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REVIEW
ΑΝΑΣΚΟΠΗΣΗ

Herbal substances and extracts in dental medicine

The main problems faced by people worldwide today in terms of tooth damage are tooth decay and gingivitis/periodontal disease. Good oral hygiene is essential for healthy teeth, gums and in general the oral cavity and the body. The use of plants to improve dental health and promote oral hygiene has a long and important history since ancient times. The main problems that people are facing worldwide today in terms of tooth damage are tooth decay, plaque, gingivitis and more serious periodontal diseases. Plenty of research and studies on traditional herbal remedies can be found for the treatment of oral damages and the handling of diseases related to oral hygiene. Good oral hygiene is essential for healthy teeth, gums and the oral cavity in general. Plants and herbs that naturally enhance oral health, such as mint (Mentha), fennel (*Foeniculum vulgare*), lemon balm (*Melissa officinalis*), coriander (*Coriandrum sativum*), etc., as they contain phytochemical compounds and substances, grow in nature. The results demonstrate that a number of herbal products and methods are used in oral hygiene to prevent and treat oral diseases. Not only are they just as effective, compared to modern chemical drugs, but their use is also safe and without the side effects of classic drugs. This research was carried out to point out the importance of using medicinal-aromatic plants in the field of dental science and how the continuation of studies with more protocols is necessary to inform patients about the treatment methods they can follow.

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ΑΡΧΕΙΑ ΕΛΛΗΝΙΚΗΣ ΙΑΤΡΙΚΗΣ 2026, 43(2):165–172

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Φυτικές ουσίες και εκχυλίσματα στην Οδοντιατρική

Περίληψη στο τέλος του άρθρου

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1. INTRODUCTION

Since prehistoric times, humans have faced various diseases that afflicted them by using plants in various ways. Thus, they began to explore and discover in nature plants that were suitable for medical purposes based on their properties. In this way, humans became familiar with plants and used them as medicines. The search for medicinal plants started instinctively, as it happens with animals.[1] Therefore, the use of medicinal plants abandoned the empirical framework and relied on well documented facts.[2,3] In recent decades, people have shown preference for natural products[4] and a need has arisen in the industry to produce non-synthetic, consumer-friendly products. With the development of the scientific field in medicinal and aromatic plants, in Western Europe the consumption of medicinal plants has almost doubled in the last ten years,[5,6] while also giving new perspectives to the study of plant substances and uses such as for example from cosmetics and food companies, from pharmaceutical industries, etc.[5] According to the World Health Organization (WHO), medicinal plants would be the best source for developing a variety of medicines. Almost 80% of people living in developed countries use traditional medicines for various ailments, which contain substances derived from medicinal plants.[7,8]

Knowledge of the chemical components of plants is desirable because such information will be evaluated for chemical composition.[9] Medicinal plants contain organic compounds that provide specific physiological actions to the human body and are widely used in human therapy, veterinary medicine, agriculture, scientific research, and countless other areas.[10] The bioactive substances that plants include are tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids.[8,11] These compounds are synthesized by the secondary metabolism of living organisms. Secondary metabolites are chemically and taxonomically extremely diverse chemical compounds, produced in nature, serve survival functions and are also considered to have evolved with the growth and adaptation of plants as they protect them from pest infections, but also help them grow in the environment in which they grow.[12] A number of phytochemicals appertain to different chemical classes have been shown to have inhibitory effects on all types of microorganisms *in vitro*.[7] Herbs play an important role in the prevention and treatment of human diseases since plants have been associated with the development of human civilization throughout the world.[4]

Nevertheless, after the increasing unwanted side effects of synthetic drugs, the use of plants as medicines became relevant again. Historically, the first written evidence of the use of plants to make medicines was found on a Sumerian clay plate, about 5,000 years old, which described 12 recipes for making medicines mentioning more than 250 different plants.[2,3] In ancient history, the most prominent writer on herbal medicines was Dioscorides, named "founder/father of pharmacognosy", who as a military physician and pharmacist of Nero's Army, studied medicinal plants wherever he traveled with the Roman Army. Around 77 AD he wrote the *"De Materia Medica"* where he described 944 drugs, 657 of which are of plant origin, with descriptions of their external appearance, the region where they grow, the method of collection, the preparation of the medicinal preparations and their therapeutic action.[3,13]

