THE EFFECTS OF CHEWING BETEL NUTS ON THE MOUTH[1]

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Abstract: The chewing of betel nuts is the widest spread masticatory habit in the world. It has a history of at least 2000 years, for people have been chewing betel nuts as a masticatory. In the Orient, the number of people having this habit is estimated at over 400 millions. Most of the residents distributed from East coast of Africa along India Ocean to some of the Islands of the Pacific. The components of the betel nut quid may be different in different localities, but the essential components, i. e. the betel nuts, gambir or cutch, *P. betle*, and lime are always the same. In Taiwan the habit of chewing betel nuts very probably came from Malaysia one thousand years ago.

The mouth condition of 280 betel nut chewers and 306 non-chewers were examined. The result shows that the average number of teeth of betel nut chewers was 29.45 and the mean value of the caries number was 5.33. The average number of teeth of non-chewers was 29.47, and the mean value of the caries number was 6.06. There is only slight difference between the caries rate of chewers and non-chewers. These differences are not significant and the preventive effects of chewing betel nut on caries is doubtful.

Gingivitis and dento-alveolar abscesses in the mouth of betel nut chewers is much commoner than non-chewers. The attrition of teeth, black stained teeth and increasing amounts of calculus are commoner and severer in betel nut chewers.

INTRODUCTION

In Taiwan the chewing of betel nut is still a very extensive habit. Betel nut stands are frequently seen both in the city and countryside. However, Taiwan is not the only place in the world where people have this habit. As a matter of fact, in the Orient, the numbers of people that have this habit is estimated at over 400 millions (Hill, 1952). Probably more people chew betel nuts than any other masticatory, and people have been chewing betel nuts as a masticatory since very ancient times. There have been many reports concering this subject, but the effects of chewing betel nut on the human body are still imperfectly known (Muir *et al.* 1960; Blatter, 1962; Aminuddin, 1971; Ahluwalia *et al.* 1968; Ellis, 1921; Chen, 1937; Nieschulz, 1967). From reports some have shown that some of its effects are good and some are bad. In old times people thought that the chewing of betel nut could be used for healing of diseases, preventing of dental caries, and for expelling tape-worms (Bailey, 1930), but recent reports show that the chewing of betel nut may be an inducer of mouth cancer (Chang, 1964; Chang, 1966; Chin *et al.*, 1970; Suri *et al.* 1971).

Neverthless, many people still think that the chewing of betel nut can prevent dental caries, and is good for the teeth, however their judgment is usually based

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on personal experiences, and not on statistical data. In 1937, Chen reported the effects of chewing betel nut on teeth and his statistics showed that the caries rate of betel nut chewers was lower than non-chewers. But after 20 years, with the improvement of medicinal knowledge and oral hygiene, the validity of Chen's results are questionable. So that a more recent survey of the effects of the chewing of betel nut on the mouth is required.

GENERAL ASPECTS OF BETEL NUT QUIDS

A. History and General Background:

The chewing of betel nut is a very old habit, it was first described by Herodotus in 340 B.C. (Hill, 1952). The exact time when man began to chew betel nut as masticatory is not known, but all admit its antiquity.

Quite apart from its dietary aspects, the betel nut has also been a traditional features in the social life of India as well as in other Orient countries. It is a link between the rich and the poor, and it is chewed on most ceremonial occasions, such as at birth, marriages and deaths. Emperors would send gifts of betel-leaves to foreign potentates. In Malaysia an offer of betel nuts became recognised as a formal token of apology, but in other countries it was intended as hint to a guest that he had overstayed his welcome (Aminuddin, 1971).

Why are so many people addicted to this masticatory? The reasons are varied. According to Linschoten (Aminuddin, 1971), "The women when they accompany secretly with their husbands, doe first eat a little Bettele, which (they think) maketh them apter to the game. All the Indians eat it after their meals, saying that otherwise their meate would upbraide them—and that such as have used to eate it, and leave it, doe get a stinking breath." In other words betel nut was chewed as an aphrodisiac, as a digestive, and as a cure for halitosis. Ahluwalia and Ponnampalam (1968) reported: "various reasons were given for commencing the habit of betel nut chewing. Most of the men and women said that they learnt the habit from others with whom they worked, or from parents. The rest took up betel nut chewing to relieve toothache, and remove any residual taste and smell of food from the mouth after a meal, or as in the case of workers in nurseries to offset the odor while attending to the toilet of children." —"Some persons described the habit as a practice which they could not forgo. In others the chewing of betel nut quid acted as a stimulant and removed depression thereby enabling them to work. In expectant women betel chewing relieved the nausea and vomiting of pregnancy. —Majority of chewers felt they could do without it."

The author has interrogated many who chew betel nuts about the reasons why they started chewing and most of them said that at first it was for curiosity and that they learned it from other people, then became addicted to the habit. Some claimed that chewing betel nut was good for their lungs and could drive away diseases. Most of those the author questioned said that they could give up the habit, if it was shown to be harmful for health, and said that is easier to stop chewing than smoking. But a few of them said they stopped chewing for a while, they would feel miserable, so they would chew betel nut again to get rid of their uncomfortable feelings.

The social level of betel nut chewers in India, is commoner among persons of the lower income groups than those in the higher income groups. Except that the higher income groups offer betel nuts as a part of the wedding ceremony and on

other special occasions. In certain occupations, such as: laborers, many are willing to forgo their rice and curry or tea, but they insist on chewing their betel leaf with arecanut and lime (Ahluwalia, 1968). In Taiwan the social level of chewers is much the same as that in India, most of them are laborers, fishermen and farmers. The price of the betel nut quids is usually one NT dollar for 3–6 betel nut quids according to the different components in the quids. The quid is chewed for a variable of time from several minutes to 20 minutes or even more. This is cheaper than chewing other masticatories or smoking. In Taiwan, the majority of betel nut chewers also smoke cigarettes and it may be for this reason that the betel nut quids in Taiwan do not contain tobacco, as they do in India and Thailand; in those countries tobacco is often mixed in the quid as one of its components (Ahluwalia, 1968; Ellis, 1921).

