



Phytochemical Properties and Pharmacological Activities of *Nicotiana Tabacum*: A Review

Aarti Rawat, Rakesh Roshan Mali*

Department of Pharmaceutics, Himachal Institute of Pharmacy, Paonta Sahib, (H.P.)

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Abstract

Since ancient times, plants have been an exemplary source of medicine. Tobacco is an agricultural product processed from the leaves of plants in the genus *Nicotiana*. In Indian agriculture, tobacco has a prominent place. Tobacco could be developed as an important food crop in combination with its traditional use for smoking and chewing. Tobacco plants are also used in plant bioengineering, and some of the more than 70 species are grown as ornamentals. The chemistry of tobacco is unique with the presence of a wide spectrum of chemical compounds of which nicotine, solanesol, malic and citric acid were identified as potential chemicals which could be recovered and converted to value-added products. The alkaloid nicotine is popularly considered the most characteristic constituent of tobacco but nicotine is not highly addictive on its own. In consumption it most commonly appears in the forms of smoking, chewing, snuffing, or dipping tobacco. Because of the powerfully addictive properties of tobacco, tolerance and dependence develop². This situation necessitated to examine the green tobacco crop as a source for recovery of phytochemicals alone. With the objective of maximizing bio-mass production for optimum recovery of proteins, nicotine, solanesol and organic acids from green tobacco. Nicotine for treatment of Alzheimer disease, Parkinson disease, depression and anxiety, schizophrenia, attention deficit hyperactivity disorder (ADHD), pain, and obesity:

Keywords: Tobacco,; *Nicotiana tabacum*,; Ayurveda, Traditional, medicinal; Phytochemicals.

1. Introduction

There are huge number of herbal medicines described in *Ayurvedic* and other alternativetraditional medicines whose popularity and use in uplifting the general health of common people is still not so efficient because of several reasons. There are so many herbal medicines either individually or in combination which are being used in various medical treatise for the cure of different ailments. Holistic approach of *Ayurveda* in regard to preventive, promotive and curative measures with due consideration of health and disease is well established. The *Materia Medica* of India provides a great deal of information on the *Ayurveda*, folklore

practices and traditional aspects of therapeutically important natural products. Tobacco is an agricultural product processed from the leaves of plants in the genus *Nicotiana*. It can be consumed, used as a pesticide and, in the form of nicotine tartrate, used in some medicines [1]. It is most commonly used as a drug, and is a valuable cash crop for countries such as Cuba, India, China, and the United States. Tobacco is a name for any plant of the genus *Nicotiana* of the Solanaceae family (nightshade family) and for the product manufactured from the leaf and used in cigars and cigarettes, snuff, and pipe and chewing tobacco. Tobacco plants are

*Corresponding Author: Rakesh Roshan Mali, Department of Pharmaceutics, Himachal Institute of Pharmacy, Paonta Sahib (H.P), India. E-Mail Id: rakesh_83mali@yahoo.com; Mobile No. +91-9882773281

also used in plant bioengineering, and some of the more than 70 species are grown as ornamentals [3]. The pharmacological activities of *N. tabacum* is mostly due to its content of nicotine which stimulates the nicotine receptors leading to release of substances such as acetylcholine, nor epinephrine, dopamine, serotonin, vasopressin and growth hormone. Nicotine which is the major component of tobacco has been demonstrated to accelerate angiogenesis

Taxonomy

Family : *Solanaceae*.

Latin name : *Nicotiana tabacum*

Synonyms:tobacco,Tamak.,Siah(Marma)

Common name: Tobacco.

Taxonomic notes: An erect glandular-pubescent herb. Leaves large, oblong-lanceolate, acuminate, the lower semiamplexicaul and decurrent. Flowers rosy or reddish, pedicelled, 4-5 cm long, in many-flowered, usually paniced racemes. Capsule 1.5-1.8 cm long, a little longer than the calyx.

