

The impact of chewing betel nuts on human dentition in Indonesia: A literature review

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ABSTRACT

Background: Human behavior can significantly alter dental conditions. One such behavior is the habit of chewing betel nuts. Known as *nginang*, this tradition holds social significance in many cultures across Indonesia. Societal beliefs include the idea that chewing betel nuts offers a sensation similar to smoking cigarettes, provides a pastime, reduces bad breath, and even enhances dental health. However, evidence shows that it can cause severe damage to teeth. **Purpose:** This research aims to analyze the literature regarding the impact of chewing betel nuts on dental conditions and to recommend actions to address the problems caused by it. **Reviews:** While this habit can have positive aspects, it may also cause tooth damage when practiced with a certain frequency and intensity and using specific compositions. Issues such as calculus, periodontitis, attrition, and antemortem tooth loss may occur due to this habit. However, inconsistencies have been found concerning this habit's relation to caries. **Conclusion:** A pathological chain reaction triggered by betel nut chewing confirms its detrimental effect on dental health. Further investigations are required to explain the inconsistencies found in this review. The researchers recommend promoting tooth brushing to enable society to maintain its tradition without risking further teeth damage.

Keywords: *Areca catechu*; behavior; dentition; ethnomedicine; oral pathology

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INTRODUCTION

Dental anthropology is a field of anthropology that studies the morphology and cultures related to human dentition. Dental modification, both intentional and unintentional, is a form of body modification targeting the teeth for various purposes, such as to signify one's social status, marital status, gender roles, and more. It is closely tied to culture. Dental anthropology is used to analyze certain characteristics of human dentition and its relationship to a society's culture—one piece of evidence for this relationship is dental modification practices. Furthermore, dental anthropology studies traditional healing and medicinal methods to cure dental pathology. This paper applies dental anthropology to analyze society's culture or tradition, its impact on human dental health, and how people cope with these impacts.^{1–6}

Teeth, small white bones that grow systematically from the periodontal layer, serve the function of chewing or

biting.⁷ Teeth and the mouth are considered social organs given their pivotal role in human social life. Therefore, teeth and the mouth are targets of modifications symbolizing social status, familial relationships, beauty, and more.^{5,8} Given its significance, dental modification has evolved into a social habit. This habit of dental modification subsequently became a tradition that developed into an important aspect of a society's culture. This culture has been passed down through generations. However, a downside to dental modification is that it may cause alterations to human dentition.⁹

The tradition of chewing betel nuts is regarded as a form of cultural dental modification because it is a societal habit characteristic of certain societies. The use of teeth as tools and for mastication might influence dental health and morphology. Teeth may undergo alterations over time due to their close contact with food, objects, and the opposing set of teeth.¹⁰ This tradition entered Indonesia many years ago. Zambroich¹¹ stated that chewing betel nuts is a

13,000-year-old tradition that originated in Southeast Asia. However, the exact commencement date of this tradition is highly debatable. Based on archaeological evidence found in Bacau, East Timor, betel nut chewing likely started 13,000 to 4,000 years ago.¹² Later research suggested the age of this tradition might be around 2,500 years, which implies the tradition is more recent than previously thought.¹³ Given the uncertainty surrounding the origination date of the betel nut chewing tradition, further research is needed to verify and confirm the date when humans started chewing betel nuts.

Betel nut chewing is a prominent cultural practice, evident in many societies around the world, with evidence found across Europe, Africa, Asia, America, and Oceania.¹⁴ Oxenham et al.¹⁵ theorize that this tradition spread throughout numerous Southeast Asia and the Pacific Islands regions, such as Papua New Guinea, the Mariana Islands, Thailand, Vietnam, Andaman Island, Java, Malaysia, and the Philippines. Fitzpatrick et al. hypothesized that this tradition is indigenous to Austronesian-speaking cultures and may have originated from India or Indonesia before being disseminated to other regions due to migration.^{16–18}