Most of people from the East coast of Africa to the remotest Islands of the Pacific chew betel nuts daily (Hill, 1952). This region includes places from Reunion and Zanzibar to India, Ceylon, Burma, Malaysia, Thailand, Vietnam, Singapore, the Philippines, Indonesia, New Guinea, Taiwan, South China, and Oceania (Muir, 1960). Over 100,000 tons of these nuts are used annually in India alone (Hill, 1952). In many of these places the chewing of betel nut is nearly universal among both the women and men (Ellis, 1921), but in Taiwan women chewers are few and most of these are very old women.

The exact time that this habit came over to this Island and just where it came from is not known. It has been postulated that this habit very probably was brought here from Malaysia in the Sixth Century (Chang, 1964). In the Malaysian language betel nuts are called, Sirih and Pinang (Curtis, 1853), the latter term is pronounced the same in Taiwanese and almost the same in Mandarin. The gambir which is mixed with the lime is imported from South East Asia, and is called "Gambir" by Malayans (Curtis, 1853). The sound of this word is also very similar to the term used by the native Taiwanese. The name "betel" bears some connection to the racial names of the aborigines in Southeast Taiwan called Bunun, and the natives of Malaysia are also called Ponen. It has recorded that before the Sui Dynasty, the Malayans had come to Taiwan. As described in "Island History of Taiwan", edited by Lies', and Englishman, that when the officers of Sui Dynasty made an attack on Taiwan, they employed men from Kong Long who could speak Malayan. Ponens are now called Bunun in Taiwan and this was the strongest race at that time. They very probably brought this habit to Taiwan (Chang, 1964).

B. The Components of the Betel Nut Quid and Their Composition:

In Taiwan, the betel nuts are mixed with lime, gambir, and the fruit or underground stem of *Piper betle*. Sometimes in order to give a better taste, some cinnamon, cloves, cardamon, or other spice is added to the quid.

(1) Betel Nuts:

Betel nuts are the fruit of the palm, *Areca Catechu L.* (Fig. 1), which was originally found in Malaysia (Blatter, 1 1926). More than 17 varieties of betel nuts are known in India alone (Bailey, 1930). In regard to its shape, betel nuts can be classified into two groups (Chang, 1964), i.e. those with an oval shape and those with tapering ends as shown in Fig. 2.

The betel nuts are very astrigent and acid in taste, but possess a slightly fragrant smell. It contains many alkaloids (Willaman, 1961): Arecaidine, Arecaine ($C_7H_{11}NO_2 \cdot H_2O$), Arecoline ($C_8H_{13}NO_2$), Guvacine ($C_6H_9NO_2$), Guvacoline, Isoguvacoline, Choline ($C_5H_{15}NO_2$), Norarecaidine, Norarecoline.

Arecoline is the only one of importance, the dried nut contains about 0.1 per cent, and has an effect similar to pilocarpin. This alkaloid is cholinergic, exerting a sialogogue, and diaphoretic action in normal dosage (Drill, 1965). Very large amounts depress the central nervous sustem and paralyzed muscles; it also has a stimulating effect on oculomotor nerve, causing mydriasis and this is followed by slight paralysis and then the dilatation of the pupil (Blatter, 1926). It may exert a deleterious effect on the dental enamal (Drill, 1958). This nut is sometimes used internally by Malayans as a vermifuge and as a cure for diarrhoea (Muir, *et al.* 1960).

Also present in the betel nuts are tannin, the glycerides of lauric, and myristic acids, and a little sugar (Muir, 1960). The other components of betel nuts are shown in Table 1 (Chang, 1964).

Table 1. Constituents of betel nut.

Constituents	Percentage (%)
Water	13.35
Total nitrogen	1.53
Teopromin	2.08
Ether extract	1.35
Starch	45.44
Tannic acid	3.79
Wood fiber	7.01
Non-nitrogen substance	18.21
Inorganic substance	2.90

In the liver homogenate arecoline is decomposed to arecaidine which has no parasympathomimetic effects but only stimulating properties. Arecaidine does not effect the general activity of an animal, but higher dosages exert a sedating effect. During betel nut mastication only small quantities of unaltered arecoline are absorbed, the larger part of the arecoline liberated from the nut is esterified by the lime components of the betel mixture to arecaidine (Nieschulz *et al*, 1967).

(2) Gambir and Cutch:

The name cutch was formerly used only for the solid extract obtained from the heartwood of *Acacia catechu*, a common tree of India, Pakistan, and Burma (Howes, 1953). This extract is used for dying, medicinal purposes and in the East, for chewing as a constituent of the betel quid. Gambir is the name given to the solid prepared from the leaves and stems of *Uncaria gambir*, a shrubby plant that occurs both wild and cultivated in Malaysia (Howes, 1953). For tanning, this extract is now used much less than formerly in European and American tanneries. Neverthless it is still of commercial importance, especially in the East where used as a masticatory in combination with betel (Howes, 1953). In Thailand, the ground root of *Curcuma aromatica* is usually added (Muir, 1960). These materials are odorless, with a bitter taste and astringent after-taste in high concentration. In low concentration it has a sweetish aftertaste. Both of these consist mainly of catechin, tannic acid and dye (Howes, 1953). The pigmented portion of catechin is responsible for the colored blackened teeth of betel nut users (Chang, 1964).

