

Awareness and Perception of Herbal Antifungal Agents (Neem and Banyan) Against Azole Resistant *Candida albicans* in Denture-Related Infections: A Questionnaire-Based Study

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Abstract: Background: Denture stomatitis represents a persistent inflammatory challenge in clinical prosthodontics, primarily driven by *Candida albicans* biofilms. The compounding emergence of azole-resistant strains necessitates the clinical investigation of traditional phytotherapeutic options. Objectives: This cross-sectional questionnaire study aimed to evaluate the baseline awareness, depth of knowledge, and contemporary clinical perceptions among the general public and dental students regarding the therapeutic efficacy of *Azadirachta indica* (Neem) and *Ficus benghalensis* (Banyan) extracts against resistant oral mycological pathogens. Methodology: A structured, 4-section survey consisting of 20 validated multiple-choice questions (MCQs) was deployed to a sample size of $n = 100$ participants, equally divided between the general public ($n = 50$) and dental students ($n = 50$). Data processing and quantitative descriptive statistical analysis were performed to evaluate percentage trends across specific blocks of questions. Results: The descriptive analysis demonstrated robust general awareness regarding oral fungal pathology and hygiene regimens (70% positive response). Moderate overall baseline competency was observed concerning the specific biochemical properties of Neem and Banyan extracts (65% positive response). Crucially, while 60% of respondents exhibited a highly favorable attitude toward integrating phytotherapy into denture care, actual translation into active clinical preference and direct prescriptive practice remains distinctly constrained. Conclusion: There is a definitive baseline willingness to adopt herbal alternatives among both clinical cohorts and patients. However, targeted educational updates and structured clinical trials are necessary to bridge the gap between abstract awareness and empirical, evidence-based chairside application.

Keywords: Denture Stomatitis, *Candida albicans*, *Azadirachta indica*, *Ficus benghalensis*, Azole Resistance, Phytotherapy

1. Introduction

Denture stomatitis is one of the most common and clinically challenging chronic inflammatory conditions in prosthetic dentistry, affecting approximately 15% to 65% of completely or partially edentulous denture wearers [5]. The condition is characterised by generalised erythema, inflammation and epithelial hyperplasia of the palatal mucosa covered by the denture base [5]. The aetiology is multi-factorial, including mechanical trauma from ill-fitting bases, poor oral hygiene, nocturnal denture wearing and continuous mucosal coverage. The ultimate primary infectious culprit is the opportunistic yeast-like fungus *Candida albicans* [10].

In the normal physiological state, *Candida albicans* is a harmless commensal organism in the oral cavity [10]. However, the introduction of a non-biological polymethyl methacrylate (PMMA) micro-porous prosthesis provides an ideal substrate for fungal adherence, colonisation and subsequent multi-layered blastospore biofilm maturation [8]. This pathological switch is particularly accelerated in the geriatric, diabetic and immunocompromised patient groups, where local mucosal defences are structurally or immunologically compromised [13].

For many years the treatment of fungal infections has been based on the use of topical and systemic synthetic antifungal agents, mainly polyenes (e.g., Nystatin) and azoles (e.g., Fluconazole and Clotrimazole) [1]. Unfortunately, their chronic and repeated use have led to serious clinical complications [10]. Most importantly, the evolutionary pressure has caused a dramatic rise of strains of azole-

resistant *Candida albicans* [10]. Underlying resistance mechanisms include the upregulation of ATP-binding cassette (ABC) transporters, major facilitator superfamily (MFS) efflux pumps, and point mutations within the ERG11 gene encoding the target enzyme lanosterol 14-demethylase [10]. Moreover, the traditional antifungal agents often have undesirable systemic adverse profiles such as hepatotoxicity, gastrointestinal disturbance, complicated drug-drug interactions [1].

Against these growing therapeutic hurdles, the contemporary prosthodontic research is heading more and more to the vast, unexplored matrix of natural phytotherapeutic options [6]. The most promising traditional candidates are *Azadirachta indica* (Neem) and *Ficus benghalensis* (Banyan tree) [2, 3]. Both botanical agents have a long history of use in Ayurvedic and traditional Indian systems of medicine and are well known for their broad antimicrobial, anti-inflammatory and wound healing properties [2,3].