In several cultures across Indonesia, chewing betel nuts is also known as *nyirih* or *nginang*. For some people, this habit is more than just a tradition. Some believe that chewing betel nuts can offer them a smoking-like sensation while strengthening their teeth and eradicating bad breath. Others engage in it merely as a pastime.^{9,19,20} Nowadays, this habit is typically practiced by older women.²¹ However, in eastern Indonesia, such as Maluku, Papua, and East Nusa Tenggara, this practice is still actively performed by many societal elements across various age groups.¹⁴

Dental and oral health is the main concern related to betel nut chewing. The International Agency for Cancer Research classifies betel nut as a Group 1 carcinogen. Betel nuts are known to cause lesions that might potentially lead to oral cancer.^{22,23} The World Health Organization (2012) stated in its report that betel nut consumption is a public health issue in the Asia Pacific, including Indonesia.²⁴ Chewing betel nuts is also associated with other dental diseases, such as calculus, periodontitis, and caries.^{17,25}

Given the decrease in dental health care, while betel nut chewing remains a relevant and active tradition in many cultures, it is necessary to review this matter.^{26–28} This study aims to explain misconceptions about the betel nut chewing tradition in society, illuminate dental and oral diseases caused by this tradition, and compare the literature on this topic to obtain a clear picture.

REVIEWS

Social Significance of Chewing Betel Nuts in Various Indonesian Cultures

Chewing betel nuts, also known as *nginang* or *nyirih*, is a cultural tradition deeply entrenched in various

Indonesian societies. It is considered a way to express human spirituality. The ingredients used to perform this tradition are simple: betel (areca) nut, gambier, betel leaf, slaked lime, and tobacco. Usually, some or all of these ingredients are mixed and chewed for a few minutes to hours.²⁹ Nowadays, *nginang* is commonly performed by older people, although this tradition is not exclusive to that age group. In some cultures, chewing betel nuts is also considered a traditional method to maintain dental and oral health. It is believed that those who are accustomed to chewing betel nuts will have stronger teeth, even into old age.³⁰

Betel nuts are socially significant in many cultures in Indonesia. Typically, it is used in various customs, ceremonies, rituals, and rites. In Javanese culture, betels are thrown at the bride and groom as part of the *temu temanten* ceremony. In Bali, betel nuts are typically served to guests in a *rayunan* for *Sulinggih* and *Pemangku*. In a ritualistic context, it is also one of the most common offerings to ancestors. The Hindu people of Bali link the Trimurti's power and divinity to their daily lives, one of which is the *nginang* tradition. The red betel nut symbolizes Brahma, the black betel leaf symbolizes Vishnu, and the white-slaked lime symbolizes Shiva.³¹

The Riring people in the Taniwel District, West Seram Regency, Maluku, stated that the betel nut is a symbol of family and state unity. In Riring, the betel nut is an essential ingredient used in many local rituals and ceremonies. It is used in marriage rituals, the King's coronation ceremony, state meetings, and the creation of family unions. During these rituals, the betel nut is typically placed next to tuak (a traditional alcoholic beverage). This tradition is believed to embody familial and social solidarity values based on local customs and the Bible. The Riring people believe that chewing betel nuts is an important part of Riring culture that should be preserved.¹⁹

In East Nusa Tenggara, betel nuts hold social significance in the structural relationships of society. The betel nut is integral to daily life, as locals consider the colors left on one's teeth after chewing betel nut as a symbol of beauty. In modern society in East Nusa Tenggara, the *nginang* tradition remains relevant and actively practiced. In fact, every city and regency in this province has a significant population that still actively performs this tradition. Contrary to Javanese culture, where chewing betel nuts is mostly limited to older people, the youth, adults, and children of East Nusa Tenggara are known to engage in this tradition as well.^{17,32}

The people of East Nusa Tenggara believe that chewing betel nuts can heal dental and gastrointestinal diseases. This traditional treatment is typically performed by a local healer known as a *dukun sembur* or spray healer. This term is used due to the healing method associated with it: they begin by chewing the betel nuts. After that, they have two methods of application. The first is to rub the chewed betel nuts on the affected area, and the second is to spray the chewed betel nuts.¹⁷