1.1. Applications of medicinal plants

Medicinal plants are the main source of medicines and their medicinal use is traced almost 5,000 years ago in China, India and Egypt.[14,15] It is remarkable that almost all pharmaceutical companies around the world forbid herbal medicines. But, there are countries such as Great Britain,[16] Russia and Germany[17] that have separate herbal pharmaceutical industries. More than one third of clinical drugs are derived from plant extracts or their derivatives.[18]

Nevertheless, in reality, a much larger number of "unofficial" medicines are traded where their application is based on the experiences of traditional medicine and people use them through self-medication or on the recommendation of a doctor or pharmacist.[3] Genome sequencing of plants can provide us a better understanding of the biosynthesis and regulation of the bioactive compounds they contain. *Artemisia annua* is one of the most commonly accepted medicinal plants, while the discovery of artemisinin, by a Chinese researcher, won the Nobel Prize in medicine in 2015.[19]

Natural medicines offer extraordinary chemical diversity and this fact results in a comprehensive action through interconnected mechanisms. In recent years, various traditional medical systems have become increasingly popular around the world due to their holistic approach. For instance, in India, Unani medicine has been integrated into the national health care system and this application is considered as a field of great research interest.[20–22] The effectiveness of herbal products depends on the applied dose and the identified phytochemicals they contain and at the same time are confirmed by experimental and clinical tests as well as complying with all requirements for their pharmaceutical quality.[23] The secondary metabolites of medicinal plants are products of nature and the human body better accepts the medicine obtained from them since humans are an integral part of it. In addition, herbal medicines are easily available, less expensive, safe, effective and rarely have side effects.[6]

1.2. Indicative examples of phytotherapy

Several medicinal plants may have an important role in the management of oral and dental diseases with specific or nonspecific mechanisms, whereas adverse reactions may occur. More analytically, green tea extract can be prepared from the leaves of the plant and used as a mouthwash to treat oral and periodontal disease. This extract has therapeutic effects on oral and periodontal disease. Moreover, researchers conducted an experiment where[44] prepared a non-toxic formulation of green tea extract and compared the antibacterial effects of this mouthwash with the chemical brand (chlorhexidine gluconate rinse) on the aerobic bacterial content of the mouth. They reported any evidence of toxicity, such as irritation, burning, vesicular or mucosal disruption. Besides, despite the similar antibacterial effects of green tea mouthwash with the chlorhexidine, using herbal green tea mouthwash was safer and more cost-effective. Scientists[39] report that, in contrast, chlorhexidine gluconate 0.2% is considered the gold standard for the treatment of human gingivitis, while studies have shown

that there is a clear relationship between green tea consumption and oral health.

A pilot clinical study evaluated the administration of catechin in a periodontal instance. Hydroxypropylcellulose tapes containing green tea catechin as a slow-release topical delivery system were applied to periodontal patient sacs once a week for eight weeks. Green tea catechin presented bactericidal activity and the combined use of mechanical processing had effective improvement of periodontal condition, as well as bactericidal effect against black spots.[45] Several studies indicate that green tea catechin has a preventive effect against the development of oxidative stress and that effect has been related to the antioxidant mechanisms of catechin. It is assumed that antioxidants can defend against inflammatory diseases.[46,47]

The root of *Curcuma xanthrorrhiza* Roxb is the most commonly used part of the plant because it has high amyl content (41.45%) and therefore has the potential to be incorporated into food ingredients. The plant also contains active substances, such as xanthorrhizol. This substance can act as an anti-metastatic, anti-cancer and anti-inflammatory drug[26] In addition, xanthorrhizol has an antibacterial effect on several pathogenic bacteria of the mouth. A study revealed that xanthorrhizol is a potent bactericide, inhibits acidogenesis and can modify the microbiofilm structure of *Streptococcus mutans.*[48] It can be found in the ethanolic extract of turmeric, along with other active compounds in the form of curcuminoids, such as terpenoids, phenol, flavonoids, saponin, glycoside, alkaloid and coumarin.[49]

