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WORLD HEALTH ORGANIZATION
INTERNATIONAL AGENCY FOR RESEARCH ON CANCER



*IARC Monographs on the Evaluation of
Carcinogenic Risks to Humans*

VOLUME 85

**Betel-quid and Areca-nut Chewing and
Some Areca-nut-derived Nitrosamines**



LYON, FRANCE
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Table 3. Production of areca nut by country since 1961 (in millions of tonnes)

Country	1961	1971	1981	1991	2001
Bangladesh	62 995	23 369	25 051	24 120	47 000
India	120 000	141 000	195 900	238 500	330 000
Indonesia	13 000	15 000	18 000	22 812	36 200
Kenya	NA	NA	NA	100	90
Malaysia	6 500	3000	2 500	4000	2500
Maldives	1	1	5	16	37
Myanmar	8000	19 203	25 807	32 270	51 463
Taiwan, China ^a	3718	10 075	24 358	111 090	165 076
Thailand	NA	NA	NA	13 250	20 500
World	428 428	423 296	583 242	892 316	1 305 732

From FAO (2003)

NA, not available

^a From Council of Agriculture, ROC (2003)

graphical cultivation in South and South-East Asia and in the Pacific basin was given by Furatado (1933). Areca nut for chewing is obtained exclusively from *Areca catechu*, which is believed to be native to Sri Lanka, West Malaysia and Melanesia (IARC, 1985a). This tropical palm tree bears fruit all year, which are ovoid or oblong with a pointed apex, measuring 3–5 cm in length and 2–4 cm in diameter. The outer surface is green when unripe and orange-yellow when ripe. The seed (endosperm) is separated from a fibrous pericarp, is rounded with a truncated base and is opaque and buff-coloured with dark wavy lines. It has a characteristic astringent and slightly bitter taste and is consumed at different stages of maturity according to preference. An individual may consume the whole nut or thin slices of the nut, in its natural state or after processing in many forms.

The nut may be used fresh or it may be dried and cured before use, by sun-drying, baking or roasting (Table 2). Areca fruit may also be boiled and fermented (in eastern parts of India, Sri Lanka) by covering it with mud to soften the nut for consumption. These treatments change the flavour of the nut and its astringency. In Taiwan, China, areca nut is most often used in the unripe stage when it is green, like a small olive.

Areca nut is known colloquially in Hindi and other languages in India as *supari*; it is called *puwak* in Sri Lanka, *gua* in Sylheti (Bangladesh), *mak* in Thailand, *pinang* in Malaysia, *daka* in Papua New Guinea, *pugua* in Guam and *Kun-ywet* in Myanmar (IARC, 1985a).

Chemical constituents

Comprehensive analyses of the chemical composition of areca nut have been reported and reviewed (Raghavan & Baruah, 1958; Shivashankar *et al.*, 1969; Arjungi, 1976; Jayalakshmi & Mathew, 1982). The major constituents of the nut are carbohydrates, fats,

proteins, crude fibre, polyphenols (flavonols and tannins), alkaloids and mineral matter. The ranges in concentration of the chemical constituents of areca nut are given in Tables 4 and 5. Variations in the concentrations of the various constituents may occur in nuts from different geographical locations and according to the degree of maturity of the nut. Of the chemical ingredients, tannins, alkaloids and some minerals that may have biological activity and adverse effects on tissues have been subjected to detailed study.

Polyphenols (flavonols, tannins) constitute a large proportion of the dry weight of the nut. The ranges in concentration of polyphenols in unprocessed and processed nuts are shown in Tables 4 and 5. The polyphenol content of a nut may vary depending on the region where *Areca catechu* is grown, its degree of maturity and its processing method. The tannin content is highest in unripe areca nuts and decreases substantially with increasing maturity (Raghavan & Baruah, 1958). The roasted nut possesses the highest average content of tannins, ranging from 5 to 41% (mean, 21.4%); the average tannin content of sun-dried nuts is 25%; and the lowest levels are seen in boiled nuts, which contain 17% (Awang, 1987).

Polyphenols are responsible for the astringent taste of the nut (Raghavan & Baruah, 1958).

Alkaloids: Among the chemical constituents, alkaloids are the most important biologically. The nut has been shown to contain at least six related alkaloids, of which four (arecoline, arecaidine, guvacine and guvacoline) (Figure 1) have been conclusively identified in biochemical studies (Raghavan & Baruah, 1958; Huang & McLeish, 1989; Lord *et al.*, 2002). Arecoline is generally the main alkaloid. The ranges in concentration of arecoline in unprocessed and processed nuts are given in Tables 4 and 5.

The contents in the four major alkaloids of fresh areca nuts obtained from Darwin, Australia, have been determined by high-performance liquid chromatography (Table 6).