Ingredients and Benefits

The betel leaf (*Piper betle* Linn) is a green, flat, smooth-surfaced vine or climbing plant capable of growing up to dozens of meters. It is enriched with antibacterial agents, such as chavicol, sesquiterpene, eugenol, and cineol. The bactericidal power of chavicol in a betel leaf is five times stronger than regular phenol. In dental health, this compound's primary function is to reduce the activity of bacteria in the oral cavity, such as *Streptococcus mutans*, commonly found in saliva and dental plaque. *Streptococcus mutans* can attach to the oral cavity and develop into a highly malicious pathogen.³¹

Areca nuts (*Areca catechu* Linn) contain tannin and flavonoid compounds. They serve to strengthen the teeth. Flavonoids can inhibit bacteria's DNA, RNA, and cytoplasmic membrane system, causing instability in their energy and defense systems. Theoretically, flavonoids can potentially reduce bacterial growth in the oral cavity. Tannin's main function is to disrupt the cell's coordination system, rendering it incapable of transferring proteins. Furthermore, tannin can also impede the growth and formation of the microbial cell wall and adhesin cell, causing the bacterial cells to perish.³¹

Slaked lime (calcium hydroxide) is a chalk-like substance. It is produced through coral rock combustion or chalkstone sedimentation. Compounds such as cadinene, carvacrol, cineole, and tannin found in slaked lime create a heat sensation when consumed, which is why slaked lime should be consumed responsibly.³¹

The catechin compound in the gambier extract (*Uncaria gambir* Roxb.) functions as an antioxidant and antitumor. Catechin is a chemical compound that may prevent the formation of extracellular glucan, making *Streptococcus mutans* unable to adhere to teeth. Moreover, gambier extract is enriched with catechol, a chemical compound that can slow down plaque formation.³¹

Tobacco (*Nicotiana tabacum* L.) is a farmed, non-food plant with numerous antibacterial compounds, such as nicotine and phenol. As a traditional medicine, tobacco is commonly used to prevent caries. Besides its antibacterial properties, tobacco leaves also contain flavonoids, an antioxidant compound.³¹ However, nicotine can lead to addiction in consumers. When consumed, nicotine creates a pleasant yet addictive sensation, making it difficult for consumers to quit tobacco. Even if they quit, the resulting addiction may cause extreme discomfort, leading them back to their addiction.³³

The Linkage Between Chewing Betel Nuts and Human Dentition

Elders who still actively consume betel nuts in Tawang Kulon, Sidomulyo Village, Ngadirojo District, Pacitan Regency no longer possess a full set of healthy teeth. The loss of teeth is not solely attributed to old age; it could be exacerbated by dental diseases, such as periodontitis and caries. Dental diseases may be caused by behaviors or habits that do not prioritize dental hygiene.^{34,35} One such behavior

includes not brushing one's teeth after chewing betel nut. Some ingredients used in the *nginang* tradition can alter dental morphology, including causing dental staining from the areca nut.⁹

Research conducted in Batubulan Kangin Village, Sukawati District, Gianyar Regency, discovered a unique relationship between the habit of chewing betel nuts and caries. This finding contrasts with other studies reviewed in this paper. The results demonstrated a significant relationship between caries and the frequency and ingredients involved in the *nginang* tradition. First, the researchers noted that the fewest instances of caries occurred in respondents who had been chewing the betel nut for a relatively long time. This may be due to a protective blackish stain left by the betel nut on the teeth. Second, the least caries were found in respondents who performed the *nginang* tradition with the greatest number of ingredients. Conversely, more caries were observed in respondents who performed the *nginang* tradition with fewer ingredients. Hypothetically, this could be due to the chemical compounds found in each ingredient. Instead of creating a harmful concoction, they mix harmoniously, creating an effective traditional medicine. Lastly, the researchers cited Waery (2012), who stated that societies with higher caries prevalence are those who do not practice this tradition. On the other hand, societies that do practice it demonstrate the least prevalence of caries.^{9,20}