Cutch as imported is in broken, irregular, dark brown or blackish masses with a dull, rusty brown external surface (Fig. 3b). When fractured, the surface is glossy, although small air holes may be present. The material is hard and very brittle. It is only partialy soluble in cold water, giving a brown magma, but almost entirely soluble in boiling water. It consists mainly of catechu-tannic acid (25–35%), catechin (2–10%), qurecetin and catechu red (Howes, 1953).

Gambir has been used in Malaysia, Indonesia, and notably on the East coast of Sumatra. Malaysia and Bornea are the main producing countries. The extract gambir, also known as catechu, pale catechu or terra japonica, is usually dark reddish-brown or greyish-brown externally and has a lighter color internally. It is friable and porous, and microscopically is seen to consist chiefly of minute acicular crystals (Fig. 3a). It contains catechu-tannic acid (22–50%) and catechin (7–33%). There are varying amounts of water, vegetable acids and their salts, sugar, starch, cellulose wax, oil, vegetable debris and mineral matter present also. The catechin is not identical with that of cutch and occurs in white, silky needles. It is sparingly soluble in cold water, but freely soluble in boiling water and alcohol (Howes, 1953). Other constituents include (Chang, 1964): Catechin retin ($C_{12}H_{10}O_4$), Oxycatechuretin ($C_{14}H_{12}O_4$), Japonic acid ($C_{13}H_{10}O_5$), Mimotanniretin ($C_{13}H_{10}O_5 \cdot 1/2H_2O \cdot O_7$), Qurecetin ($C_{15}H_{10}O_7$), Mucous.

In Taiwan, the material, mixed with lime and placed in betel nut quids for chewing, may be gambir. A dealer stated this was imported from Malaysia.

(3) Lime (Fig. 3c):

By itself the areca nut is highly acid and astringent to the taste. The addition of lime not only neutralizes this to a large extent, as can easily demonstrated in vitro, but also promotes the appearance of a reddish dye (Muir, 1960). In Taiwan, and most other places having this habit, lime is used. The aborigines of Ceylon prepare their slaked lime from the shells of snails, and coral is frequently used to prepare the lime in the Pacific Islands (Muir, 1960).

(4) Fruit, Underground stem and Leaf of *Piper betle L*:

The betel nut quids, sometimes contain a section of the underground stem of *P. betle* (Fig. 3f), sometimes contain a section of *P. betle*'s fruit (Fig. 3e) and sometimes are wrapped in a *P. betle* leaf (Fig. 3g). The fruits are derived from pistillate plants, and the leaves and the under-ground stems are derived from staminate plants.

Piper betle L. (*Piperaceae*) is a native of India (muir, 1960). It has been extensively cultivated in southern and central Taiwan (Fig. 4). Since it is diecious, it is cultivated in different ways depending on what is desired. When cultivated for fruits, two pistillate plants and one staminate plant are planted together around a bamboo pole or around a betel palm tree. The cluster of berries of the pistillate plant elongates to 6 or 7 cm in length and thickens to about 1 cm in diameter as in Fig. 5. It is harvested when mature and cut into small sections, then placed between the two halves of a betel nut which has been split and prepared already for chewing.

The vegetative form of the pistillate plants and staminate plants are almost the same, but the flower spikes of staminate plants do not thicken, so their diameter remains about 3 mm, as seen in Fig. 6, these are not use for chewing.

When cultivating the plant for under-ground stems, farmers first cut the younger stem into 6 feet lengths and lay three of these sections together in rows in the field. They are then covered with soil with 5 feet of the stem covered underground and 1 foot exposed above the surface. The vines will then grow up on bamboo poles

which have been erected. Every year the soil at the base of the plant is uncovered and the adventitious roots cut off, then the stems are again covered with soil. This is done to increase the thickness of the underground stems. After 2½ or 3 years, the undergroud stems will be from 3 to 6 cm in diameter (Fig. 7). These are then cut into small pieces and placed in betel nut quids for chewing.

It has been said that when Kozinga first come to Taiwan about 300 years ago, most of his soldiers became sick, but after they used this plant's underground stems as medicine all of them were cured. People have been encouraged to grow the *P. betle* ever since that time. From this saying we know that the cultivation of *P. betle* started before Kozinga came to Taiwan.

The leaves, the underground stems and the fruit of *P. betle*, all possess a fragrant flavor which is due to the presence of volatile oils. The chief of these is eugenol, an unsaturated aromatic phenol, which has a strong pungent odor, and reminds one of cloves, and also a pungent spicy taste. Terpenes are also present, these are pungent, and unpleasant if present in excess. Usually large amounts of potassium nitrate, and small quantities of sugar, starch, and tannin have been found. The chewed leaf, is a gentle stimulant and carminative, sweetening the breath (Muir, 1960).

(5) Methods of Chewing Betel Nut Quids:

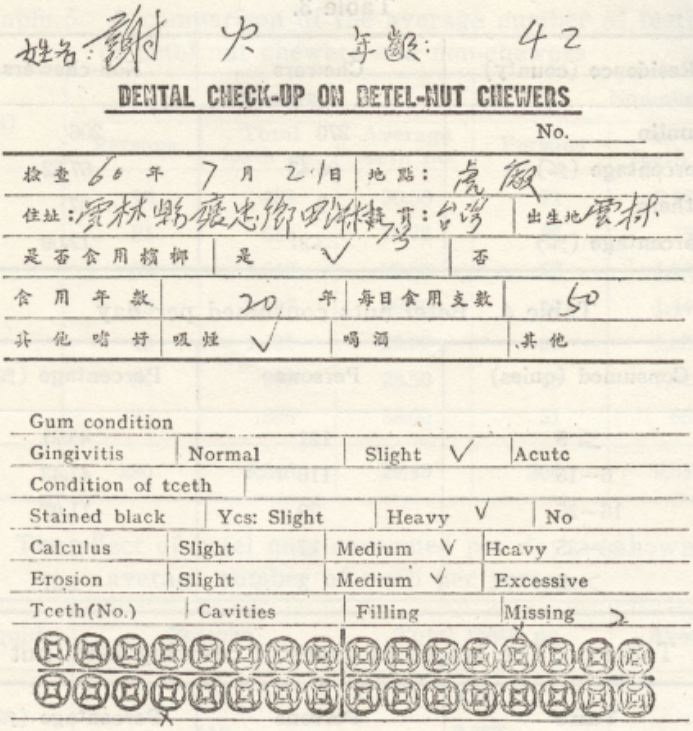
There are various methods for chewing betel nut. In Taiwan, people prepare betel nut for chewing with a very sharp knife which is triangle in shape. They first cut off the ends of the unripe betel nut, and split it into two halves, then place a piece of the underground stem or a section of the fruit of *Piper betle* between the halves of the betel nut, and then add a little amount of a viscous brown paste of gambir and lime. This brown paste is called "Huei", and this Taiwanese word means "lime". In order to obtain better tasting quids some people add table salts or other kinds of seasoning to it. Most of these betel nut quids are wrapped in a leaf of *P. betle*. In Taiwan both freshed betel nuts and preserved betel nuts are chewed. The preserved ones can be kept longer than the fresh ones, but they are harder and not so delicious as the fresh ones. Tobacco is not added to the quids in Taiwan, but it is added to quids in India and Ceylon.

Chewing of betel nut promotes intense salivation. When a person begins to chew a quid, there is too much lime and other stimulants in the saliva, so the chewers spit out the first two or three mouth fulls of saliva, the balance of the quid is chewed for 20 minutes or so, then after the quid has become tasteless, it is spit out. When a person first starts chewing betel nuts whether the quids contain tobacco or not, he become giddy and nauseated, but after having chewed the nuts several times he becomes used to it and addicted to the habit.

THE EFFECTS OF CHEWING BETEL NUT ON THE MOUTH

A) Group Survey and Check Methods:

To find out the effects of chewing betel nut on the teeth and gums, a survey of the mouth conditions of a large number of betel nut chewers as well as non-chewers is required. The results have been analysed by statistical methods and compared between these two groups. The check-up on the mouth conditions were all carried out by a dentist Dr. F. L. Huang, and the data were analysed by the author. The check-up card as designed and used in this survey follows:



姓名：謝 大 年齡：42

DENTAL CHECK-UP ON BETEL-NUT CHEWERS

No.

檢查 60 年 7 月 21 日	地點：虎尾		
住址：雲林縣褒忠鄉田洋村	省：台灣	出生地 雲林	
是否食用檳榔	是 √	否	
食用年數	20 年	每日食用支數	50
其他嗜好	吸煙 √	喝酒	其他

Gum condition			
Gingivitis	Normal	Slight √	Acute
Condition of teeth			
Stained black	Yes: Slight	Heavy √	No
Calculus	Slight	Medium √	Heavy
Erosion	Slight	Medium √	Excessive
Teeth(No.)	Cavities	Filling	Missing 2

Betel nut chewers are not so numerous in Northern Taiwan as in the South, and dental check-ups for them are more difficult. The most promising location we found to carry out our experiments was at Taiwan Sugar Corporation Factory at Hu Wei. At this place the staffs and workers were checked for their dental conditions, and each person was asked to state the total number of betel nut quids which were chewed per day and the number of years they had been chewing. The persons examined, with respect to age and many other characteristics, are considered representative of many communities in Taiwan.

A total of 586 persons were examined. There were 280 betel nut chewers and 306 non-chewers, both classes were analysed and compared with each other. The range of age was from 20 to 62 years old, and two thirds of the chewers were between 40 and 50 years old.

In Taiwan, betel nut chewers are commoner than on the Mainland (Table 2). In the sugar factory at Hu wei 80% of the Taiwanese we examined lived at Yunlin county. Table 2 and 3 compares the workers as to their background.

The number of betel nuts consumed per day and the length of time each person had been chewing is shown in Tables 4 and 5. For most of the chewers the number of quids consumed per day were less than 10, neverthless, a few of the chewers

Table 2.

Province	Chewer	Non-chewer
Taiwan	279	243
Others	1	63

Table 3.

Residence (county)	Chewers	Non-chewers
Yunlin	270	206
Percentage (%)	96 43	67.32
Others	9	37
Percentage (%)	3.21	12.09

Table 4. Betel nuts consumed per day

Consumed (quies)	Persons	Percentage (%)
≤ 5	121	43.21
6–15	116	41.43
16–25	29	11.07
26–35	11	3.93
≥36	3	1.07

Table 5. The length of times of chewing betel nut

Years	Persons	Percentage (%)
2– 5	116	41.43
6–15	104	37.14
16–25	52	18.57
≥26	8	2.86

consumed more than 100 quids per day. The length of time of chewing betel nuts correlates with the age of the chewers, older people usually have been chewing for a longer time.

B) Findings:

1) Total Teeth Number:

The total teeth number and the average teeth number of both chewers and non-chewers are presented in Table 6. The average teeth number of betel nut chewers was 29.45, and for non-chewers was 29.47, the difference being negligible. The relation of total teeth number to betel nuts consumed per day (Table 7) shows that if the rate consumed per day is above 26 quids the average number of teeth per person seems higher, but the difference are not significant as compared to the average teeth number of non-chewers as is shown in Table 6.