Table 4. Ranges in concentration^a of the chemical constituents of a variety of unprocessed green and ripe areca nuts

Constituents	Green (unripe) nut	Ripe nut
Moisture content	69.4–74.1	38.9–56.7
Total polysaccharides	17.3–23.0	17.8–25.7
Crude protein	6.7–9.4	6.2–7.5
Fat	8.1–12.0	9.5–15.1
Crude fibre	8.2–9.8	11.4–15.4
Polyphenols	17.2–29.8	11.1–17.8
Arecoline	0.11–0.14	0.12–0.24
Ash	1.2–2.5	1.1–1.5

From Jayalakshmi & Mathew (1982)

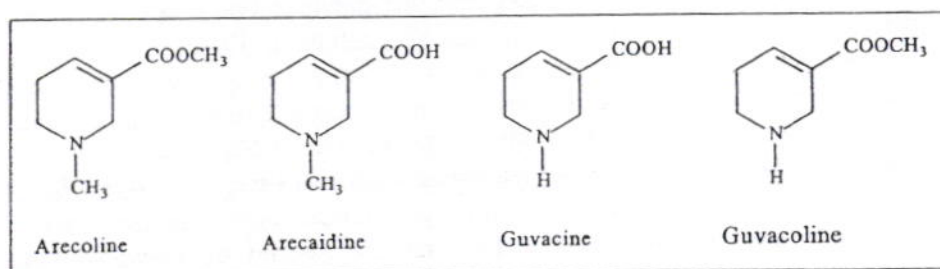
^a Percentage based on dry weight (except moisture)

Table 5. Ranges in concentration^a of some chemical constituents of a variety of processed areca nuts in India

Type/trade name	No. of samples analysed	Poly-phenols (%)	Arecoline (%)	Fat (%)	Crude fibre (%)	Total poly-saccharides (%)
Chali	65	7.3-34.9	0.1-0.7	4.9-24.4	7.1-17.4	14.3-26.3
Parcha	18	11.7-25.0	0.1-0.5	12.3-18.1	8.0-14.3	13.0-27.3
Lyon	25 ^d	19.6-45.9	0.1-0.7	6.8-18.1	5.4-13.3	13.5-28.2
Api	54	15.2-41.3	0.2-0.9	5.3-18.5	5.4-18.5	9.2-28.2
Batlu	31	22.4-55.2	0.1-0.9	4.3-17.9	3.1-12.3	14.2-27.0
Choor	33	24.9-43.7	0.1-0.9	5.9-17.8	5.1-15.2	11.1-28.1
Erazel	9	16.9-38.0	0.2-0.8	5.5-12.3	5.9-8.7	13.1-26.6
Chalakudi	3	32.0-39.3	0.4-0.9	7.1-10.5	5.3-14.9	22.1-26.9
Nuli	6	39.0-47.9	0.6-0.9	3.7-13.8	3.8-6.0	16.4-22.7

From Shivashankar *et al.* (1969)

^a Percentages based on dry weight

Figure 1. Chemical structure of areca alkaloids

From Mujumdar *et al.* (1982)

Table 6. Alkaloid content of fresh areca nuts from Darwin, Australia

Alkaloid	% Nut ^a
Arecoline	0.30-0.63
Arecaidine	0.31-0.66
Guvacoline	0.03-0.06
Guvacine	0.19-0.72

From Huang & McLeish (1989)

^a [Percentage not specified, probably based on dry weight]

The levels were slightly higher than those observed for Indian and Papua New Guinean nuts. The authors concluded that this difference may result from seasonal and geographical variations (Huang & McLeish, 1989).

In an aqueous extract of Taiwanese betel quid composed of fresh areca nut, betel inflorescence and red lime paste (80.5:12.5:7 by weight), arecaidine was the most abundant alkaloid (7.53 mg/g dry wt) and guvacoline the least abundant (0.26 mg/g dry wt). No change in the levels of alkaloids was observed during cold storage or during the process of freeze-drying (Wang *et al.*, 1999).

Examining volatile alkaloids in areca nut [source unspecified] by gas chromatography-mass spectrometry, Holdsworth *et al.* (1998) and Self *et al.* (1999) described the presence of at least six other related alkaloids in addition to arecoline and guvacoline. These were identified as nicotine (~0.02%), methyl nicotinate, ethyl nicotinate, methyl- and ethyl-*N*-methyl piperidine-3-carboxylate and ethyl-*N*-methyl-1,2,5,6-tetrahydro-pyridine-3-carboxylate.