Biology & Ecology

Nicotiana tabacum is a perennial herbaceous plant. It is found only in cultivation, It grows to heights between 1 to 2 metres. *N. tabacum* is a native of tropical and subtropical America but it is now commercially cultivated worldwide. Other varieties are cultivated as ornamental plants or grow as a weed. *Nicotiana tabacum* Linné is a robust annual little branched herb up to 2.5 m (8.2 ft) high with large green leaves and long trumpet shaped white-pinkish flowers. All parts are sticky, covered with short viscid-glandular hairs, which exude a yellow secretion containing nicotine.

and wound healing in genetically diabetic mice .The ethno medical uses include the use of the leaves (decoction) as antispasmodics, diuretics, emetics, expectorants, sedatives, and in rheumatic swellings, anesthetics, antibacterial, anticonvulsants and for anti-fungal activities. Other uses includes; treatment of asthma by Indians, treatment of worms in East Africa, treatment of wounds in Columbia and treatment of dysmenorrheal in Cuba among others .

Fig.1 *Nicotiana tabacum*



Traditional Uses

In *Ayurveda* texts Tobacco is referred as *Tamakhu*, *Ksharapatra*, *Krimighni*, *Dhumrapatrik*[5], *Vajrabhringi* [6],*Bahubeeja*, *Bahuphala*, *Sukshmabeeja*, *Deerghaka*[7]. The *Ayurvedic* pharmacology indicates that it is *Ushna* (hot), *Tikshna* (Sharp), *Sara* (stimulates peristaltic movements) and increases *Pitta* (Digestive fire / Bile juice/ enzymatic metabolisms). It is a drug of choice in *Bastivishodhana* (Urinary track disorders and diseases related with urinary bladder). It is bitter and pungent in taste. In proper dosing it can be used in *Kapha* (cough), *Shwasha* (Asthma), *Kandu* (itching), *Krimi* (anti-helminthes). It is very good as analgesic and utilized in *Dantaruja* (dental pain),

Shukraruja (pain related with genital organ) and *Drishtiruja* (pain related with eye). It can control dandruff and hair infections. It can dwindle the poison of scorpion bite and related swelling [7]. The clever administration of the drug effective in *Madakrit* (narcotic), *Bhramaka* (Induces vertigo), *Drishtimandyakara* (diminishes the vision) and *Vamaka* (Emetic). Tobacco has been used as an antispasmodic, a diuretic, an emetic, an expectorant, a sedative, and a sialagogue, and in homeopathy. Tobacco has a long history of use by medical herbalists as a relaxant, though since it is a highly addictive drug it is seldom employed internally or externally at present. The leaves act as antispasmodics, discutients, diuretics, emetics, expectorants, irritants, sedatives and sialagogues. Wet tobacco leaves are applied externally in the treatment of rheumatic swelling, skin diseases and stings, as the active ingredients can be absorbed through the skin. They are also a certain cure for painful piles. A homeopathic remedy made from the dried leaves is used in the treatment of nausea and travel sickness. Some other activities reported for *Nicotiana tabacum* are: analgesic activity, anesthetic activity, angiogenesis inhibition, antibacterial activity, anti convulsant activities, anti estrogenic effect, antifungal activity, antiglaucomic activity, antioxidant activity, antistress effect, antiviral activity, aromatase inhibition, arrhythmogenic effect, carcinogenic activity, Nicotine for treatment of Alzheimer disease, Parkinson disease, depression and anxiety, schizophrenia, attention deficit hyperactivity disorder (ADHD), pain, and obesity:

Iran

Ointments made from crushed leaves are used for baldness, dermatitis, infectious ulcers & Pediculicide [10]. Juice is applied externally as an insect repellent [8]. Leaf is added to betel quid and used as a mild stimulant [9].

Nepal

Leaf juice is applied externally to treat scabies [11]

Nicaragua

Leaves are chewed for tooth ache [12]. It is also applied externally for pain, stings & skin rashes [13].

Haiti

Decoction of dried leaf is taken orally for bronchitis & pneumonia [12, 10].

India

The leaves of the tobacco plant have been used in traditional Indian medicine as a sedative, antispasmodic, and vermifuge. They are also considered antiseptic, emetic and narcotic. A decoction of leaves is applied locally for muscle relaxation associated with joint dislocation. It is also used to relieve pain and swelling associated with rheumatic conditions. Tobacco is also utilized traditionally to treat strangulated hernia, orchitis, and skin diseases. The tribal inhabitants of Surguna district of Madhya Pradesh state apply warmed leaves on testis to treat hydrocele. Even the oil extracted from the leaves is used in the treatment of arthralgia, gout and lumbago [15]. Powdered tobacco, or masher, is rubbed on the teeth for this purpose and tobacco toothpaste is marketed commercially [16].