Cranberry *(Vaccinium macrocarpon)* has been recognized for its beneficial effects on human health, including the prevention of urinary apparatus infections by inhibiting the adhesion of *Escherichia coli* to cells and preventing the adhesion of *Helicobacter pylori* to the gastric mucosa.[24,50] Numerous studies have investigated the ability of cranberry juice or cranberry components to prevent adhesion of oral pathogens such as glucan and fructan production and biofilm formation. Exposure of oral *Streptococci* to 25% cranberry juice for 10 seconds has been shown to inhibit cell absorption on saliva-coated hydroxyapatite coats by 61.8% to 95.1%, with the exception of *Streptococcus sobrinus* for which reduced absorption was observed after 10 minutes.[24] In addition, cranberry juice could prevent the development of dental plaque by inhibiting the initial phase of biofilm formation. A preparation of high molecular weight cranberry material was also shown to reduce fructosyltransferase and glycosyltransferase activity and promote desorption of *Streptococcus sobrinus* biofilms.[40,51] Recently, the components of cranberry juice that are active against *Streptococcus mutans* biofilms have been identified as polyphenols, specifically proanthocyanidins and flavonols.[52]

Quercus infectoria trees belong to the Fagaceae family and grow in Greece, Asia Minor, Persia, Syria and some regions of India (Garhwal Himalayas) and Nepal. Quercus species originated in Iran, Iraq and Turkey and then proliferated to Asia Minor, Europe and North Africa.[53] Also known as *Majuphal* in traditional medicine, manjakani has been used as a tooth powder to treat toothache and gingivitis. Researchers[54] concluded that the antibacterial activity against tested *Staphylococcus aureus* and *Streptococcus sanguis* is due to the presence of tannin and gallic acid in *Quercus infectoria* extracts. In addition, it has been reported that plant extracts have greater inhibitory action on Gram-positive bacteria compared to Gram-negative bacteria. Bacterial species were more sensitive to plant extracts compared to commercial antibiotics. *Quercus infectoria* extract and gallic acid are known to suspend the growth of oral cancer cells and this plant has been used in various herbal mouthwashes and tooth powders.[54,55]

A study that investigated a collection of 27 medicinal and random plant extracts identified a number which suspended the growth of oral *Streptococci*. The most active extracts included: *Abies canadensis* (Pinaceae), *Albizia julibrissin* (Fabaceae), *Chelidonium majus* (Papaveraceae), *Ginkgo biloba* (Ginkgoaceae), *Juniperus virginiana* (Cupressaceae), *Pinus virginiana* (Pinaceae), *Rosmarinus officinalis* (Lamiaceae), *Sassafras albidum* (Lauraceae), *Tanacetum vulgare* (Asteraceae) and *Thuja plicata* (Cupressaceae).[24]

2. MEDICINAL PLANTS AND ORAL HEALTH

Dental caries is a bacterial infection that occurs in the hard tissue of teeth and is considered a serious health problem due to its high incidence.[26] Toothache, periodontal diseases, oral neoplasms and other deterioration of the oral mucosal (e.g., autoimmune diseases, potentially cancerous conditions, infections, trauma, etc.) are the most common complications affecting the teeth and the general oral cavity, leading to chronic diseases. Inflammation of the gums is called gingivitis and when left untreated, can turn into periodontitis.[27] The main causes of oral damage are alcohol and foods that have a high sugar content, limited access to health care facilities and the reduced amount of fluoride in toothpastes. Thus, bacterial causes, cachexia, vitamin deficiency, etc. lead to inflammation of the gums; however, the main cause of gingivitis is bacteria, which can initiate the destruction of gum tissues in the above diseases while their treatment is expensive and long-term.[28,29] In

gingivitis, the gums become red and swollen and bleed easily. It can usually be improved with daily brushing and flossing as well as regular scaling ("cleaning") by a dentist. Gingivitis that is not treated can lead to periodontitis. In periodontitis, the periodontal tissues become inflamed, the gums move away from the teeth and sac are created that, if not treated, the bones, gums and connective tissue that supports the teeth are destroyed, while there is also that creates a problem in the quality of life of the patient. Progressively periodontal disease leads to gingival recession, tooth decay and their loss with all the obvious consequences.[30] Plaque-induced gingivitis is one of the most common periodontal diseases, affecting more than 90% of the population, regardless of age, gender or race.[31] Dental caries is a health problem that affects people all over the world and Asians were found to have dental caries at a percentage about 58.8% in permanent teeth and 52.6% in deciduous teeth. Without treatment, caries enters the pulp tissues leading to tooth necrosis.[32,33] Dental plaque is a biofilm on the surface of teeth that plays an important role in the development of caries and periodontal diseases.[34] Removing dental plaque and reducing its recurrence are the main preventive measures. Pain originating from a decayed tooth or periodontal disease can be particularly strong.[35] Oral pain is the result of several conditions, e.g., dental caries, abscess, trauma, periodontal disease and temporomandibular structure dysfunction, etc.[36,37] It has been suggested by the WHO that the reduction of dental etiology of pain is one of the priorities in the global agenda for health promotion throughout the organism.[37]

