

HERBAL PLANTS AND *PROPIONIBACTERIUM ACNES*: AN OVERVIEW

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ABSTRACT

Propionibacterium acnes are gram-positive anaerobic microorganism, which have been most recognized as a key factor for the development of acne. Acne is the most common skin disease and *Propionibacterium acnes* have been recognized as pus-forming bacteria triggering an inflammation in acne. Acne vulgaris is a chronic inflammatory disease of the pilosebaceous follicle, characterized by comedones, papules, pustules, cysts, nodules and often scars in certain sites of predilection, namely, the face, neck, upper trunk and arms. The present compiled work was conducted to make an overview and correlation between antimicrobial activities of medicinal plants against these etiologic agents of acne vulgaris. Different parts of various medicinal plants belongs to families like **Liliaceae**, **Rutaceae**, **Zingiberaceae**, **Myrtaceae**, **Lamiaceae**, etc. contains alkaloids, tannins, flavonoids, terpenoids, volatile oil and essential oil which are reported with significant effect against this bacteria.

KEY WORDS: *Propionibacterium acnes*, Pus, Anaerobic microorganism, Skin disease, Pimples

1. INTRODUCTION

1.1 Acne :Acne vulgaris is a chronic inflammatory disease of the pilosebaceous follicle, characterized by comedones, papules, pustules, cysts, nodules and often scars in certain sites of predilection, namely, the face, neck, upper trunk and arms.¹ *Propionibacterium acnes* release pro-inflammatory cytokines as well as antigens and mitogen(s), with cellular and non-cellular responses to these products triggering inflammation.² Acne vulgaris is a common skin disease that involves individuals of all ages. It has been estimated to affect 79% to 95% of the adolescent population, 40% to 54% of individuals older than 25 years, and 12% of women and 3% of men in their mid ages.³ Acne is genetic and if it runs in family, three out of four children may

have it, because it is genetic problem brought on by hormones.⁴ The major hormones involved in the etiology of acne are androgens, taking into account that 5 α -reductase type 1, responsible for the conversion of testosterone into dehydrotestosterone (DHT), appears to be most prevalent in the sebaceous glands of isolated acne areas and to have greater activity in women with moderate to severe acne.^{5,6,7} Acne is a group of disorders that causes outbreaks of skin lesions commonly called pimples factors which contribute to the development of acne include hormonal imbalance, bacterial infection, stress, food, or cosmetic application additionally some species of *Propionibacterium* are found in milk and cheese and some time in other agricultural product.⁸ *Propionibacterium acnes* are a

gram positive microaerophilic bacteria which are responsible for the local inflammatory response of acne, with the activation of monocytes and production of cytokines.^{5,9} It is caused by the oil glands present in the skin making too much sebum, an oily substance, which leads to plugged pores. It is the most common skin disease. *Propionibacterium acnes* are a common contaminant found in blood and CSF (cerebrospinal fluid) culture.¹⁰ Although acne is not a serious health threat, severe acne can lead to disfiguring and permanent scarring. For many years antibiotics and hormones were usually applied to treat acne. However, these agents are often accompanied by severe side effects and drug resistance.¹¹ Acne shows up in the form of filthy lesions like blackheads, whiteheads, inflammatory lumps or boils such as pustules, papules, cysts, and nodules. *Propionibacterium acnes* are found briefly on the skin of neonates, but true colonization begins during the 1-3 years prior to sexual maturity due to hormonal imbalance.¹² Factors promoting the development of acne are: increased sebum production, ductal cornification, hyperkeratinization, bacterial colonization of the pilosebaceous ducts and inflammation.²

1.2 Types of Acne : Acne could be classified into five categories: acne vulgaris, acne rosacea, acne conglobata, acne fulminans, and pyroderma faciale. Among these acne vulgaris is the most common and mild type of acne.

1.2.1 Acne Vulgaris: Acne vulgaris is the most common cutaneous chronic inflammatory disorder of multifactorial origin with prevalence in adolescents. It consists of the pilosebaceous follicles characterized by comedones, papules, pustules, nodules, cysts and often scars in certain sites of predilection, namely the face, neck, chest, arms and back. Acne vulgaris is common among 95% and 83%

of teenage boys and girls, respectively, and affects 85%, 8% and 3% of people aged between 12-25, 25-34 and 35-44 years, respectively.¹³ It is further classified as¹⁴:

1.2.1.1. Papules: Slightly larger, tender, and red or pink blemishes which are most often found to be inflamed are called papules. This type of acne is potentially risky to be picked or popped since they can turn into larger and painful cysts with some possibility of scarring.