Nicaragua

Leaves are chewed for tooth ache [12]. It is also applied externally for pain, stings & skin rashes [8].

Brazil

Dried leaves are used as an insecticide [10]. The Tukanoan peoples of the Vaupes rub a decoction of

the leaves over sprains & bruises. The leaf juice is taken orally to induce vomiting & narcosis [10, 11].

Pedro Alvarez Cabral in Brazil reported using the herb for ulcerated abscesses, fistulas, sores, inveterate polyps and many other ailments [12, 13].

Phytochemical Properties

Tobacco leaf contains several pyridine alkaloids, the principal one being a liquid alkaloid, nicotine. Other alkaloids present include nicotine, nicotimine, anabaine, anatabine and nornicotine. It also contains a high percentage of organic acids. Leaves also contain glucosides, tannic acid, tannin and *iso*-quercitrin, 1-quinic, chlorogenic, caffeic and oxalic acids. They also contain terpenic and carcinogenic substances [5]. Anatabine and (+) nornicotine have been isolated from roots. Quercetin-3,3'-dimethyl ether and quercetin-3-Me ether

have been isolated from flowers. Three new gibberellins-nicotiana α , β and γ along with gibberellins A and A3 have been isolated from shoot apices and flower buds. Seed contains cycloartenol, cycloartenol 24-daturadiol and solavetivone. Cholesterol, cholest-7-enol, 24-methylenecholesterol, campesterol, stigmasterol, sitosterol, 28-isofucosterol, lanosterol, 31-norlanosterol, lanost-8-enol, obtusifoliol, 31-norcycloartenol, cycloeucaleanol, granisterol, citrostadienol, β -amyrin, lupeol, cycloartenol and 24-methylenecycloartenol have also been reported in seed oil [6].

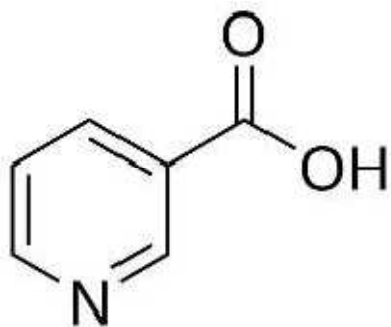


Figure 2. Nicotinic acid

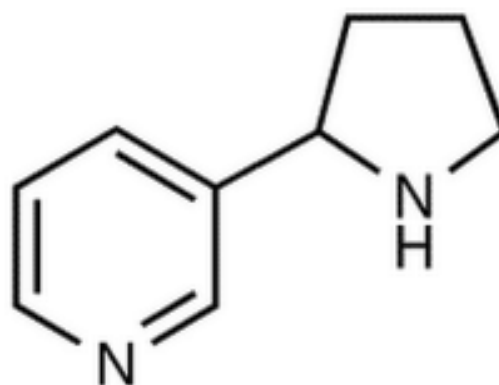


Figure 3. Nornicotine

Pharmacological Activities:

Antibacterial activity

Nicotine, isolated from leaves of *Nicotiana tabacum* was complexed with

zinc and studied for their antibacterial activities against ten different strains of Gram positive and Gram negative bacteria. Results showed that zinc (II)

complex of nicotine is more active against different types of bacterial strains as compared to zinc metal salt used for complexation and nicotine alone [15].

Anti-nociceptive activity

The antinociceptive activities of the methanolic leaf extract of *Nicotiana tabacum* (Linne) was evaluated using tail immersion, hot plate and acetic acid-induced abdominal constrictions or writhing models in albino Wistar mice [21]. Doses of 100, 200 and 300mg/kg body weight of the extract were used orally while indomethacin (10mg/kg body weight) was used as standard reference drug. In the tail immersion and hot plate models, *N. tabacum* exhibited good level of antinociceptive activities by significantly ($p < 0.01$) increasing the pain reaction time (PRT) or latency period in the mice in a dose dependent manner [22]. In the acetic acid-induced writhing model, *N. tabacum* and the reference drug, indomethacin, significantly ($p < 0.02$) decreased the mean total number of abdominal constrictions or writhes in the mice in a dose dependent manner and also the percentage protection of the abdominal constriction reflex was increased from zero percent in the negative control group to 59.0% at the dose of 300mg/kg of the extract. Methanolic leaf extract of *Nicotiana tabacum* showed significant antinociceptive activity and may be acting through both central and peripheral nociceptive mechanisms [19].