2) Dental Caries:

"Betel nut chewing can prevent the decay of teeth" was an unanimous statement by physicians and dentists of the early 19 century. Chen reported on the dental conditions of 313 betel nut chewers and 385 non-chewers in Taiwan, he conclude that dental caries are rather rare in betel nut chewers (Chen, 1937). Many natives in the islands of South Pacific reported that chewing betel nuts can be used as a treatment for dental diseases (Sterly, 1967).

Table 6. A comparison of the average number of teeth of betel nut chewers and non-chewers

Age (in years)	Chewers			Non-chewers		
	Persons	Total teeth no.	Average teeth no.	Persons	Total teeth no.	Average teeth no.
≤38	16	489	30.56	71	2,167	30.52
39–41	21	625	29.76	25	732	29.28
42–44	55	1,649	29.98	52	1,535	29.52
45–47	73	2,197	30.10	49	1,447	29.53
48–50	49	1,421	29.00	35	1,057	30.20
51–53	34	969	28.50	43	1,226	28.51
≥54	32	896	28.00	31	855	27.58
Total	280	8,246	29.45	306	9,019	29.47

Table 7. The effect of betel nuts consumed per day as shown by the average number of teeth per person

Consumed/day (quids)	Persons	Total teeth no.	Average teeth no.
≤ 5	121	3,635	30.04
6–15	116	3,357	28.97
16–25	29	836	28.83
26–35	11	325	29.55
≥36	3	93	31.00

The relation of dental caries to betel nut chewing is presented in Table 8, and the dental caries of non-chewer is shown in Table 9.

For purposes of precision and brevity, the term "CMF" (Cavity, Missing, and Filled) is introduced and used in this report to designate the complete caries experience.

Table 8. The average number of dental caries as shown by betel nut chewers

Age	Persons	Total teeth no.	Caries no. (CMF)**	Ratio (%)*	Mean value of caries no. (CMF)
≤38	16	489	58	12	3.63
39–41	21	625	69	11	3.29
42–44	55	1,649	231	14	4.20
45–47	73	2,197	233	11	3.19
48–50	49	1,421	281	20	5.73
51–53	34	969	291	30	8.56
≥54	32	896	328	37	10.25
Total	280	8,246	1,491	18	5.33

* $\frac{\text{Caries no.}}{\text{Total teeth no.}} \times 100$

** Cavity (C), Missing (M), Filling (F)

Table 9. The average number of dental caries as shown by non-chewers

Age	Persons	Total teeth no.	Caries no. (CMF)**	Ratio (%)	Mean value of caries no. (CMF)
≤38	71	2,167	213	10	3.00
39–41	25	732	126	17	5.04
42–44	52	1,535	288	19	5.54
45–47	49	1,447	296	20	6.04
48–50	35	1,057	243	23	6.94
51–53	43	1,226	401	33	9.33
≥54	31	855	287	34	9.26
Total	306	9,019	1,854	21	6.06

* $\frac{\text{Caries no.}}{\text{Total teeth no.}} \times 100$

** Cavity (C), Missing (M), Filling (F).

And crowned teeth are also included in CMF in this paper. As shown in Table 8, 280 chewers had a total of 8246 teeth, CMF was 1491, and the ratio was 18%, and the mean vale of the caries number was 5.33. CMF for non-chewers was 1854, the ratio was 21%, and the mean value of the caries number was 6.06 (Table 9). The difference between these groups is not significant.

3) Attrition:

It was generally believed that attrition, a pathological condition of teeth, is more marked in betel nut chewers. The attrition of teeth of betel nut chewers is shown in Table 10, where the percentage of attrition above the medium is 51.07, and was only 2.94% for non-chewers. The percentag of teeth attrition is much higher in betel nut chewers than that in non-chewers (Table 11). Tables 12 and 13 show that greater the number of quids consumed per day as well as the longer period of time that the person had been chewing, resulted in the more severe attrition of the teeth. This can be attributed to the vigorous mastication of the fibrous betel nuts.

Table 10. The attrition of teeth of the betal nut chewers

Age	Persons	N	S	M	E	Percentage above medium
≤38	16	3	10	3	0	18.75
39–41	21	3	12	6	0	28.57
42–44	55	4	28	18	5	41.82
45–47	73	3	31	29	10	53.42
48–50	49	5	15	20	9	59.18
51–53	34	1	10	15	8	67.65
≥54	32	2	10	14	6	62.50
Total	280	21	116	105	38	51.07
Percentage (%)	—	7.5	41.43	37.50	13.57	—

N: Normal, S: Slight, M: Medium, E: Excessive.

Table 11. The attrition of teeth of non-chewers

Age	Persons	N	S	M	E	Percentage above medium
≤38	71	45	26	0	0	0
39–41	25	3	22	0	0	0
42–44	52	16	36	0	0	0
45–47	49	11	37	1	0	0.33
48–50	35	11	22	2	0	0.65
51–53	43	7	33	3	0	0.98
≥54	31	3	25	3	0	0.98
Total	306	96	201	9	0	2.94
Percentage (%)	—	31.37	65.69	2.94	0	—

N: Normal, S: Slight, M: Medium, E: Excessive.

Table 12. The relationship between the teeth attrition and betel nuts consumed per day

Age	Persons	N	S	M	E	Percentage above medium
≤ 5	121	14	86	21	0	17.36
6–15	116	5	28	66	17	71.55
16–25	29	2	2	14	11	86.21
26–35	11	0	0	3	8	100.00
≥36	3	0	0	1	2	100.00
Total	280	21	116	105	38	51.07

N: Normal, S: Slight, M: Medium, E: Excessive.