Wide variations in the arecoline content of areca nut have been demonstrated in commercially available nuts, ranging between 0 and 1.4% (Table 5; Awang, 1986; Canniff *et al.*, 1986). Arecoline content is reduced following processing of the nut (Awang, 1988). The content is reduced from 1.4% to 1.35% by sun-drying, to 1.29% by roasting, to 0.7% by soaking in water and to 0.1% by boiling in water (Awang, 1988). The practice of boiling the nut in a liquor obtained from the previous year's boiling is designed to increase the alkaloid content of treated nuts (Canniff *et al.*, 1986).

Elemental composition: Concentrations of sodium, magnesium, chlorine calcium, vanadium, manganese, copper and bromine were measured in areca nut, *pan masala* and other chewing materials available in the United Kingdom (Ridge *et al.*, 2001). The values obtained for areca nut were lower than those reported in areca nut from Taiwan, China (Wei & Chung, 1997), but generally showed good consistency. Mean concentrations of 36 elements in areca nut, betel leaf, slaked lime and catechu are shown in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

In view of possible fibrogenic, mutagenic and toxic effects of areca nut, the copper content in samples of raw and processed areca nut was analysed and reported to be much higher than that found most frequently in other nuts consumed by humans (Trivedy *et al.*, 1997). The mean concentration of copper in samples of processed, commercially available areca nut was 18 ± 8.7 $\mu\text{g/g}$ (Trivedy *et al.*, 1999). In an Indian Food Report, the copper content of processed areca nut was found to be 2.5 times that of the raw nut (Gopalan *et al.*, 1989).

Areca-nut-derived nitrosamines: No study has been undertaken to determine areca-nut-derived nitrosamines in any variety of areca nut (J. Nair, personal communication).

Table 7. Concentration^a of trace elements in betel-quin ingredients

Element ^b	Areca nut	Betel leaf	Slaked lime	Catechu
Cr (µg/g)	0.50 ± 0.06	0.46 ± 0.06	19.2 ± 2.9	7.3 ± 1.2
Mn (µg/g)	47 ± 6	380 ± 38	57.1 ± 8.6	170 ± 20
Fe (µg/g)	75 ± 8	171 ± 21	190 ± 29	5156 ± 774
Co	27 ± 4	132 ± 16	66 ± 9	2250 ± 360
Zn (µg/g)	5 ± 1	16.6 ± 2.2	1.24 ± 0.19	1.77 ± 0.27
Mg (µg/g)	2.8 ± 0.4	6.2 ± 0.9	1.30 ± 0.06	19.4 ± 2.9
Na (µg/g)	127 ± 14	793 ± 95	67 ± 7	6424 ± 964
K (% wt)	0.43 ± 0.04	4.42 ± 0.44	0.013 ± 0.002	0.46 ± 0.07
Ba (µg/g)	1.7 ± 0.3	15.4 ± 1.8	16.0 ± 2.4	7.7 ± 1.2
Ca (µg/g)	1.2 ± 0.2	4.8 ± 0.7	NA	12.6 ± 1.2
Ga	9 ± 1	16 ± 3	5 ± 1	58 ± 9
Al (µg/g)	2.9 ± 0.5	5.7 ± 0.8	7.2 ± 1.2	18.4 ± 0.2
V	12 ± 2	26 ± 4	15 ± 2	67 ± 10
Ti	14 ± 2	36 ± 6	48 ± 7	73 ± 12
In	18 ± 3	26 ± 4	31 ± 5	89 ± 13
Sn (µg/g)	1.4 ± 0.2	7.2 ± 1.1	9.4 ± 1.4	23.1 ± 3.4
Sb	13 ± 2	46 ± 5	404 ± 60	1100 ± 200
As (µg/g)	0.34 ± 0.04	18.3 ± 2.2	0.28 ± 0.04	5.96 ± 0.89
Se	120 ± 20	38 ± 5	70 ± 8	1045 ± 158
Hg	6 ± 1	9 ± 1	8 ± 1	12 ± 2
Cl (% wt)	0.15 ± 0.02	0.55 ± 0.1	ND	0.064 ± 0.01
Br (µg/g)	7.2 ± 0.9	7.1 ± 0.9	0.46 ± 0.07	0.61 ± 0.01
Cs	250 ± 40	7 ± 1	6 ± 1	14 100 ± 2100
Sc	18 ± 2	33 ± 4	274 ± 41	2490 ± 398
Rb (µg/g)	57 ± 7	225 ± 27	20.2 ± 2.8	232 ± 37
Ta	7 ± 1	9 ± 2	38 ± 6	1100 ± 180
La	44 ± 4	37 ± 4	2958 ± 473	7300 ± 1022
Ce (µg/g)	0.24 ± 0.04	1.14 ± 0.20	8.5 ± 1.3	20.6 ± 3.1
Nd	10 ± 2	18 ± 2	16 ± 2	21 ± 3
Sm	23 ± 4	35 ± 5	19 ± 3	51 ± 8
Eu	5 ± 1	7 ± 1	120 ± 20	296 ± 44
Gd	21 ± 5	12 ± 2	38 ± 6	49 ± 7
Tb	10 ± 2	9 ± 1	90 ± 10	121 ± 18
Dy	12 ± 2	10 ± 2	26 ± 3	38 ± 4
Yb	8 ± 1	78 ± 13	347 ± 56	2142 ± 343
Hf	18 ± 2	98 ± 12	78 ± 12	1200 ± 200