In contrast to previous research, a study in Oesusu Village, Takari District, Kupang Regency, revealed another fact. This study demonstrated that caries severity increased due to chewing betel nuts. The blackish stain left by the ingredients concealed the caries stains, which led to people not noticing them readily. Furthermore, the teeth' sensitivity was dulled by the constant intense pressure from the ingredients, preventing them from feeling the pain caused by caries. As a result, they continued to ignore it until it became extremely severe and the pain unbearable. By the time they sought professional help, it was too late.³⁶

The discrepancy found in these two caries-related studies is still unexplained. Several factors could contribute to this inconsistency, such as the variation in mean tooth strength among individuals, the mass of the ingredients, and other variables. However, the actual cause of this inconsistency will remain unknown until further research is conducted.

In Tanjung Medan Village, Bilah Barat District, Labuhanbatu Regency, researchers conducted a study confirming the linkage between periodontal disease and the frequency and ingredients used in betel nut consumption. To begin, there was a significant relationship between the daily frequency of consuming betel nuts and periodontitis. This suggests that an individual who consumes betel nuts as frequently as possible in a day is likely to suffer from periodontitis. Second, a significant correlation was found between the time spent consuming betel nuts in each session and periodontitis. This implies that periodontitis is more likely to occur in those who consume betel nuts

for longer durations. Finally, a significant relationship was observed between the ingredients used in the *nginang* tradition and periodontitis. If an individual performs the *nginang* tradition with all five ingredients, the risk of periodontitis increases. Conversely, consuming betel nuts with fewer ingredients might minimize the risk of periodontitis.²⁹

The Society's Popular Belief

Society believes that chewing betel nuts can create a sensation similar to smoking, reduce bad breath, and enhance teeth strength. However, some continue this practice merely out of tradition. This belief is supported by numerous pieces of literature, which state that societies in Asia and Oceania—such as Java, East Nusa Tenggara, Papua, Micronesia, and Guam—hold the view that chewing betel nut may provide additional protective layers on the tooth's surface and prevent the growth of caries.^{20,31,32,36} Nevertheless, there are just as many contradicting pieces of literature.^{9,17,21,29} Some claim that chewing betel nut can cause issues for the teeth, such as dental misalignment, tooth loss, and dental staining.

Not only the teeth but other oral organs and chewing apparatuses can also be affected by betel nut chewing. It might induce lesions in the oral mucosa, cause periodontal diseases, promote poor oral hygiene, and result in atrophy of the tongue mucosa.^{22,23,37,38} Given the public's generally low level of dental health awareness, this habit might precipitate a public health problem.^{28,39} Unfortunately, misconceptions surrounding the practice of betel nut chewing and dental health remain widespread in Indonesia.

Morphologically speaking, society's habit of consuming betel nuts can be viewed as an intentional dental modification. Aside from chewing betel nuts, the people of Tawang Kulon, Sidomulyo Village, engage in other behaviors that alter dental morphology. The first is food-related behavior, likely due to the use of hard-textured wooden tools in meal preparation, which may cause food to be infused with hardwood. The second pertains to unintentional dental modifications, such as the habit of using toothpicks to clean teeth. However, the people of Tawang Kulon do not believe that these three behaviors contribute to dental diseases. Instead, they hold the belief that these behaviors can help cure various dental ailments.⁹

The Nginang Tradition in the Prehistoric Societies of Lewoleba and Liang Bua, East Nusa Tenggara

The human remains observed originated from Liang Bua, Flores Island, and Lewoleba, Lembata Island, in East Nusa Tenggara. The remains were stored in the Museum of Ethnography and Mortality Study Centre at the Faculty of Social and Political Sciences, Universitas Airlangga. Ten remains were observed: five were from the Liang Bua site, and the other five were from the Lewoleba site.