Antifungal activity

Different isoforms of chitinases and α -1,3-glucanases of tobacco (*Nicotiana glauca* cv Samsun NN) were tested for their antifungal activities. The class I,

vacuolar chitinase and α -1,3-glucanase isoforms were the most active against *Fusarium solani* germlings, resulting in lysis of the hyphal tips and in growth inhibition. In addition, we observed that the class I chitinase and α -1,3-glucanase acted synergistically. The class II isoforms of the two hydrolases exhibited no antifungal activity. However, The class II α -1,3- glucanases showed no inhibitory activity in any combination. . Both modified proteins lack their Cterminal propeptide, which functions as a vacuolar targeting signal. Furthermore, the extracellular washing fluid (EF) from leaves of transgenic plants expressing either of the secreted class I enzymes exhibited antifungal activity on *F. solani* germlings in vitro comparable to that of the purified vacuolar class I proteins. Mixing EF fractions from these plants revealed synergism in inhibitory activity against *F. solani*; [16].

Antimicrobial activity

The antimicrobial activity of extracts of twelve Nigerian medicinal plant species and a “wonder cure” concoction (Epa – Ijebu) used in traditional medicine for the treatment of tuberculosis and cough were screened for activity against *Mycobacterium tuberculosis* isolated from tuberculosis patient sputum and the control strains of *M. tuberculosis* (H37RV). Both ethanolic and aqueous solution of the extract of *Allium ascalonicum*, *Terminalia glaucescens*, *Allium cepa* and *Securidaca longepedunculata* (ethanolic extract only) at 0.05 g/ml as well as aqueous solution of “wonder cure” concoction at same concentration inhibited the growth of *M. tuberculosis*. Aqueous and ethanolic extract of nicotiana tobacco

used as medicinal plant extract in treatment of tuberculosis 20].

Anthelmintic activity

In-vitro and *in vivo* anthelmintic activity of *N. tabacum* Linn leaves was studied to rationalize its traditional use. Live *Haemonchus contortus* were used to assess the *in vitro* anthelmintic effect of a crude aqueous extract and methanol extract for the *in vivo* studies both the extract were administered in increasing doses (10 -3.0g/kg) to sheep naturally infected with mixed species of gastrointestinal nematodes. The results of the study showed that both the extract possess dose – dependant anthelmintic activity. Justifying the use of plant in traditional system of medicine [17].

Anti Alzheimer's activity

Memory is the ability of an individual to record the information and recall it whenever needed. Dementia is a mental disorder characterized by loss of intellectual ability (judgment or abstract thinking) which invariably involves impairment of memory. The most common cause of dementia is Alzheimer's disease (AD), which is a progressive neurodegenerative disorder associated with loss of neurons in distinct brain areas and cord. *Nicotiana tabacum* plant extract show anti Alzheimer's activity which improved memory [18].

Peripheral nervous system activity

Nicotine is a major chemical constituents of *nicotiana tabacum* plant. Plant extract show PNS (Peripheral nervous system activity) activity. The major action of nicotine consists initially of transient stimulation and subsequently of a more persistent depression of all autonomic ganglia. Nicotine also possesses a biphasic action on the

adrenal medulla: small doses evoke the discharge of catecholamines, and larger doses prevent their release in response to splanchnic nerve stimulation. Nicotine, like Acetylcholine is known to stimulate a number of sensory receptors [25].

Central nervous system activity

Plant extract of different solvent show CNS activity. leaf extract *nicotiana tabacum* show different action on nervous system. Nicotine is chief chemical compound which show several pharmacological activity. Nicotine markedly stimulates the CNS. Low doses produce weak analgesia; with higher doses tremors leading to convulsions at toxic doses are evident. The excitation of respiration is a prominent action of nicotine. Nicotine induces vomiting by both central and peripheral actions. The primary sites of action of nicotine in the CNS are prejunctional, causing the release of other neurotransmitters. Accordingly, the stimulatory and pleasure-reward actions of nicotine appear to result from release of excitatory amino acids, dopamine, and other biogenic amines from various CNS centers [26].

