured with a Brookfield-type viscometer. Because Carbopol gels thin when sheared, the spindle, speed and temperature must always be stated. One neem gel study reported a value of 125 cP at 3% Carbopol [7].

• Spreadability: a weighed amount of gel is pressed between two glass slides, a known load is attached to the upper slide, and the time it takes to move a set distance is noted. S
= (M x L)/T, where M is the pulling weight, L the length of the slide and T the time [4]. Some authors instead report the diameter of spread in cm [2].

• Extrudability: the gel is filled into a collapsible tube and pressed under a fixed weight; the percentage extruded is graded as excellent (above 90%), good (above 80%) or fair (about 70%) [2,6]. Aloe-containing gels in one study extruded 87.95-95.35% [2].

• Washability: how easily the gel rinses off the skin under running water [4,6].

2.Safety and stability

• Skin irritation test: about 1 cm2 of skin on the back of the hand is covered with the gel and watched for redness, itching or swelling for up to 24 hours [6]. Any test on volunteers needs ethical approval and informed consent.

• Stability: the gel is stored at room temperature and under accelerated conditions for about a month, and colour, odour, pH, consistency and separation are checked at intervals. In one study the pH fell only from 6.4 to 6.3 over 30 days, with no other
Change[4].

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3. Biological tests

• Agar well diffusion: agar plates are seeded with the test bacteria, wells (8 mm in [8]) are filled with the gel or extract, and the clear zone around each well is measured after incubation. Results are compared with a standard antibiotic or a marketed product and with a negative control (DMSO in [8]).

• Minimum inhibitory concentration (broth microdilution): the lowest concentration that stops visible growth. One study tested S. epidermidis, S. aureus, E. coli, P. aeruginosa and C. albicans [2], but not C. acnes, the organism most relevant to acne.

• Tests on people: the only human data on neem gel came from a very small study in adults aged 17-22 years (four per group). Pimples cleared in 26, 21 and 15 days with the 1%, 2% and 3% gels [7].

Suggested evaluation tests and acceptance criteria for the polyherbal gel

Category	Test	Acceptance guide
Physical	Colour, odour, texture, homogeneity	Uniform and smooth; no grit or separation
Physical	pH	About 5-6.5; stable within ± 0.5 over storage
Rheology	Viscosity; spreadability	Consistent with the intended Carbopol level; easy spreading, short slide time
Application	Extrudability; washability	Extrudability above 80%; washes off easily, no stain
Safety	Skin irritation / patch test	No erythema or oedema at 24 h
Stability	Room temperature, 40 °C/75% RH, freeze-thaw, light	No change in appearance or pH; marker content retained
Microbial	Total count; yeast and mould	Within pharmacopoeial limits for topical preparations

Discussion

Taken together, the reviewed studies show that Carbopol-based herbal gels can be made with acceptable appearance, spreading and pH, and that they show antibacterial activity in the laboratory [2,6-8,16,17]. Two gaps stand out. First, almost no study has tested the gels against C. acnes directly, so the link between the in-vitro findings and real acne remains weak. Second, claims that the four herbs act synergistically are mostly assumed; very few papers test the extracts alone and in combination. Practical issues also matter: catechins degrade with light and heat, aloe gel and neem decoctions are prone to microbial spoilage without adequate preservation, and extract strengths differ so widely between studies that results are hard to compare. Standardising each extract to a marker compound would make future work far more comparable.

II. CONCLUSION

Each of the four herbs has a plausible role against a different part of acne: neem for its antibacterial and anti-inflammatory action, aloe vera for soothing and healing, licorice for calming inflammation and lightening marks, and green tea for its antioxidant and sebum-controlling effects. A Carbopol gel can carry them in a form that spreads well, washes off easily and has a skin-friendly pH. Green tea has the best clinical support when applied to the skin [10], whereas the evidence for neem, aloe vera and licorice comes mostly from laboratory work, small studies and reviews [7,12-15]. Herbal gels reported so far perform close to some marketed gels in the laboratory but less well than standard antibiotics, and synergy has not yet been tested. A neem, aloe vera, licorice and green tea gel is therefore a reasonable candidate for development. Before it can be recommended, it needs standardised extracts, direct synergy testing, stability work focused on catechins and colour, and controlled clinical trials.

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