The potent antifungal, antiadhesive, and biofilm-disruptive properties of Neem and Banyan extracts against oral pathogens are strongly supported by the initial laboratory in-vitro and biochemical tests, however, the real-world clinical acceptance of these extracts is predominantly dependent on the perceptions of the public and the professionals [8,9,11]. Therefore, the aim of the present study was to systematically evaluate the current baseline levels of awareness, specific knowledge, and attitudes regarding the clinical use of these herbal agents among the general consumer population and active dental clinicians [4].

2. Phytochemical Properties and Literature Support

To contextualize the study's framework, a comprehensive exploration of the active botanical candidates is essential:

2.1 *Azadirachta indica* (Neem)

Azadirachta indica is one of the well-established medicinal trees of the family *Meliaceae*, native to the Indian subcontinent [2]. The phytopharmacological profile of Neem leaves and seed extracts is a highly complex mixture of chemically active, highly oxygenated tetranortriterpenoids. Its main active constituents responsible for its therapeutic activity are nimbin, nimbidin, nimbolide and azadirachtin [2].

As for the antimycotic mechanisms, these active fractions actively interfere with the cell membrane integrity, significantly suppressing fungal dimorphic transition from the blastospore phase to the highly invasive hyphal phase [1]. Literature established that crude extracts of Neem severely interfere with the initial attachment of *Candida* species on synthetic acrylic polymer matrices [8]. Furthermore, its natural anti-inflammatory properties synergistically reduce mucosal erythema through lysosomal membrane stabilisation and the down-regulation of proinflammatory cytokine expression [2].

2.2 *Ficus benghalensis* (Banyan)

Another pillar of traditional therapeutics is *Ficus benghalensis* (Banyan tree). As a member of the *Moraceae* family, the bark, leaves and aerial roots show great clinical utility [3]. Phytochemical screening shows that the active therapeutic extracts are very rich in complex secondary metabolites such as specific polyphenols, flavonoids, condensed tannins, saponins and sterols [3].

The high concentration of tannins and flavonoids are powerful natural astringents and have strong protein precipitating and cell wall disrupting action on fungal pathogens [9]. Tannins form explicit complexes with cell wall proteins, destabilising the outer layer of *Candida albicans* and causing cytoplasmic leakage [9]. Moreover, the peculiar sterol composition favours local tissue repair and enhances mucosal reepithelialization, a key aspect in the repair of the chronic tissue erosion typical of advanced denture stomatitis [12].