1.2.1.2. Macule- A macule is a temporary red, or red-pink, spot that is left after the acne has healed. This has a well-defined border and may stay for many days before disappearing.

1.2.1.3. Pustules: Pustules are much like whiteheads, but with greater inflammation, larger size, and a visible center filled with pus. They are generally red in color at their base.

1.2.1.4. Nodules: Nodules are larger and more deep seated than pustules. These lesions are characterized by painful, firm, and solid lumps filled with pus.

1.2.1.5. Cysts: Acne cysts or cystic acne is the most severe and persistent type of acne. These large inflamed lesions are oftentimes playing as the most influential threat behind acne scar. More often than not, it is found that cystic acne is the outcome of popping or squeezing pus filled and inflamed smaller comedones.

1.2.2. Acne rosacea: Rosacea is a common skin disorder affecting middle-aged and older adults. Many patients mistakenly assume that early rosacea is normally a sign of aging skin and are not aware of effective treatments that exist to prevent progression to permanent disfiguring skin changes. It mainly affects middle-aged and older adults and found in cheeks, nose, chin, and forehead.¹⁵

1.2.3. Acne conglobata: Acne conglobata is an uncommon and unusually severe

form of acne characterized by burrowing and interconnecting abscesses and irregular scars (both keloidal and atrophic), often producing pronounced disfigurement. The comedones often occur in a group of 2 or 3, and cysts contain foul-smelling seropurulent material that returns after drainage. The nodules are usually found on the chest, the shoulders, the back, the buttocks, the upper arms, the thighs, and the face.¹⁶ Acne conglobata may develop as a result of a sudden deterioration of existing active papular or pustular acne, or it may occur as the recrudescence of acne that has been quiescent for many years.¹⁷

1.2.4. Acne fulminans: It is an uncommon form of ulcerative acne with acute onset. It usually affects adolescent boys who have associated musculoskeletal pain and septic fever. Osteolytic bone lesions have been reported in these patients. Severe cystic acne occurs almost equally in both sexes, but it has a less dramatic clinical course than acne fulminans and rarely causes ulcerative skin lesions and systemic symptoms. In this study we investigated the imaging features of bone lesions associated with acne fulminans and determined if patients with severe cystic acne have similar bone lesions.¹⁸

1.2.5 Pyoderma faciale: Rosacea fulminans is a rare disease of unknown etiology which occurs mainly in postadolescent women. It is characterized by an abrupt explosive outbreak without prodromes, consisting of papules, pustules, confluent nodules with draining sinuses on the face. A dull to blue-red, cyanotic erythema of all involved facial areas is typical, often accompanied by pronounced facial edema.¹⁹

1.4 Causes of Acne: Acne vulgaris is a multifactorial disease affecting the pilosebaceous follicles for which *Propionibacterium acnes* and, less often,

Propionibacterium granulosum and *Propionibacterium avidum* have been identified as etiological agent.²⁰ Acne is inflammation of the skin, due to blockage of skin's pores. Blockage occurs due to an excessive secretion from the skin's oil glands and accumulated, dead skin cells. This combination encourages the skin bacterium *Propionibacterium* which multiplies and causes increased skin inflammation.¹⁴ Hyperkeratinization and formation of a plug of keratin and sebum (a microcomedo) is the earliest change. Enlargement of sebaceous glands and an increase in sebum production occur with increased androgen (DHEA-S) dehydroepiandrosterone sulfate production at adrenarche. The microcomedo may enlarge to form open comedones (blackhead) or closed comedones (milia). Comedones are the direct result of sebaceous glands becoming clogged with sebum, naturally occurring oil, and dead skin cells. In these conditions, the naturally occurring largely commensal bacterium *Propionibacterium acnes* can cause inflammation, leading to inflammatory lesions (papules, infected pustules, or nodules) in the dermis around the microcomedo or comedone, which results in redness and may result in scarring or hyperpigmentation.^{2,21}

Some causes are:

1.4.1.Genetics: Acne is a multi-factorial disease, and genetics probably contributes to the development of acne. Studies indicate that the size, number and activity of sebaceous glands are genetically determined. In addition, the concordance rate of acne in identical twins is high, confirming the role of genetics in the development of acne.

1.4.2.Diet: A recent study concluded that dairy products contribute to the pathogenesis of acne. This is postulated to be mediated via the synthetic hormones

used in cows in the milk industry. Caution must be used in interpreting such studies and the general recommendations remains for individuals to eat a well-balanced diet.