Table 13. The relationship between the teeth attrition and years of chewing betel nuts

Years of chewing	Persons	N	S	M	E	Percentage above medium
≤ 5	116	17	78	19	2	18.10
6–15	104	3	30	61	10	68.27
16–25	52	1	7	22	22	84.62
≥26	8	0	1	3	4	87.50

N: Normal, S: Slight, M: Medium, E: Excessive.

4) The Stained Black Teeth:

In the habitual chewer, the teeth become dark brown or almost black in color, the lips and tongue and to a lesser degree, the mucosa of the checks are colored reddish-brown. This is due to the tannic acid and catechin contained in the gambir, and the tannin contained in the betel nuts, which are strong dyes, staining the teeth and other parts of the oral cavity. The degree that the teeth had been stained black by betel nut chewing was easily observed from Tables 14 and 15.

Table 14. The stained teeth of betel nut chewers

Age	Persons	N	S	H	Percentage above heavy
≤38	16	1	9	6	37.50
39–41	21	0	10	11	52.38
42–44	55	0	29	26	47.27
45–47	73	0	34	39	53.42
48–50	49	1	24	24	48.98
51–53	34	0	16	18	52.94
≥54	32	2	10	20	62.50
Total	280	4	132	144	51.43
Percentage (%)	—	1.43	47.14	51.43	—

N: not stained black, S: slight, H: heavy.

Table 15. The stained teeth of non-chewers

Age	Persons	No	S	H	Percentage above heavy
≤38	71	24	46	1	1.41
39–41	25	3	22	0	0
42–44	52	1	50	1	1.92
45–47	49	4	39	6	12.24
48–50	35	5	30	0	0
51–53	43	3	36	4	9.30
≥54	31	1	28	2	6.45
Total	280	41	251	14	4.58
Percentage (%)	—	13.40	82.02	4.58	—

No: Without stained black, S: Slight, H: Heavy.

5) Calculus:

The lime present in betel nut quids and debris of betel nut quids remain in mouth after chewing. These are easily deposited on the teeth surfaces forming calculus, and notable deleterious effects on the gums. Tables 16 and 17 show that the percentage of calculus of medium degree is 26.35 for betel nut chewers and is 15.69 for non-chewers, and is correlated with the number of years of betel nut chewing and also the number of betel nuts consumed per day (Table 18).

6) Gum Conditions:

Gingivitis is rather common with betel nut chewers. The occurrence of dento-alveolar abscesses are first noted by the gingiva becoming hyperemic, due to chronic and repeated irritation resulting from chewing, gingivitis becomes initiated. If there is a chronic infection, the patholgic condition inevitably develops into a dento-alveolar abscess. In the table gingivitis is represented by "S" and dento-alveolar abscesses by "A". A check-up and the results are analysed and summarized in Tables 19 and

Table 16. The calculus condition of betel nut chewers

Age	Persons	N	S	M	H	Percentage above medium
≤38	16	1	14	1	0	6.25
39–41	21	0	14	6	1	33.33
42–44	55	0	40	13	2	27.27
45–47	73	0	54	18	1	26.03
48–50	49	1	36	12	0	24.49
51–53	34	2	26	6	0	17.65
≥54	32	2	19	6	5	34.38
Total	280	6	203	62	9	26.35
Percentage (%)	—	2.14	72.50	23.14	3.21	—

N: Normal, S: Slight, M: Medium, H: Heavy.

Table 17. The calculus condition of non-chewers

Age	Persons	N	S	M	H	Percentage above medium
≤38	71	13	52	5	1	8.45
39–41	25	3	20	2	0	8.00
42–44	52	1	41	9	1	19.23
45–47	49	3	38	7	1	16.33
48–50	35	1	28	6	0	17.14
51–53	43	3	31	9	0	20.93
≥54	31	0	24	6	1	22.58
Total	306	24	234	44	4	15.69
Percentage	—	7.84	76.47	14.38	1.31	—

Table 18. The relationship between the calculus condition and betel nuts consumed per day

Consumed per day (quids)	Persons	N	S	M	H	Percentage above medium
≤ 5	121	3	93	23	2	20.66
6–15	116	2	86	24	4	24.14
16–25	29	1	17	10	1	37.93
26–35	11	0	7	3	1	36.36
≥36	3	0	0	2	1	100.00
Total	280	6	203	62	9	25.36

20. The percentage of "S" of betel nut chewers was 80.72 and for non-chewers was 71.90, and the difference for "A" between betel nut chewers and non-chewers is also

Table 19. The gingivitis of betel nut chewers

Age	Persons	N	S	A	Percentage above slight
≤38	16	5	10	1	68.75
39–41	21	9	12	0	57.14
42–44	55	11	43	1	80.00
45–47	73	11	60	2	84.93
48–50	49	8	38	3	83.67
51–53	34	7	27	0	79.41
≥54	32	3	28	1	90.63
Total	280	54	218	8	80.72
Percentage	—	19.29	77.86	2.86	—

Table 20. The gingivitis of non-chewers

Age	Persons	N	S	A	Percentage above slight
≤38	71	27	43	1	61.97
39–41	25	9	15	1	64.00
42–44	52	12	40	0	76.92
45–47	49	13	33	3	73.47
48–50	35	7	26	2	80.00
51–53	43	13	30	0	69.77
≥54	31	5	26	0	83.87
Total	306	86	213	7	71.90
Percentage	—	28.10	69.61	2.29	—

small, the percentage for betel nut chewers was 2.86 and for non-chewers was 2.29. Gingivitis is correlated with age regardless of whether the person is a chewer or non-chewer. The ratio of gingivitis is higher with incresaing age. Tables 21 and 22

Table 21. The relationship of gingivitis condition and betel nuts consumed per day

Consumed por day (quids)	Persons	N	S	A	Percentage above slight
≤ 5	121	26	92	3	78.51
6–15	116	21	91	4	81.90
16–25	29	5	23	1	82.76
26–35	11	2	9	0	81.82
≥36	3	0	3	0	100.00
Total	280	54	218	8	80.71

Table 22. The relationship of gingivitis conditions and the years of chewing betel-nut

Years of chewing	Persons	N	S	A	Percentage above slight
≤ 5	116	25	89	2	78.54
6–15	104	21	78	5	79.81
16–25	52	8	43	1	84.62
≥26	8	0	8	0	100.00
Total	280	54	218	8	80.71

show that the ratios of gingivitis are correlated with the length of chewing time and also with the number of betel nuts consumed per day.