From Zaidi *et al.* (2002)

NA, not applicable; ND, not detected

^a Mean ± standard deviation of five determinations

^b Values expressed in ng/g dry weight, unless otherwise specified

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Figure 2. Trace elements found in the main ingredients of betel quid

		Groups																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIII			IB	IIB	IIIB	IVB	VB	VIB	VIIB	VIII
		IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1		H ¹																	
2		Li ³	Be ⁴																He ²
3		Na ¹¹	Mg ¹²											B ⁵	C ⁶	N ⁷	O ⁸	F ⁹	Ne ¹⁰
4		K ¹⁹	Ca ²⁰	Sc ²¹	Ti ²²	V ²³	Cr ²⁴	Mn ²⁵	Fe ²⁶	Co ²⁷	Ni ²⁸	Cu ²⁹	Zn ³⁰	Ga ³¹	Ge ³²	As ³³	Se ³⁴	Br ³⁵	Ar ¹⁸
5		Rb ³⁷	Sr ³⁸	Y ³⁹	Zr ⁴⁰	Nb ⁴¹	Mo ⁴²	Tc ⁴³	Ru ⁴⁴	Rh ⁴⁵	Pd ⁴⁶	Ag ⁴⁷	Cd ⁴⁸	In ⁴⁹	Sn ⁵⁰	Sb ⁵¹	Te ⁵²	I ⁵³	Kr ³⁶
6		Cs ⁵⁵	Ba ⁵⁶	La ⁵⁷	Hf ⁷²	Ta ⁷³	W ⁷⁴	Re ⁷⁵	Os ⁷⁶	Ir ⁷⁷	Pt ⁷⁸	Au ⁷⁹	Hg ⁸⁰	Tl ⁸¹	Pb ⁸²	Bi ⁸³	Po ⁸⁴	At ⁸⁵	Xe ⁵⁴
7		Fr ⁸⁷	Ra ⁸⁸	Ac ⁸⁹	Rf ¹⁰⁴	Db ¹⁰⁵	Sg ¹⁰⁶	Bh ¹⁰⁷	Hs ¹⁰⁸	Mt ¹⁰⁹	Uun ¹¹⁰	Uuu ¹¹¹	Uub ¹¹²		Uuq ¹¹⁴		Uuh ¹¹⁶		Rn ⁸⁶
6					Ce ⁵⁸	Pr ⁵⁹	Nd ⁶⁰	Pm ⁶¹	Sm ⁶²	Eu ⁶³	Gd ⁶⁴	Tb ⁶⁵	Dy ⁶⁶	Ho ⁶⁷	Er ⁶⁸	Tm ⁶⁹	Yb ⁷⁰	Lu ⁷¹	
7					Th ⁹⁰	Pa ⁹¹	U ⁹²	Np ⁹³	Pu ⁹⁴	Am ⁹⁵	Cm ⁹⁶	Bk ⁹⁷	Cf ⁹⁸	Es ⁹⁹	Fm ¹⁰⁰	Md ¹⁰¹	No ¹⁰²	Lr ¹⁰³	

BETEL-QUID AND ARECA-NUT CHEWING

1.1.3 *Betel leaf*

The most common accompaniment for chewing areca nut globally is the leaf of *Piper betle*. This has led to areca nut being labelled 'betel nut' in the English literature, but the Working Group does recommend this nomenclature.

Betel leaves contain betel oil, a volatile liquid, which contains several phenols including hydroxychavicol, eugenol, betel phenol and chavicol. Vitamin C (1.9 mg/g) and a large amount of carotenes (80.5 mg/g) have also been reported (Wang & Wu, 1996).

Mean concentrations of 36 trace elements in betel leaf are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.4 *Betel inflorescence*

Apart from the leaf, other parts of the vine such as the stem, inflorescence (also called flower or pods) or catkins are also consumed with areca nut (Tables 1 and 2). Consumption of the inflorescence is common in Melanesia and in parts of Taiwan, China, and it is mostly added to the quid for its aromatic flavour.

Betel inflorescence contains a high concentration of phenolic compounds including hydroxychavicol, eugenol, isoeugenol, eugenol methyl ester and safrole (Hwang *et al.*, 1992; Wang & Hwang, 1993). Concentrations of phenolic compounds in fresh *Piper betle* flower, determined by high-performance liquid chromatographic analysis, are listed in Table 8. Safrole, the major phenolic compound, is a possible human carcinogen (IARC, 1976).