3. Methodology

3.1 Study Design and Sampling Frame

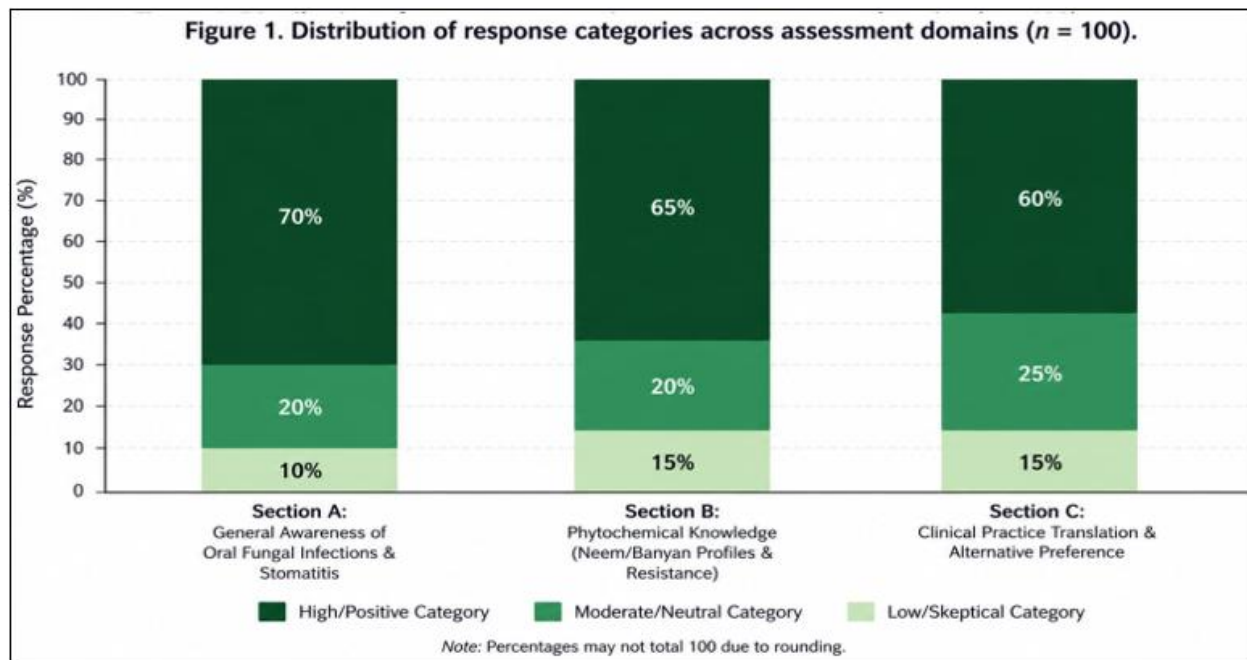
The present study was designed as a cross-sectional, descriptive, questionnaire-based survey targeting a sample size of $n = 100$ participants. To accurately capture the divergence between healthcare consumers and healthcare providers, we strategically divided the study population into two parallel, equal cohorts: a general public group ($n = 50$) consisting of diverse dentate and edentulous individuals, and a dental student group ($n = 50$) consisting of undergraduate students actively participating in clinical dental therapies.

3.2 Survey Instrument Validation and Administration

- The main data collection instrument was a highly structured 20-item multiple choice questionnaire (MCQ) where each question had 4 different options to prevent ambiguous responses. The instrument was rigorously validated through a preliminary pilot study to test linguistic clarity and internal consistency. The 20 questions were carefully categorised into four key assessment areas:
- Section A (General Awareness): Consisting of Questions 1 to 6, this section dealt with basic perception about oral fungal infection, general awareness about oral candidiasis, and basic hygiene for dentures.
- Section B (Knowledge about Herbal Antifungal Agents): Consisting of Questions 7 to 13, this set tested basic knowledge of herbal antifungal agents like Neem and Banyan, its history in clinical practice, and its importance in drug resistance.
- Section C (Dental Practice & Opinion): Comprising Questions 14 to as mentioned earlier, this part assessed current chair-side clinical preferences, operating procedures, and conceptual perceptions about the formal prescription of herbal alternatives.
- The questionnaire was sent via an institutional electronic distribution system within a stipulated period. Each of the respondents provided informed consent through the electronic medium before taking up the survey. The anonymity of each respondent was fully preserved.

4. Results and Analysis

The data gathered through the extensive questionnaire survey produced some obvious trends. Instead of resorting to conventional dense text tables, the performance trend for the three main functional blocks has been depicted graphically below.



4.1 Analysis of Section A: Overall Awareness on Oral Fungal Infections

The information gathered through the introductory portion clearly indicated a very high level of awareness with respect to oral mycological awareness. As many as 70% of those who were surveyed came under the category of "Good Awareness." The survey respondents had knowledge that poor denture hygiene was linked with palatal inflammation, and denture stomatitis was a symptom of the condition.

However, 20% had "Moderate Awareness," where they would confuse symptoms of fungal infections to being aphthous ulcers or even just mechanical trauma. A very small percentage of the respondents had "Poor Awareness," accounting for only 10% of the total population of the study, and thus suggesting that there is indeed a lack of knowledge in the basic principles of oral hygiene and its preventive measures.