Beside the constant irritation resulting from chewing, the tannic acid has an astringent effect while the lime and alkaloids from the betel nuts also exert some effects, and these finally result in perio-alveolar abscesses.

7) pH of the Chewers Saliva:

The chewing of betel nuts causes extensive salivation and it has been stated that the betel nuts make the chewers' saliva more alkaline than that of non-chewers. The juices extract from *P. betle* leaves as well as from their fruits and underground stems are acid in nature, and the extract of the betel nut is also acid, and the pH of the gambir solution is 5.6 (Table 23); but the pH of the lime is alkaline. It may be that the acidity of the various components of the betel nut quid is neutralized by the lime thus causing the pH of the saliva to be more alkaline. The pH of three habitual chewers is shown in Table 24.

Table 23. pH of extracted juices of betel nut quids components

Juices extracte	pH
Fruit of *P. betle*	5.1
Underground stem of *P. betle*	4.8
Leaf of *P. betle*	4.3
Betel nuts	4.9
Gambir	5.6

Table 24. pH of saliva from betel nut chewers

Persons	pH
Wg	8.8
Ba	8.6
Wu	9.2

The pH range of non-chewers varies between 6.3 and 7.2, depending on his diet, but is not so high as for betel nut chewers. One betel nut quid can maintain the saliva in an alkaline condition for one hour or so. The alkaline pH of saliva has

an effect of preventing bacteria from fermenting food in the oral cavity, as well as neutralizing the acid produced by bacterial fermentation, and in this way, the teeth may be protected from caries.

DISCUSSION

The check-up results of both total teeth number and caries number of betel nut chewers as well as non-chewers in this report are different from Chen's results (Chen, 1937). In this report the total teeth number and caries number of betel nut chewers is only slightly (not signficantly) greater than that of non-chewers as was shown in Tables 6, 8 and 9. In Tables 26, Chen's results were presented, and shows that the total teeth number of 313 betel nut chewers was 8681, and the average number of teeth per person was 27.73, both of these are greater than the total teeth number of 388 non-cherers which was 8352 and the average number of teeth per person was 21.53. Usually, the teeth number of a person decreases with increasing age as is shown in Tables 6 and 25. However, the average number of teeth of 94 non-chewers between the ages of 61 to 70 years was 8.81, which is much smaller than the average number of teeth of the persons between the ages of 71 to 80. And the ages of the most non-chewers examined was greater than that of betel nut chewers as shown in Table 25. For these two reasons it may be that Chen's results showing that the number of caries and total number of teeth of betel nut chewers was less than the non-chewers was probably not caused as a result of chewing of betel nuts. Another possible reason for less caries in betel nut chewers was that at that time people did not pay much attention to their oral hygiene and the chewing of betel nuts certainly did help clean the teeth to some degree and thus prevent dental caries. But at present time every one is paying much attention to their oral hygiene, and this minimize the significance of cleaning the teeth by chewing betel nuts. The preventive effects of chewing betel nuts on dental caries is doubtful.

Table 25. The comparison of the average number of teeth of betel nut chewers and non-chewers

Age	Chewers			Non-chewers		
	Persons	Total teeth no.	Average teeth no.	Persons	Total teeth no.	Average teeth no.
21-30	10	309	30.90	40	1,232	30.80
31-40	44	1,344	30.55	55	1,638	29.78
41-50	106	2,975	28.07	64	1,792	28.00
51-60	117	3,194	27.30	63	1,635	25.95
61-70	24	594	24.75	94	828	8.81
71-80	12	265	22.08	72	1,227	17.04
Total	313	8,681	27.73	388	8,352	21.53

The result of this report also contradicts the report of Ellis. He stated that the covering of the teeth by the dense calculus apparently protect the teeth of betel nut chewers and thus was a preservative of the teeth (Ellis, 1921). But we have found that an increase of calculus is harmful to the mouth.

Regarding gum conditions, our results are the same as reported by Chen and Ellis. Gingivitis and dento-alveolar abscesses in the mouth of betel nut chewers is

much commoner than non-chewers, and most of betel nut chewers show varying degree of retraction of their gums. In many old habitual chewers the teeth have been lossened by the retraction of their gums.

Other effects, such as, attrition, black stained teeth and increasing amounts of calculus are more frequently found in the mouth of betel nut chewers. Recent reports (Chang, 1964; Chang, 1966; Chin *et al*, 1970; Suri *et al*, 1971) have shown that in Asia mouth cancer is very common, and the chewing of betel nut is very probably an inducing factor of mouth cancer. Thus we can see that all the effects of the chewing betel nuts on the mouth are harmful. Besides neighbors of betel nut chewers are digusted by the reddish-brown juice, which has been spit everywhere by the careless chewers.

Since educated people think that this most popular masticatory is a disgusting habit, it is obvious that the number of betel nut chewers is going to decrease as civilization progresses.