Table 8. Concentrations of phenolic compounds in fresh *Piper betle* flower by high-performance liquid chromatographic analysis

Phenolic compound	Molecular weight (g)	Concentration (mg/g fresh wt)
Safrole	162	15.35
Hydroxychavicol	151	9.74
Eugenol	164	2.51
Eugenol methyl ester	178	1.81
Isoeugenol	164	1.81
Quercetin	338	1.11

From Hwang *et al.* (1992)

1.1.5 *Slaked lime*

Slaked lime (calcium hydroxide) is often combined with areca nut (Table 1). In coastal areas, it is obtained by heating the covering of shell fish (sea shells) or is harvested from corals. In central parts of a country, it is quarried from limestone (Table 2). In the

Asian markets, slaked lime is sold as a paste mixed with water, which is white or pink. In Papua New Guinea, slaked lime is available in the powdered form and stored in air-tight containers.

Free calcium hydroxide, iron(II) and magnesium(II) were measured in 25 samples of slaked lime from Papua New Guinea, and large variations in their concentrations were found (Nair *et al.*, 1990). Mean concentrations of 35 trace elements measured in slaked lime are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.6 *Catechu*

Catechu is an astringent, reddish-brown substance which is often smeared on the betel leaf used to wrap the ingredients of betel quid. Two main types of catechu may be used depending on the tree or shrub from which the catechu has been extracted (Table 2). One type of catechu is prepared by decoction and extraction from the heartwood of *Acacia catechu*, Willd. (N.O. Leguminosae), a tree indigenous to India and Myanmar. It is sometimes referred to as black catechu or cutch. The main constituents are catechu-tannic acid (25–35%), acacatechin (2–10%), quercetin and catechu red. Another type of catechu is an aqueous extract prepared from the leaves and young shoots of *Uncaria Gambier*, Roxb. (N.O. Rubiaceae), a climbing shrub indigenous to the Malay Archipelago. It is sometimes referred to as pale catechu or *gambir*. The main constituents are catechin (7–33%), catechu-tannic acid (22–50%), quercetin and catechu red (Council of the Pharmaceutical Society of Great Britain, 1911). In addition, in Northern Thailand, catechu may be derived from the sun-dried pounded bark of *Lithocarpus polystachya*. It is referred to as *nang ko* (Mougne *et al.*, 1982).

Mean concentrations of 35 trace elements measured in catechu are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.7 *Tobacco*

Tobacco is often added to the quid mixture. Chewing tobacco in the Indian subcontinent is prepared from sun-dried and partly fermented, coarsely cut leaves of *Nicotiana rustica* and *Nicotiana tabacum* without further processing. Sometimes tobacco is powdered and combined with molasses or boiled before use (Table 2).

1.1.8 *Miscellaneous additives and contaminants*

Some of the most common additives are listed in Table 2.

Sago palm nut is sometimes used as an adulterant in packages of sun-dried or processed areca nut. Sweet potato and tapioca are other adulterants (Jayalakshmi & Mathew, 1982).

Areca nut can be contaminated with fungi such as *Aspergillus flavus*, *A. niger* and *Rhizopus sp.* (Borle & Gupta, 1987). Almost 40% (12/32) of samples of areca nut from India analysed using thin-layer chromatography contained aflatoxins (IARC, 2002). The mean concentration of aflatoxin B₁ in the analysed samples was 94 µg/kg (range,

18–208 µg/kg), largely exceeding the commonly accepted food limit of 5 µg/kg. Nine samples contained concentrations of aflatoxin B₁ higher than 50 µg/kg (Raisuddin & Misra, 1991). All 10 samples of raw areca nut analysed in a South African study contained aflatoxin B₁, with a mean concentration of 5 µg/kg (range, 2.1–10.2 µg/kg) (Van der Bijl *et al.*, 1996).

1.2 Areca nut-based industrial packaged products

A variety of packaged areca products are now available in several countries. Based on labelling, these packaged products may fall into any one of the four categories described in Section 1.1.1, depending on the substances included (see Table 1).

Two main products are *gutka* and *pan masala*. *Gutka* is a dry, relatively non-perishable commercial preparation containing areca nut, slaked lime, catechu, condiments and powdered tobacco. The same mixture without tobacco is called *pan masala*. The products arrived on the market in the late 1960s and early 1970s. Both *gutka* and *pan masala* come in attractive foil packets (sachets) and tins which can be stored and carried conveniently. Aggressive advertising, targeted at the middle class and adolescents since the early 1980s, has enhanced the sales of these products. In advertisements, *pan masala* is depicted as implying hospitality and equality, as is betel quid. *Pan masala* and *gutka* are very popular in urban areas of India and Pakistan, especially among adolescents, and their popularity is growing fast in rural areas (Gupta & Ray, 2002). Although the actual prevalence of this habit is unknown, its popularity can be gauged by current commercial estimates valuing the Indian market for *pan masala* and *gutka* at several hundred million US dollars. These products are exported to all countries where Asian migrants live (see Section 1.3.20).