The research found that nine of the ten skeletal remains exhibited evidence of dental staining and discoloration. Variations of gradation were found in the staining on the

remains, presumably caused by variations in intensity, frequency, and ingredients used. The presence of red-blackish dental staining indicates that there was evidence of betel nut consumption. This further suggests that the prehistoric population of Liang Bua and Lewoleba actively consumed betel nuts. This supports the theory that chewing betel nuts has been a part of Indonesia's society since prehistoric times.¹⁷

Chewing betel nuts might cause attrition, as many heavy and solid ingredients could subject the occlusal surface to excessive pressure. However, it is important to note that chewing betel nuts is not the sole cause of attrition. The research also detailed the domino effect caused by this tradition. After attrition, there is an indication that calculus and periodontitis follow, causing the remains to exhibit antemortem tooth loss (AMTL).¹⁷

Consequently, the idea that chewing betel nuts can improve dental health and strengthen teeth contradicts the findings of this research. In fact, based on the observation of these remains, chewing betel nuts was suspected of causing a series of tooth pathologies. The cause of dental pathology found was associated with the amount of time an individual spent consuming them. Poor dental hygiene also played a part in causing said dental pathology. This paper asserts that betel nuts might indeed strengthen one's teeth. However, if consumed with higher intensity, more frequently, and using more comprehensive ingredients, this habit might cause a domino effect of dental diseases, starting from attrition and calculus and eventually leading to AMTL.¹⁷

DISCUSSION

The tradition of betel nut chewing has maintained its relevance in multiple cultures across Indonesia, especially in the eastern part of the region. Although scientists have revealed the tradition's prehistoric origin, the precise date signifying the entry of this tradition into the Indonesian archipelago remains undetermined. Some propose that it began 13,000 to 4,000 years ago, but many others debunk this, theorizing that it is actually more recent.^{12–15}

Every piece of literature reviewed shares similar conclusions. It can be inferred that there is a relationship between the habit of chewing betel nuts and dental health, whether in the context of modern or prehistoric society. One reviewed article serves as a foundation, describing chewing betel nuts as a cultural practice while highlighting their significance and benefits.³¹ Six articles stated that chewing betel nuts harms human teeth. Evidence includes the existence of AMTL, caries, staining, periodontitis, calculus, and attrition.^{9,17,20,21,29,32} Only one article contradicts these findings, supporting the belief that chewing betel nuts can strengthen dental health. In this article, the researchers found that those who chew betel nuts more frequently had minimal caries.³⁶ The inconsistency discovered indicates that further research is necessary, as numerous factors could affect these outcomes.

It is important to note, however, that chewing betel nuts also provides certain benefits for both the biological and sociocultural aspects of human life. Dondy (2009) and Hsiao et al. (2015) stated that chewing betel nuts can reduce the formation of caries.^{20,29,36} Several cultures in Indonesia perceive chewing betel nuts as a medical practice to minimize inflammation and fever while also strengthening teeth. Wei (2015) noted that betel leaf contains antibacterial substances, hence its traditional use as a rub to treat inflammation and toothache. Furthermore, betel nut itself contains antiparasitic, antifungal, anti-inflammatory, antioxidant, antidepressant, analgesic, antiallergic, and anti-diabetic substances.¹⁷ On a social level, the use of betel nut holds significant value as a symbol of unity, family, health, home, and tradition in some Indonesian cultures.^{9,19,21,31}

Despite the positive impacts of betel nuts, several pieces of literature and reports highlight the negative effects of betel nut consumption on oral and dental health. The World Health Organization released a report stating that chewing betel nuts can cause oral cancer and recommended global cessation of its consumption.²⁴ Another study found that the accumulation of ingredients used in betel nut consumption, coupled with the frequency of this tradition, might increase the chances of oral cancer and other oral and dental diseases.¹⁷ Moreover, chewing betel nuts may also cause severe damage to periodontal tissues, dentition, and the temporomandibular joint, as indicated by tooth wear, attrition, abrasion, dental staining, periodontitis, and AMTL.^{15,21,29,36–38} Hsiao et al. (2015) revealed that while chewing betel nuts reduces the risks of caries, the calculus caused by chewed betel nuts might stain and accumulate on the teeth, further increasing the risks of periodontitis and other dental pathologies. Their study showed that individuals who actively chew betel nuts are more likely to lose their teeth due to periodontitis than those who do not.^{29,32}