2.1. Prevention of oral diseases with medicinal plants

Oral diseases are important health problems with caries and periodontal diseases being the most common lesions. Oral health affects overall quality of life, and poor oral health is associated with chronic disease. The association between oral diseases and the oral microbiota is well documented.[23] There are more than 750 species of bacteria that inhabit the oral cavity and most coexist normally and only a few are involved in oral diseases. The development of dental caries involves acidogenic and acid Gram-positive bacteria (*Streptococcus mutans, Lactobacillus* and *Actinomycetes*). Periodontal diseases have been linked to anaerobic Gram-negative bacteria *(Porphyromonas gingivalis, Actinobacillus, Prevotella* and *Fusobacterium)*.[24] Given that antibiotics show increased resistance in bacteria, the adverse effects of some antibacterial agents currently used in dentistry and economic considerations in developing countries, there is a clear need for alternative prevention and treatment options that are safe, effective and less expensive.[25]

Finally, concluded that there is significant evidence that plant extracts, essential oils and pure phytochemicals have the potential to be developed into active agents that can be used in the prevention and treatment of oral diseases.[25]

2.2. Side effects of drugs

According to recent studies, the adult population is unable to perform proper tooth brushing and this has led to the search for chemotherapeutic agents in order to maintain or improve oral health. However, some of these chemicals, mainly triclosan and chlorhexidine, have been used in mouthwashes or added to toothpastes to prevent plaque and gingivitis. But some of these substances can have side effects, such as staining of teeth and tissues, as well as deterioration of taste.[38]

2.3. Phytotherapy

The word "phytotherapy" comes from the Greek word *therapeia* and the Greek prefix *phyton* meaning plant. It is (the study of) the use of extracts of natural origin as medicines or health promoting agents. The term "phytonutrients" refers to plant nutrients with particular biological activities.[39] Many medicinal plants have been evaluated for their potential application in the prevention or treatment of oral diseases. Several studies have investigated the action of plant extracts and products against specific oral lesions, while others have focused on the ability of plant products to inhibit biofilm formation by reducing the adhesion of microbial pathogens to the tooth surface.[40]

2.4. Medicinal plants and teeth diseases

A great percentage of professionals (98.7%) believe that it is a priority to use phytotherapy as a supplement to health services, with the aim of reducing resistance and side effects caused by commonly used drugs. However, it is necessary to promote studies and standardize protocols for the use and management of these active ingredients and phytochemicals contained in plants through experimental studies.[41] For instance, collected data on the properties of some plants and natural products from 1965 to 2011 and reported results from grapes, berries, tea, cocoa, myrtle, chamomile, honey and propolis, aloe vera and from three groups of polyphenols (flavonoids, stilbenes and proanthocyanidins), investigating their effect on oral pathologies such as gingivitis, caries, periodontal disease, candidiasis, oral mucositis, oral lichen planus, leukoplakia and oral cancer. In randomized clinical trials, the evidence exhibits that there is inadequate information on the effectiveness

of the above substances.[42] In general, polyphenols can be divided mainly into tannins, lignins and flavonoids. Preclinical studies indicate interesting activities of the three polyphenols in more recurrent cases (candidiasis, caries and periodontitis).[39,41] In dentistry, phytotherapy has been applied as an anti-inflammatory, antibiotic, analgesic, and sedative. Herbal medicine is easily accessible at low cost and is less toxic than chemical drugs.[34] In addition, it is used in the prevention of toothache, gingivitis, mouth ulcers, inflammation of the tonsils, oral candidiasis and hairy tongue. In contrast, antibiotics such as tetracycline, metronidazole and antiseptics such as chlorhexidine have been used for a long time, but many undesirable side effects are observed.[43] The following figure 1 and table 1 contain alternative plant solutions to treat oral and dental diseases and their specific mechanisms.