1.3 Consumption by geographical region

Global estimates report up to 600 million chewers (Gupta & Warnakulasuriya, 2002). This section reviews patterns and prevalence of consumption in different countries. For the sake of clarity, the nomenclature has been made uniform throughout the section (see Glossary A for definitions).

1.3.1 India

Countrywide surveys on the use of areca nut have not been conducted, nor have any other surveys been conducted to investigate specifically the use of areca nut. Surveys of habits have been conducted on the use of tobacco and other chewing habits, especially betel-quid chewing, in limited populations. Studies of adults are presented first, followed by those of children and adolescents. Within these categories, rural studies are presented first, followed by available urban studies.

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1.3.1 India

Countrywide surveys on the use of areca nut have not been conducted, nor have any other surveys been conducted to investigate specifically the use of areca nut. Surveys of habits have been conducted on the use of tobacco and other chewing habits, especially betel-quid chewing, in limited populations. Studies of adults are presented first, followed by those of children and adolescents. Within these categories, rural studies are presented first, followed by available urban studies.

The tobacco included in betel quid varies from region to region. In Uttar Pradesh, *mainpuri* tobacco, which is a mixture of tobacco with slaked lime, finely cut areca nut and powdered cloves or camphor, is commonly used (Wahi, 1968).

(a) *Adults*

(i) *Rural studies*

Several studies have investigated the prevalence of betel-quid chewing in limited population samples.

The prevalence of all chewing habits, with and without areca nut and with and without tobacco, was recorded in house-to-house surveys among villagers in various parts of India (Mehta *et al.*, 1971, 1972). There were marked differences between localities and some differences between sexes (Table 9).

In Ernakulam District, Kerala, information on smoking and chewing habits was collected during a survey of oral lesions in a sample of 5099 persons aged 15 years and older (Daftary *et al.*, 1980). Betel-quid chewing, mostly with tobacco, was practiced by 23.7%, smoking by 21.5% and both habits by 9.8% (Table 10). Overall, 34.7% of men and 32.4% of women indulged in the habit, and only about 0.7% chewed betel quid without consuming any form of tobacco.

In another house-to-house survey during 1977-78 in Ernakulam District, 12 212 tobacco users aged 15 years or older were identified in a rural population of about 48 000 (Gupta *et al.*, 1986, 1989). Of these, 11 412 were interviewed. Among tobacco users, 37.7% were chewers only, mostly of betel quid, and 14.3% both chewed and smoked (Table 11). Thus, approximately 50% of tobacco users chewed betel quid. Among tobacco users, 95.5% of women and 33.6% of men (of whom more than half also smoked) chewed. Betel-quid chewing was most common in the group aged 35 years and above.

Table 9. Prevalence of chewing habits (with and without smoking) in house-to-house surveys among villagers in India^a

Location (state)	Sample size	Prevalence of chewing habits (%)	
		With tobacco	Without tobacco
Andhra Pradesh	10 169	2.3	0.5
Bihar, Darbhanga	10 340	15	1.3
Bihar, Singhbhum	10 048	13	0.4
Gujarat	10 071	3	1.5
Kerala	10 287	26	0.4
Maharashtra	101 761 ^b	28	0.6

^a From Mehta *et al.* (1971), unless otherwise specified

^b From Mehta *et al.* (1972)

Table 10. Prevalence of tobacco and areca-nut habits in a population ≥ 15 years old in Ernakulam District, Kerala, India

Habit	Men		Women		All	
	No.	%	No.	%	No.	%
No habit	467	19.6	1828	67.2	2295	45.0
Smoking only	1087	45.6	11	0.4	1098	21.5
Chewing only	338	14.2	868	31.9	1206	23.7
With tobacco					1170	23.0
Without tobacco					36	0.7
Both habits	487	20.5	13	0.5	500	9.8
Total	2379	100.0	2720	100.0	5099	100.0

From Daftary *et al.* (1980)

Table 11. Prevalence of tobacco and areca-nut habits among tobacco users ≥ 15 years old in Ernakulam District, Kerala, India

Tobacco habit	Men		Women		All	
	No.	%	No.	%	No.	%
Smoking only	5330	66.5	150	4.4	5480	48.0
Chewing only ^a	1137	14.2	3162	93.2	4299	37.7
Both habits	1554	19.4	79	2.3	1633	14.3
Total	8021	100.0	3391	100.0	11 412	100.0

From Gupta *et al.* (1986)

^a Tobacco was chewed mostly in the form of betel quid.