Cardiovascular system activity

Plant extract of *Nicotiana tabacum* show cardiovascular activity. The cardiovascular responses to nicotine are due to stimulation of sympathetic ganglia and the adrenal medulla, together with the discharge of catecholamines from sympathetic nerve endings. Also contributing to the sympathomimetic response to nicotine in the activation of chemoreceptors of the aortic and carotid bodies, this reflexly results in vasoconstriction, tachycardia, and elevated blood pressure [26].

Gastrointestinal tract activity

Plant extract show gastrointestinal tract activity .which give different effect in gastrointestinal tract system.The combined activation of parasympathetic ganglia and cholinergic nerve endings by nicotine results in increased tone and motor activity of the bowel [27].

Exocrine glands activity

Plant extract show effect on exocrine glands .Nicotine show effect on exocrine glands .Nicotine causes an initial stimulation of salivary and bronchial secretions that is followed by inhibition [28].

Conclusion

Tobacco is a plant with an extraordinary history of use. *Nicotiana tabacum* possesses various pharmacological activities as discussed in present paper. However, it is imperative that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plant [32]. Therefore, author feels to carry out some potential activities which are still

References

- 1.Ren Nan and Timko Michael., AFLP analysis of genetic polymorphism and evolutionary relationship among cultivated and wild *Nicotiana* species,2001;44;(4):559-571.
- 2 AS Villégier, G Blanc, J Glowinski, JP Tassin, "Transient behavioral sensitization to nicotine becomes long-lasting with monoamine oxidases inhibitors". *Pharmacol. Biochem. Behav* ,2003 ;76 ;(2): 267–74.
3. Jacobi Johannes, J. Jag Jawes, Suniraw Uma, Dayous Hayan, F-Farjado Luis and P. Looke John., Nicotine accelerates angiogenesis and wound healing in genetically diabetic mice.

unexplored on the various parts of the plant. In addition, it had a wide variety of uses for physical complaints, such as venomous bites and stings, internal and external parasites, and the symptomatic relief of pain, which justifies its wide use and appreciation by traditional practitioners all over the world [29]. As we release our addiction to, and dependence on smoking tobacco, one should not forget its many practical folklore traditional medicinal uses [28]. It is understood that if used in positive ways it had the power to heal and protect; but if abused, it also had the power to harm [35].

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Conflict of interest statement

We declare that we have no conflict of interest.

- American Journal of Pathology*, 2002 ;161: 97- 104.
4. Groark, P Kevin., Therapeutic, and Protective Uses of Tobacco (*Nicotiana tabacum*) among the Tzeltal and Tzotzil Maya of Chiapas, Mexico. *Journal of Ethnobiology*, 2010, 30;(1):5-30.
 - 5.VLShaligram, S Nighantubhushanam., Krishnadas Khemraj Prakashan Mumbai.,4, 2004:908.
 6. G Vaidya Bapalal.,Nighantu Adarsha Chaukhambha Bharati Academy, 2009 ; 2:146.
 - 7.Vaidya Laxmipat Shastry, Yogaratnakar with Vidyotini., Choukhambha Sanskrit Samsthan, 7,1999:34.