1.4.3.Hormones: Sebaceous gland excretion may be stimulated by male sex and adrenal gland hormones. During puberty, the levels of these hormones are not elevated, but the sebaceous glands are more sensitive to them. There are certain medical conditions which can lead to inappropriately high levels of male sex hormones, thereby producing acne.

1.4.4.Drugs: Acne form eruptions can occur as an adverse drug eruption, and stopping the offending drug will often alleviate the problem. This must be done in consultation with the prescribing physician, with a detailed review of risks and benefits of stopping the offending medication undertaken.

1.4.5.Hair grooming agents-Pomade acne: Excessive use of hair pomades (also known as hair moisturizers, hair styling products and hair grease), which are often part of the hair care regime of blacks, can lead to the development of acne. This occurs especially around the hairline and forehead. Counseling and review of the hair care regime can alleviate pomade acne.

1.4.6.Cosmetics: Acne can result from heavy cosmetic use and the associated pigmentation changes may be exacerbated by harsh agents applied to the skin as part of an individual's grooming practice and vigorous washing of the skin with rubbing and scrubbing, or using puffs or abrasive sponges can also cause or worsen acne.

2. PLANTS USED FOR THE *PROPIONIBACTERIUM ACNES*

The aim of this study was to compile the antimicrobial medicinal plant used in Ayurveda and traditional medicinal system for treatment of manifestations caused by *Propionibacterium acnes*.

Therefore, extracts of the following plants from different families which contain different phytoconstituents like essential oils,¹¹ flavonoids, tannins,²⁴ alkaloids,³⁰ terpenoids,³² volatile oil³⁵ and phenolic compounds⁴⁴ having potential activity against *Propionibacterium acnes*. *Propionibacterium acnes* have been most recognized as a key factor for the development of acne and the plants which are use as antiacne or to prevent acnes are enlisted in table no. 1.

CONCLUSION

Propionibacterium acnes have been recognized as pus-forming bacteria triggering an inflammation in acne. *Propionibacterium acnes* is a Gram-positive, anaerobic microorganism, which has been most recognized as a key factor for the development of acne.¹¹ Acne vulgaris is a chronic inflammatory disease of the pilosebaceous follicle, characterized by comedones, papules, pustules, cysts, nodules and often scars in certain sites of predilection, namely, the face, neck, upper trunk and arms. Factors which contribute to the development of acne include hormonal imbalance, bacterial infection, stress, food, or cosmetic application.¹¹ The use of oral antibiotics for the treatment of acne may be associated with adverse effects.²² The plants having phytoconstituents like alkaloids, phenolic compounds, volatile oil, essential oil, might be used for the preparation of topical herbal formulations. Currently the problem associated with the therapy for acne is that the topical products available are either cream based (mostly oily) or associated with adverse effects contributed to their chemical nature and natural remedies are more acceptable in the belief that they are safer with fewer side effects than the synthetic ones so, herbal anti-acne solution which is approximately non-toxic, safe, effective

and improves patient compliance by the utilization of herbal extracts would be highly acceptable.²³⁻²⁴ The importance of the acne treatment in the adult should be enhanced as it can also lead to symptoms of serious depression and anxiety.⁵

The topical and oral ayurvedic compounds contain herbal agents have been reported to have value in the treatment of acne.²⁵ Herbal medication are considered safer than allopathic medicines because allopathic medicines are associated with various side effects such as like contact allergy, local irritation, scaling, photosensitivity, itching, pruritus, redness, skin peeling, xerosis of the skin etc.²⁶

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1.3 Differentiation points between types of acne.

Acne Vulgaris	Acne rosacea	Acne conglobata	Acne fulminans	Pyoderma faciale
It is the most common cutaneous chronic inflammatory disorder of multifactorial origin. Found in face, neck, arms, and back Common for teenage	It is a common skin disorder affecting middle-aged and older adults. It mainly affects middle-aged and older adults. Found in cheeks, nose, chin, and forehead.	It is an uncommon and unusually severe form of acne characterized by burrowing and interconnecting abscesses and irregular scars. Found in chest, shoulders, back, buttocks, upper arms, thighs and face.	It is an uncommon form of ulcerative acne with acute onset. It usually affects adolescent boys.	It is rare disease of unknown etiology. It occurs mainly in postadolescent women. Found at facial areas.