In 1986, a house-to-house survey of tobacco habits was conducted among 30 544 villagers of all ages in 373 villages in three areas of Kolar District, Karnataka, to gather baseline information for an intervention study (Anantha *et al.*, 1995). About 8–16% of men and 29–39% of women had chewing habits (Table 12). While the content of the substances chewed was not defined in this study, a case-control study carried out in Karnataka by one of the authors identified the chewing habits of women as including tobacco, betel leaf, areca nut and slaked lime and as being the only tobacco habit of women (Carley *et al.*, 1994).

Mawa is popular in Gujarat, India, especially among the young. The prevalence of this habit increased tremendously in the 1970s and 1980s (Sinor *et al.*, 1990).

Table 12. Prevalence of tobacco and areca-nut habits among villagers in Kolar District, Karnataka, India

Habit	Dibbur ^a	Malur	Gudiband
<i>Men</i>			
No.	5464	5369	4893
Tobacco smoking	17.7%	21.0%	21.7%
Tobacco chewing	16.4%	7.7%	8.4%
<i>Women</i>			
No.	5236	4905	4677
Tobacco smoking	0%	0%	0%
Tobacco chewing ^a	38.5%	28.7%	30.4%

From Anantha *et al.* (1995)

^a Inferred as betel quid with tobacco from Carley *et al.* (1994)

The distribution of areca-nut use and tobacco smoking and chewing habits was assessed through a house-to-house survey in Bhavnagar District, Gujarat. Of 21 842 villagers aged 15 years and above (Gupta *et al.*, 1998), 2298 men (20.4% of all men) were chewing only and used areca nut in the form of *mawa* or betel quid with tobacco (Table 13).

Table 13. Prevalence of tobacco and areca-nut habits among villagers in Bhavnagar District, Gujarat, India

Habit	Men		Women	
	No.	%	No.	%
No habit	3 648	32.4	9 325	88.1
Smoking only (any)	3 942	35.0	16	0.2
Chewing only (any)	3 124	27.7	1 242	11.7
<i>Mawa</i>	2 127	18.9	7	0.1
Betel quid with tobacco	171	1.5	2	-
Tobacco	799	7.1	2	-
<i>Bajar</i> ^a	27	0.2	1 231	11.6
Mixed habits	544	4.8	1	-
Total	11 258	100.00	10 584	100.0

From Gupta *et al.* (1998)

^a Dry snuff

In West Bengal, 1990 women aged 16–60 years attending rural cancer detection clinics attached to a Calcutta-based cancer institute were interviewed about their tobacco and areca-nut habits (Chakrabarti *et al.*, 1990). The habit usually consisted of chewing betel leaf, areca nut, slaked lime, catechu and a few flavouring agents. Sometimes women added *zarda*. A total of 23.3% reported chewing betel quid, half of whom used tobacco in the quid (Table 14).

Table 14. Prevalence of tobacco and areca-nut habits in women attending rural cancer detection clinics in West Bengal, India

Habit	No.	%
No habit	1502	75.5
Betel quid without tobacco	226	11.4
Betel quid with tobacco	236	11.9
Other habits ^a	26	1.3
Total	1990	100.0

From Chakrabarti *et al.* (1990)

^a Other habits included drinking and chewing of anise seeds and cloves.

A study of chewing and smoking habits among 259 rural school teachers (230 men and 29 women) aged 28–63 years was conducted in Hoogly District, West Bengal (Pandey *et al.*, 2001). In this population, 51% were current tobacco users and 16.2% were former users. Among the current users, 72% were predominantly smokers, while 28% preferred smokeless forms of tobacco. Some 12% of all teachers chewed betel leaves with tobacco (Table 15). A small fraction used manufactured areca-nut products such as *gutka* and *pan masala*.

(ii) Urban studies

The most detailed account of chewing habits was reported among 10 000 persons admitted to the clinic of the dental school in Lucknow, Uttar Pradesh. No less than 22 different betel-chewing habits were reported (Pindborg *et al.*, 1967).

Dayal *et al.* (1978) presented a detailed report on chewing habits without a simultaneous smoking habit among 57 518 textile-mill workers aged 35 years and above in Ahmedabad, Gujarat (Table 16). Of all workers, 8710 (15.2%) had no oral habit, 2212 (3.8%) had a current chewing habit and 475 (0.8%) had a past chewing habit, all of them without a simultaneous smoking habit. The data show that the practice of a single chewing habit is rare.