Table 1. Indicative examples of herbal treatment.

Bark/Neem branches	Antibacterial properties/treatment of gum problems/fighting bad breath/toothache relief/teeth cleaning
Green tea	Prevent periodontal gum disease, bad breath, loss of gum tissue
Cissus quadrangularis	Periodontal filling material in periodontal regeneration
Curcuma xanthrorriza Roxb	Contains xanthorrizol with antibacterial activity/changes the structure of the microbiofilm of *Streptococcus mutans*
Vaccinium macrocarpon	Infection prevention urinary tract/prevention of oral pathogen attachment and biofilm formation
Zingiber officinale	Reduction of bleeding gums/bacterial plaque formation/reduction of anaerobic bacteria in saliva
Quercus infectoria	Antibacterial properties against oral pathogens *(Staphylococcus aureus* and *Streptococcus sanguis)* thanks to the presence of tannin and gallic acid

3. CONCLUSIONS

The oral cavity is the largest microbiological population in the human body. It becomes a suitable environment for hosting various types of microorganisms. There are medicinal plants that have been proven to have a natural fungicide effect and this is due to the secondary metabolites. Herbal medicine is still beneficial to this day. There are many plants in nature that have not been studied and may have some secrets for the medical community. However, concerns are constantly being raised by scientists and practitioners due to the increase in the use of phytochemicals. Quality, safety, long-term adverse effects and toxicity are the main questions. A systematic approach through experimental

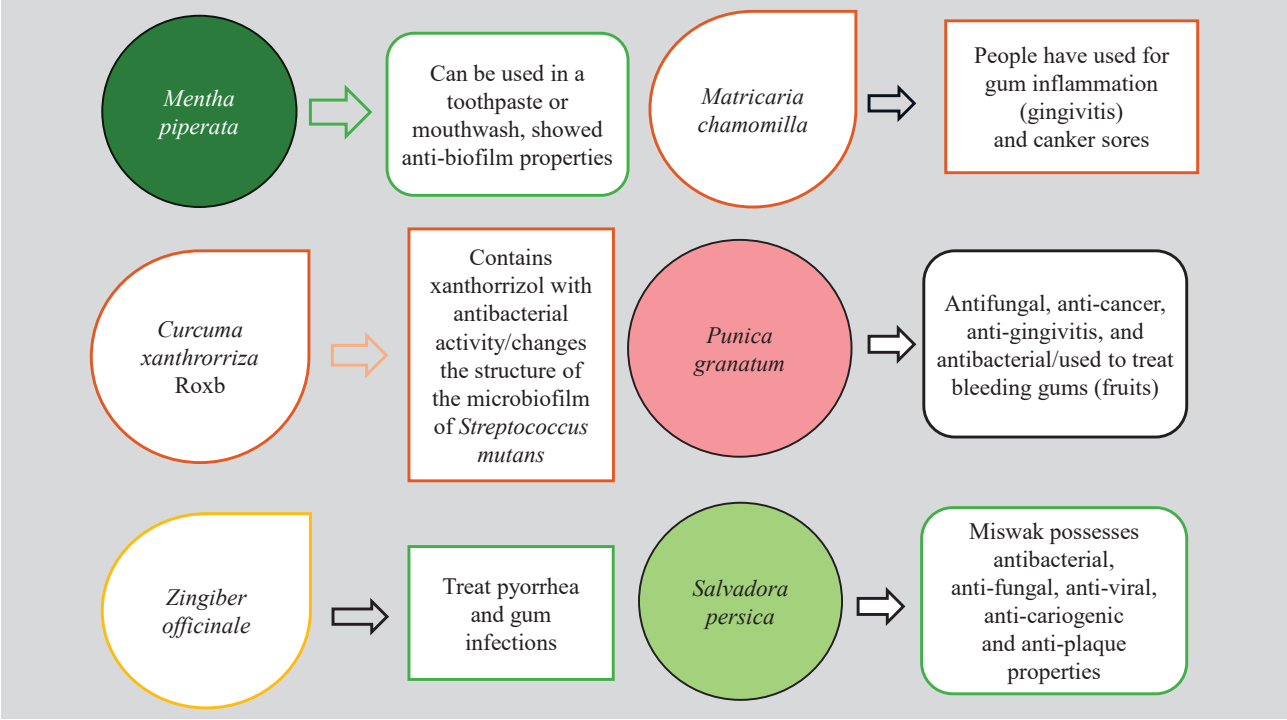

Figure 1. Medicinal plants used for oral health.