8. A. Zargari., Medicinal Plants, Tehran University publications, 5, 1992;3 :889.
9. Vanio H., Tobacco and Cancer. *Cancer Res*,1986; 46;(1):444-7.
10. NK Bhattarai., Medical ethnobotony in the Karnali zone, Nepal ,1992; 46;(3):257-61.
11. B Barrett., Medicinal Plants of Nicaragua'satlantic coast,1994; 48;(1):8-20.
12. NK Bhattarai.,Medical ethnobotony in the Karnali zone, *Econ Bot*,1992; 46;(3):257-61.
13. B Barrett., Medicinal Plants of Nicaragua'satlantic coast; *Econ Bot*, 1994; 48;(1):8-20.
14. FG.,Coe Ethnobotony of Garifuna of eastern Nicargua, *Econ Bot* ,1996; 50;(1):71-107.
15. Muhammad idrees zaidi ,Feroza Hmid Wattoo,Muhammad Hamid Sarwar Wattoo,Syed Ahmed Tirmizi ., et al, Antibacterrial activities of nicotine and its Zinc complex, *Affrican journal of MicrobiologyResearch*,2012;6(24):5134-5137.
16. Anee S. ponstein,Sandra A.Bres-Vloemans,Marianne B.sela Buurlage.,et al,A Novel Pathogen- and Wound – Inducible Tobacco(*Nicotiana tabacum*) Protein with Antifungal Acitvity,*Plant Physiol*,1994;104:109-118.
17. Anita A Mehta ,Ravindra G Mali., A Review on Anthelmintic Plants,Natural produch Radiance,*Review paper*,2008;7(5):466-475.
18. CharlesScerri.,Nicotine:Pharmacology and Therapeutic Implications in Neurodegenerative and Psychiatric Disoders,*Maltamedicaljournal*,2005;I(4) :17-21.
19. I Ezeja Maxwell ,S Yusuf Omeh.,Anti –Nociceptive Activity of The Methanolic leaf of *Nicotiana tabacum*(LINN),*wilolud journals*,2010;3: 5-10.
20. A.Adeleye,C.Conubogu,C.I.Ayolabi., et al,Screening of crude extracts of twelve medicinal plants and “wondercure” concoction used in Nigeria unorthodox medicine for activity against *mycobacterium tuberculosis* from tuverculosis patients sputum, *African journal of Biotichnology*,2008;7(18):3182-3187.
21. GETreaseW.CEvans.,pharmacology, *Bailliere tindall,London*,1996;113th; 89-122,313-544.
22. JB.Harboume., Phytochmicla methods, *A Guide to modern techniques of plant analysis 2nd ed , chapman and Hall, London* ,1991:1-3,84-86,222-236.
23. MW Decker, JD Brioni, JP Sullivan, MJ Buckley, RJ Radek, JL Raszkievicz, CH Kang, DJ Kim, WJ Giardina, JT Wasicak., (S)- 3-methyl-5-(1-methyl-2-pyrrolidinyl)isoxazole (ABT 418)a novel cholinergic ligand with cognition-enhancing and anxiolytic activities,1994;2:319-328.
24. S Cheeta, PJ Kenny, SE File.,Hippocampal and septal injections of nicotine and 8-OH-DPAT distinguish among different animal tests of anxiety, 2000;24:1053-1067.
25. DJK Balfour, KO Fagerstrom. Pharmacology of nicotine and its therapeutic use in smoking cessation and neurodegenerative disorders ,1996;72:51-81.
- 26 P.Francis , A. Palmer, M Snape. and G Wilcock.,The cholinergic hypothesis of Alzheimers disease: a review of progress, *J. Neurol. Neurosurg. Psychiatry* ,1999; 66;137-47.
27. A.E Khalifa.: *Hypericum perforatum* as a nootropic drug, enhancement of retrieval memory of a passive avoidance conditioning paradigm in mice, *J. Ethnopharmacol* , 2001,76;(1), 49-57.
- 28 K. Sairam., C Rao. and R Goel., Effect of *Convolvulus pluricaulis* Chois

on gastric ulceration&secretion in rats, *Indian J. Exp. Biol* ,2001;39,350-54.

29. J Haber. Smoking is a major risk factor for periodontitis. *Curr Opin Periodontol*, 1994;1:12–8.

30. Haber J, Kent RL. Cigarette smoking in a periodontal practice, *J Periodontol* 1992;63:100–6.

31. GM Horning, CL Hatch, ME Cohen., Risk indicators for periodontitis in a military treatment population. *J Periodontol* ,1992;63:297–302.

32 Jr Greer, TC Poulson .,Oral tissue alterations associated with the use of smokeless tobacco by teen-agers, *Oral Surg Oral Med Oral Pathol*, 1983;56:275–84.

33. RS Feldman, JE Alman, HH Chauncey. Periodontal disease indexes and tobacco smoking in healthy aging men. *Gerodontology* ,1987;3:43–6.

34. AJ. van Winkelhoff, CJ Bosch-Tijhof, EG Winkel, WA van der Reijden, Smoking affects the subgingival microflora in periodontitis.,*J Periodontol*, 2001;72:666–71.

35. C. Giannopoulou, JJ Kamma, A Mombelli. Effect of inflammation, smoking and stress on gingival crevicular fluid cytokine level.,*J Clin Periodontol*, 2003;30:145–53.

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