Table no.1: List of plants used for treating the *Propionibacterium acnes*

S.No.	Plant and family	Plant part	Solvent used /preparation	Reference
1.	<i>Albizia lebbek</i> Fabaceae	Whole plant	Pet.ether, water	K. Sudharameshwari <i>et al.</i> (2007)
2.	<i>Aloe vera</i> Liliaceae	Leaves	Water	Bhaskar G <i>et al.</i> (2009)
3.	<i>Alpinia galanga</i> Zingiberaceae	Rhizome	Ethyl acetate	Niyomkam P <i>et al.</i> (2010)
4.	<i>Apis mellifera</i> Apidae	Venom	Water	Han <i>et al.</i> (2010)
5.	<i>Azadirachta indica</i> Meliaceae	Leaves	Ethanol	Mamgain, R.K. <i>et al.</i> (2000), Harisaranraj. R. <i>et al.</i> (2010)
6.	<i>Barleria lupulina</i> Acanthaceae	Whole plant	ND	M.T.Chomnawang <i>et al.</i> (2005)
7.	<i>Cardiospermum halic acabum</i> Sapindaceae	Leaves	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
8.	<i>Casuarina equisetifoli a</i> Casuarinaceae	Fruit	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
9.	<i>Cinnamomum zeylanicum</i> Lauraceae	ND	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
10.	<i>Citrus hystrix</i> DC. Rutaceae	Leaf	Essential oils	S.Luangnarmithai <i>et al.</i> (2007), Aranya manosroi <i>et al.</i> (2008)
11.	<i>Citrus limon</i> Rutaceae	Fruit	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
12.	<i>Citrus paradisi</i> Rutaceae	Grape fruit	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
13.	<i>Coscinium fenestratum</i> Menispermaceae	Stem	Methanol	Sudhir Chaudhary. <i>et al.</i> (2010) Kumar. <i>et al.</i> (2007)
14.	<i>Cucurbito pepo</i> L. Cucurbitaceae	Seeds	Ethanol	Kumar. <i>et al.</i> (2007)
15.	<i>Cynodon dactylon</i> Poaceae	Leaves	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
16.	<i>Cymbopogon citrates</i> Stapf. Gramineae	Leaves	Methanol	S.Luangnarmithai <i>et al.</i> (2007), Aranya manosroi <i>et al.</i> (2008), Tsai T <i>et al.</i> (2010)

17.	<i>Eclipta alba</i> Asteraceae	Fruit	Ethanol	Kumar. <i>et al.</i> (2007)
18.	<i>Eucommia ulmoides</i> Eucommiaceae	Leaves	Methanol	Tsai T <i>et al.</i> (2010)
19.	<i>Eucalyptus globules</i> Myrtaceae	Leaves	Methanol– dichlorometh ane (1:1)	Eric Yarnell <i>et al.</i> (2006), T. Takahashi <i>et al.</i> (2004)
20.	<i>Eucalyptus maculate</i> Myrtaceae	Leaves	Methanol– dichlorometh ane (1:1)	T. Takahashi <i>et al.</i> (2004), Eric Yarnell <i>et al.</i> (2006),
21.	<i>Eucalyptus viminalis</i> Myrtaceae	Leaves	Methanol– dichlorometh ane (1:1)	T. Takahashi <i>et al.</i> (2004), Eric Yarnell <i>et al.</i> (2006),
22.	<i>Euphorbia hirta</i> Euphorbiaceae	Root	Ethanol	Harisaranraj. R. <i>et al.</i> (2010), Kumar. <i>et al.</i> (2007)
23.	<i>Eupatorium odoratum</i> Asteraceae	Whole plant	ND	M.T.Chomnawang <i>et al.</i> (2005)
24.	<i>Excoecaria cochinchinensis</i> Euphorbiaceae	ND	Ethanol, water	P. Leelapornpisid. <i>et al.</i>
25.	<i>Ficus religiosa</i> Moraceae	Leaves	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
26.	<i>Garcinia mangostana</i> Guttiferae	Fruit	Ethanol	W. Pothitirat <i>et al.</i> (2009), M.T.Chomnawang <i>et al.</i> (2005), U Sukatta <i>et al.</i> (2008)
27.	<i>Glycyrrhiza glabra</i> Leguminosae	Rhizome	Ethanol	C. Nam <i>et al.</i> (2003)
28.	<i>Hemidesmus indicus</i> Apocynaceae	Root	Ethanol	Kumar. <i>et al.</i> (2007)
29.	<i>Hibiscus sabdariffa</i> Malvaceae	Whole plant	ND	M.T.Chomnawang <i>et al.</i> (2005)
30.	<i>Houttuynia cordata</i> Saururaceae	Whole plant	ND	M.T.Chomnawang <i>et al.</i> (2005)
31.	<i>Jasminum grandiflora</i> Oleaceae	Flower	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
32.	<i>Jasminum sambac</i> Oleaceae	Flower, leaf	Ethanol, methanol	Harisaranraj. R. <i>et al.</i> (2010), Tsai T <i>et al.</i> (2010)
33.	<i>Jasminum officinale</i> Oleaceae	Flower	Ethanol	Kumar. <i>et al.</i> (2007)
34.	<i>Lavandula angustifolia</i> Lamiaceae	Leaf	Methanol	Tsai T <i>et al.</i> (2010)
35.	<i>Lavandula stoechas</i> Lamiaceae	ND	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
36.	<i>Lawsonia inermis</i> Lythraceae	Whole plant	Pet.ether, water	K. Sudharameshwari <i>et al.</i> (2007)
37.	<i>Llex paraguariensis</i>	Leaves	Methanol	Tsai T <i>et al.</i> (2010)