and clinical confirmation of efficacy for a plant identified for phytotherapy is needed to determine potential side effects. Several studies have used plant extracts to combat oral pathogens. However, it is necessary for the active ingredient to be pure to elucidate its mechanism, property and effect for future drug development. Extracts from medicinal and aromatic plants can be useful in dentistry and lead to new treatment methods, resulting in contributing to the improvement of dental treatments. All this reveals the need to present strategies that allow us to explore and formulate new therapeutic options based on natural active ingredients through experimental studies, reducing the toxicity of chemical drugs and resistance in order to improve the quality of life of people who are suffering. Thus, it is necessary to pave the way for the discovery of new drugs by following the ethnobotanical indications of medicinal plants. However, it is necessary to be careful in the use of medicinal plants. Therefore, preclinical and clinical trials are required to measure the biocompatibility and safety of medicinal plants to obtain optimal results without side effects.

ΠΕΡΙΛΗΨΗ

Φυτικές ουσίες και εκχυλίσματα στην Οδοντιατρική

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Τα κύρια προβλήματα που αντιμετωπίζουν οι άνθρωποι παγκοσμίως σήμερα όσον αφορά στις βλάβες των δοντιών είναι η τερηδόνα και η ουλίτιδα/περιοδοντική νόσος. Η καλή στοματική υγιεινή είναι απαραίτητη για υγιή δόντια, ούλα και γενικά τη στοματική κοιλότητα και το σώμα. Η χρήση φυτών για τη βελτίωση της υγείας των δοντιών και την προαγωγή της στοματικής υγιεινής έχει μακρά και σημαντική ιστορία από την αρχαιότητα. Τα κύρια προβλήματα που αντιμετωπίζουν σήμερα οι άνθρωποι παγκοσμίως όσον αφορά στις βλάβες των δοντιών είναι η τερηδόνα, η πλάκα, η ουλίτιδα και πιο σοβαρές περιοδοντικές παθήσεις. Υπάρχει πληθώρα ερευνών και μελετών σχετικά με παραδοσιακά φυτικά φάρμακα για τη θεραπεία στοματικών βλαβών και τον χειρισμό ασθενειών που σχετίζονται με τη στοματική υγιεινή. Η καλή στοματική υγιεινή είναι απαραίτητη για υγιή δόντια, ούλα και γενικότερα τη στοματική κοιλότητα. Φυτά και βότανα που ενισχύουν φυσικά τη στοματική υγεία, όπως η μέντα (Mentha), ο μάραθος *(Foeniculum vulgare)*, το βάλσαμο *(Melissa officinalis)*, ο κόλιανδρος (*Coriandrum sativum)* κ.λπ., καθώς περιέχουν φυτοχημικές ενώσεις και ουσίες, αναπτύσσονται στη φύση. Τα αποτελέσματα καταδεικνύουν ότι ένας αριθμός φυτικών προϊόντων και μεθόδων χρησιμοποιούνται στη στοματική υγιεινή για την πρόληψη και τη θεραπεία παθήσεων του στόματος. Όχι μόνο είναι εξ ίσου αποτελεσματικά, σε σύγκριση με τα σύγχρονα χημικά φάρμακα, αλλά η χρήση τους είναι επίσης ασφαλής και χωρίς τις ανεπιθύμητες ενέργειες των κλασικών φαρμάκων. Η εν λόγω έρευνα διεξήχθη για να επισημάνει τη σημασία της χρήσης φαρμακευτικών-αρωματικών φυτών στον τομέα της οδοντιατρικής επιστήμης και ότι είναι απαραίτητη η συνέχιση των μελετών με περισσότερα πρωτόκολλα για την ενημέρωση των ασθενών σχετικά με τις μεθόδους θεραπείας που μπορούν να ακολουθήσουν.

Λέξεις ευρετηρίου: Βοτανοθεραπεία, Οδοντική υγεία, Φαρμακευτικά φυτά, Φυτοθεραπεία

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