4.2 Analysis of Section B: Knowledge on Herbal Antifungal Agents

The appraisal of knowledge about the properties of the Neem and Banyan tree indicated favorable developments. From the results derived from the aggregated data, 65% of the total number of respondents obtained the "Good Knowledge" category by recognizing the traditional antimicrobial properties of *Azadirachta indica* and *Ficus benghalensis*. They were knowledgeable about the significance of active secondary metabolites such as azadirachtin, flavonoids, and tannins; and they were knowledgeable about the fact that over-the-counter azoles have microbial resistance limitations.

Also, 20% of respondents fell into the "Moderate Knowledge" category, displaying knowledge of the role played by the trees in healing but without an accurate knowledge of the chemical composition or the biochemistry behind the plants. Finally, 15% of respondents performed poorly, illustrating a group of people who are totally unaware of recent advancements in dental pharmacognosy.

4.3 Analysis of Section C: Contemporary Dental Practice & Alternative Opinion

The last critical area covered practical applications of the therapy and its clinical purposes. It is worth mentioning that 60% of the interviewed respondents exhibited a "Positive Attitude & Practice" category, indicating a positive and enthusiastic attitude towards the use of natural options of phytotherapy in their future professional life. They regarded herbal remedies as affordable, safe, and biocompatible additions to clinical practice.

Yet again, a noteworthy 25% of participants maintained their stance of being "Neutral" due to the absence of clinical trials and guidelines on the commercial side of things. The remaining 15% clearly stated their "Negative Attitude & Practice" because of their distrust in the predictability of non-man-made drugs and preference for classic azoles alone. This clear separation proves that the main problem here is that although the intellectual curiosity regarding the topic is great, the lack of guidelines stops its clinical application.

5. Discussion and Clinical Significance

Findings from this cross-sectional study shed light on important clinical implications. The results show a paradoxical but positive finding that the public and dental academia have adequate knowledge on oral fungi problems and positive attitude towards herbal treatments, but there is definitely a bottleneck that stops the use of these natural treatments in practice.

It is hard to underestimate the clinical need for the study. Denture stomatitis is more than a temporary inconvenience in one localized area because it is a continuous biofilm-based infection that can function as a systemic reservoir of opportunistic organisms and cause aspiration pneumonia and systemic candidiasis in susceptible individuals[5,13]. With the increasing ineffectiveness of azole treatment due to mutations and resistance, it is vital that dentistry comes up with an alternative solution [6].

Phytotherapy with the help of Neem (*Azadirachta indica*) and Banyan (*Ficus benghalensis*) proves to be a brilliant option in this regard. The multiple chemical constituents of these plants that comprise cell wall disruption by tannins, anti-adherence properties of nimbinooids, and the tissue repairing abilities of sterols make it extremely unlikely for *Candida albicans* to become resistant [8,9]. Also, the cytotoxicity of these herbs is very low.

For the 60% positive attitude to be translated into action and daily practice, this group of professionals needs to find ways to address the issues raised by the neutral (25%) and skeptical (15%) groups. This may be achieved using a two-pronged approach:

- 1) Pharmacological Standardization: Turning crude plant extract preparations into standardized formulations which can then be used in practice, such as herbal denture paste, soaking solution, or muco-adhesive gel formulations [14].
- 2) Robust Evidence-based Studies: Moving from academic studies based on observation to randomized clinical trials (RCTs) which prove the minimum inhibitory concentrations (MIC), biocompatibility and structural stability with PMMA acrylic bases [15].

6. Conclusion

From this research, it is clear that there exists great awareness concerning fungal infections in the mouth, along with a very positive attitude in terms of accepting herbal therapy as an alternative treatment such as Neem and Banyan, with the previous reluctance towards these types of treatments disappearing because of the growing danger posed by azole-resistant fungi [4,6,11].

For there to be success in bridging the gap between theoretical knowledge and practical clinical practice, future dental training programs have to increase their focus on pharmacognosy, which is evidence based [11]. Simultaneously, dental research centers need to focus on clinical development. In this way, the dental field will be able to venture forward with confidence and efficacy into an age of oral health care [15].

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