Overall, every piece of literature concurs on one aspect—the chewing betel nut tradition has both positive and negative impacts. These impacts can be viewed from both biological and sociocultural perspectives. From a biological standpoint, chewing betel nuts might reduce caries formation and is frequently used as a traditional medicine to treat toothache, inflammation, and clean open wounds. The rising risks of negative impacts caused by chewing betel nuts are influenced by increases in the ingredients used, the duration of chewing, and frequency per day. Previous studies have proven that conditions such as gingivitis and periodontitis are highly likely to occur in individuals who chew a combination of all commonly used ingredients (betel nut, betel leaf, gambier, slaked lime, and tobacco) more than five times a day, with each session lasting for more than 30 minutes.²⁹ By considering these variables, the negative impacts of the betel nut chewing tradition can be controlled and reduced.

Betel nuts also hold cultural significance. They are often used as supplementary material in local rituals and daily lives, such as during marriage rites, house events,

and religious services, and again, as a form of traditional medicine.^{15,17,19,25,31,37} Based on the literature review, the recommended solution to tackle the negative impact of this tradition is to increase dental and oral care. Scholars suggest that it is necessary to develop the habit of properly brushing one's teeth after chewing betel nuts.^{27,34} However, many people reject this suggestion. Instead, they practice *menyusur*, a method of distributing the chewed betel nut across their entire dental surface to strengthen and clean their teeth.³⁶

Nonetheless, systematic efforts are required to encourage society to prioritize dental health. Stakeholders such as the government, non-governmental organizations, academics, public figures, and common citizens should collaborate to boost public health measures and raise public awareness. The term “systematic effort” implies that all stakeholders will plan, execute, and evaluate the program continuously. One example is conducting a tooth brushing socialization campaign to prevent the increase of dental diseases. A previous study revealed that dental health socialization in schools is highly effective, thus making it a potentially promising public health measure.^{40,41}

Since betel nut-induced calculus might accumulate on the teeth and encourage bacterial growth, it is important to clean them routinely, both personally and professionally—i.e., through tooth brushing and scaling, respectively. If done correctly, society can still perform and sustain the *nginang* tradition while minimizing its negative impact on dental health.^{27,34}

Those who actively chew betel nuts are more likely to lose their teeth due to periodontitis compared to individuals who do not chew betel nut.^{29,32}

The implementation of the proposed solution presents many challenges. Altering tradition is difficult since it is deeply rooted in a society's cultural norms and values.^{3,30,42,43} However, changes in the practice of these traditions are necessary to ensure the health and safety of the betel nut-chewing tradition. A public figure is needed to influence the community. To this end, health scientists must collaborate with social scientists to make socialization and public education efforts as non-invasive as possible. Continuous community service, school, and village partnerships are recommended to evaluate the program further, ensuring the “new culture” is appropriately implemented and passed down to future generations—thus preserving tradition while minimizing risks.

Consuming betel nuts is a socially significant tradition in many Indonesian cultures. The tradition, which has prehistoric origins, continues to be prevalent in modern society. The materials used in this custom are tobacco, slaked lime, betel, areca nut, and gambier. Based on the literature, we can conclude that consuming betel nuts has both positive and negative impacts on human dental health. The negative impact of chewing betel nuts might amplify if tradition is practiced more frequently and with more materials. Morphologically, chewing betel nuts can leave a red-blackish stain on one's teeth. We found inconsistent

and contradictory studies suggesting that chewing betel nuts might improve dental health, particularly concerning caries, instead of deteriorating it. Further research on the influence of the betel nut-chewing tradition on dental and oral pathology in other geographic areas, and in terms of pathology, frequency, and ingredients, is needed to analyze the inconsistencies identified in this review. We recommend that both society and government increase socialization and education efforts regarding dental and oral health, especially in communities that actively practice this tradition. Additionally, we recommend regular teeth brushing to maintain the tradition without increasing dental health risks.

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