	Aquifoliaceae			
38.	<i>Magnolia grandiflora</i> Magnoliaceae	Stem	ND	J. Park <i>et al.</i> (2004)
39.	<i>Matricaria chamomilla</i> Compositae	ND	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
40.	<i>Mentha piperita</i> Lamiaceae	Leaves	Ethanol	Kumar. <i>et al.</i> (2007)
41.	<i>Mentha spicata</i> Lamiaceae	Leaves	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
42.	<i>Michelia alba</i> DC. Magnoliaceae	ND	Essential oils	S. Luangnarmithai <i>et al.</i> (2007)
43.	<i>Momordica charantia</i> Cucurbitaceae	Fruit	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
44.	<i>Ocimum sanctum</i> Lamiaceae	Leaves	Ethanol	Harisaranraj. R. <i>et al.</i> (2010), Aranya manosroi <i>et al.</i> (2008)
45.	<i>Ocimum Americana</i> Lamiaceae	Whole plant	ND	Aranya manosroi <i>et al.</i> (2008)
46.	<i>Ocimum basilicum</i> Lamiaceae	Leaves	Water	Aranya manosroi <i>et al.</i> (2008), Eric Yarnell <i>et al.</i> (2006)
47.	<i>Piper nigrum</i> Piperaceae	Seed	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
48.	<i>Phyllanthus niruri</i> Euphorbiaceae	Whole plants	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
49.	<i>Pongamia pinnata</i> Fabaceae	Seeds	Ethanol	Kumar. <i>et al.</i> (2007)
50.	<i>Psidium guajava</i> Myrtaceae	Leaf	Water	R.M.P. Guti´errez <i>et al.</i> (2008), Qadan <i>et al.</i> (2005), Girish Kumar Gupta <i>et al.</i> (2011)
51.	<i>Quercus infectoria</i> Fagaceae	Whole plant	Methanol	Sudhir Chaudhary. <i>et al.</i> (2010)
52.	<i>Rauwolfia serpentina</i> Apocynaceae	Root	Ethanol	Harisaranraj. R. <i>et al.</i> (2010)
53.	<i>Rosa damascena</i> Rosaceae	Leaf	Methanol	Yuangang Zu. <i>et al.</i> (2010), Tsai T <i>et al.</i> (2010)
54.	<i>Salvia officinalis</i> Lamiaceae	Leaf	Ethanol, water	P. Leelapornpisid. <i>et al.</i>
55.	<i>Senna alata</i> Fabaceae	Whole plant	ND	M.T.Chomnawang <i>et al.</i> (2005)
56.	<i>Symplocos racemosa</i> Symplocaceae	Bark	Ethanol	Kumar. <i>et al.</i> (2007)
57.	<i>Syzygium aromaticum</i> Myrtaceae	Flowering bud	Essential oils	S.Luangnarmithai <i>et al.</i> (2007)
58.	<i>Tephrosia purpurea</i> Fabaceae	Root	Ethanol	Kumar. <i>et al.</i> (2007)
59.	<i>Terminalia arjuna</i>	Bark	Acetone	A.Vijayalakshmi <i>et al.</i> (2011)

	Combretaceae			
60.	<i>Thespesia populnea</i> Malvaceae	Root	Ethanol	Kumar. <i>et al.</i> (2007)
61.	<i>Thymus vulgaris</i> Lamiaceae	ND	Essential oils	Yuangang Zu. <i>et al.</i> (2010)
62.	<i>Tinospora cordyfolia</i> Menispermaceae	Root	Ethanol	Kumar. <i>et al.</i> (2007)
63.	<i>Zingiber officinale</i> Zingiberaceae	Rhizome	Essential oils	Yuangang Zu. <i>et al.</i> (2010), Eric Yarnell <i>et al</i> (2006)

ND: Not Defined in articles.



figure: Different types of acne