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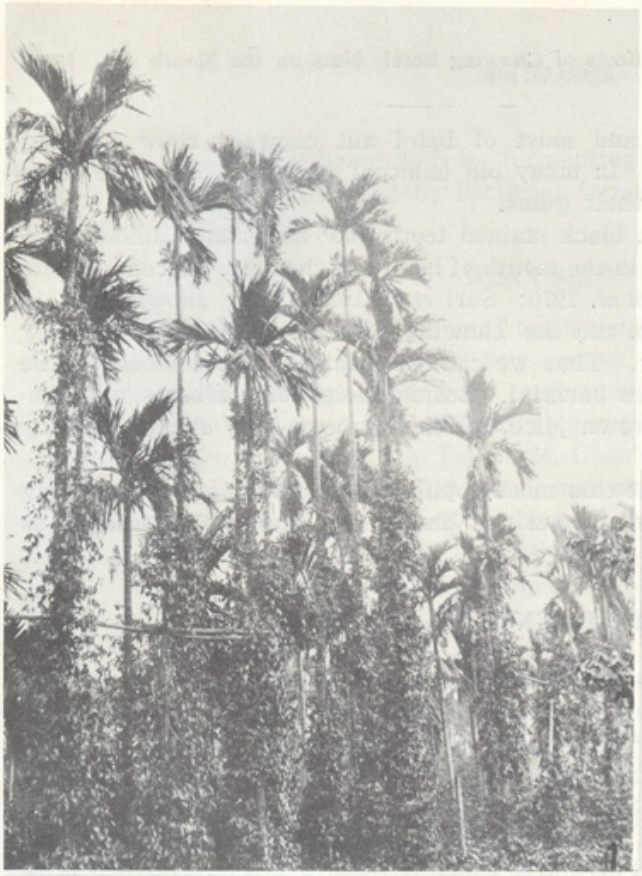

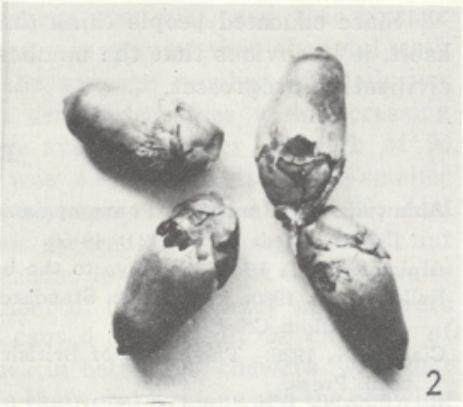

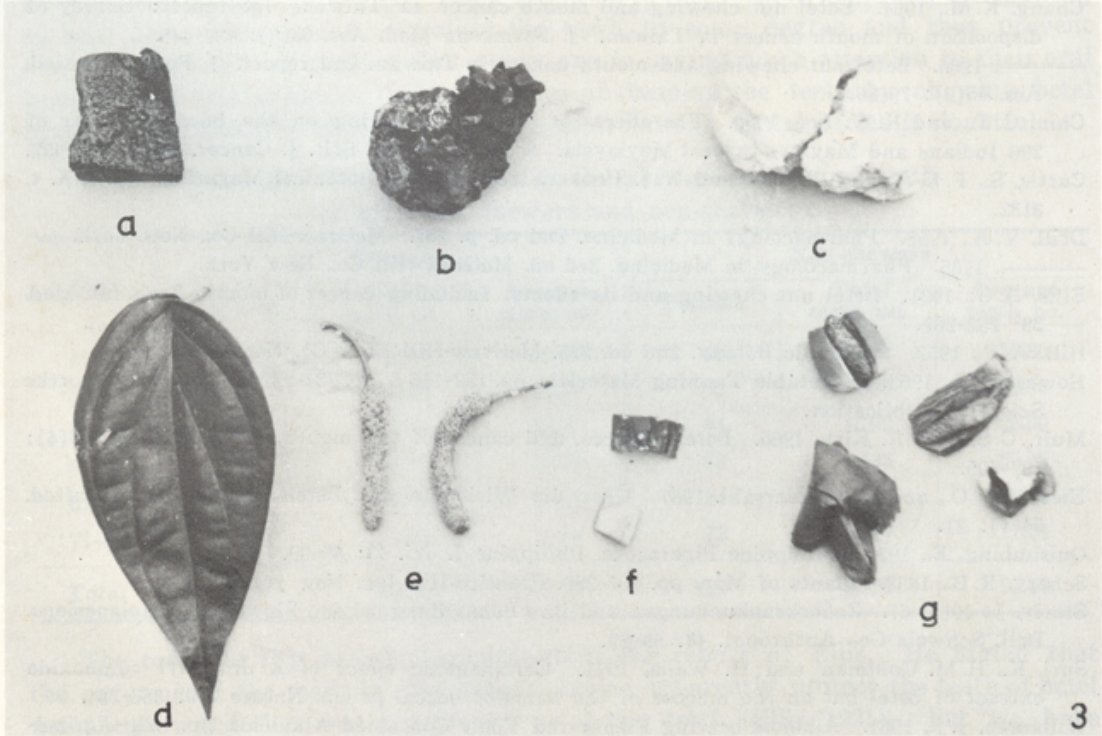

Plate I

Figure 1. *Areca catechu L.* and *Piper betle* climbing on it.
Figure 2. Betel nuts.
Figure 3. The components of a betel nut quid. (a) gambir, (b) cutch, (c) lime, (d), (e) and (f) are leaf, fruits and underground stem of *Piper betle L.* (g) different kinds of betel nut quids.

Plate II

Figure 4. The plantation of *P. betle* at Chia-li (佳里).
Figure 5. Fruit of *P. betle* (♀).
Figure 6. Flower of *P. betle* (♂).
Figure 7. Underground stems of *Piper betle L.*