A survey on issues pertaining to the control of oral cancer was conducted among 120 health professionals in the field of oncology from all over India, 85% of whom were men

Table 15. Prevalence of smoking and chewing habits in rural school teachers of Hoogly District, West Bengal, India

Habit	No.	% ^a
No habit	127	49.0
Smoking		
Filter-tipped cigarettes	82	[31.7]
Untipped cigarettes	75	[29.0]
Chewing		
Betel leaves with tobacco	32	[12.4]
Others ^b	17	[6.6]

From Pandey *et al.* (2001)

^a Percentages do not add up because 66 respondents used more than one form of tobacco.

^b Including tobacco quid (*khaini*), snuff, tobacco paste (*gudaku*), *pan masala* and *gutka*

Table 16. Prevalence of current chewing habits among 57 518 textile-mill workers in Ahmedabad, Gujarat, India

Chewing habit	No.	%
Betel quid with slaked lime, catechu, areca nut and tobacco	1335	[2.3]
Betel quid with slaked lime, catechu and areca nut	737	[1.3]
Betel quid with slaked lime	2	[0.003]
Betel quid with areca nut	3	[0.005]
Areca nut	113	[0.2]
Others	22	[0.04]

From Dayal *et al.* (1978)

and 28% of whom were under 35 years of age (Stanley & Stjernsward, 1986). Among those surveyed, 8% currently chewed betel quid with tobacco, 4% were previous regular chewers and 22% reported occasional chewing (Table 17). The prevalence of chewing was similar among men and women.

In 1992–94, a baseline survey on tobacco and areca-nut habits was conducted among 99 598 permanent residents of Mumbai, aged 35 years and above, belonging to the lower socioeconomic strata (Gupta, 1996). The prevalence of smokeless habits was high among both women and men (Table 18). Overall, areca nut in all forms was used by 29.7% of women and 37.8% of men, and betel quid without tobacco by 0.4% of men and 0.5% of women. Ten per cent of men practised both smokeless (including areca-nut habits) and smoking habits.

Table 17. Prevalence of tobacco and areca-nut habits of 120 health professionals in the field of oncology in India

Habit	Prevalence (%)				Total
	Current	Occasional	Past ^a	Never	
Cigarette	10	9	14	66	100
Bidi	0	1	1	97	100
Betel quid with tobacco	8	22	4	66	100

From Stanley & Stjernsward (1986)

^a Past habit was defined as those having quit for at least 1 month.

Table 18. Prevalence of tobacco and areca-nut habits among permanent residents of Mumbai, India, of lower socioeconomic status

Habit	Men		Women		All	
	No.	%	No.	%	No.	%
No current habit ^a	[12 280]	[30.7]	[25 268]	[42.5]	[37 548]	[37.7]
Smokeless tobacco	18 322	45.7	34 019	57.1	52 341	52.5
Smoking	5 494	13.7	146	0.2	5 640	5.7
Smokeless tobacco and smoking	3 975	9.9	94	0.2	4 069	4.1
Total	40 071	100.0	59 527	100.0	99 598	100.0
<i>Use of smokeless tobacco</i>						
<i>Mishri</i>	[4 140]	10.3	15 740	26.5	19 880	20.0
<i>Mishri</i> + betel quid with tobacco	4 976	12.4	10 687	18.0	15 663	15.7
Betel quid with tobacco	5 871	14.7	3 527	5.9	9 398	9.4
Tobacco + slaked lime	2 997	7.5	640	1.1	3 637	3.7
Others with tobacco	1 144	2.9	1 200	2.0	2 344	2.4
Multiple practices	2 993	7.4	2 013	3.3	5 006	5.0
Areca nut ^b	176	0.4	306	0.5	482	0.5
No smokeless tobacco use (no habit + smoking only)	17 774	44.4	25 414	42.7	43 188	43.4
Total	40 071	100.0	59 527	100.0	99 598	100.0

From Gupta (1996)

^a Includes about [14%] of men and [5%] of women who were former users of tobacco, mostly in the form of smokeless tobacco.

^b Areca-nut chewing, most often as betel quid without tobacco

In a northern suburb of Trivandrum City, Kerala, two groups of men and women, 35 years of age or older, mostly of lower socioeconomic status, were interviewed in 1995–98 (Sankaranarayanan *et al.*, 2000). Chewing habits, consisting mainly of betel quid with tobacco, were practised by 26.8% of men and 26.4% of women in one group and 20.5% of men and 17.6% of women in the other group (Table 19). Chewing habits were more common in low-income, low-education participants and in individuals with a manual occupation or retirees (Hashibe *et al.*, 2003). Among those for whom information was available, 89% chewed betel quid with tobacco, 11% chewed betel quid without tobacco and 0.4% chewed tobacco only (Thomas *et al.*, 2003).

Table 19. Prevalence^a of tobacco and areca-nut habits among urban residents in Trivandrum, Kerala, India

Habit	Men (%)		Women (%)	
	Group I	Group II	Group I	Group II
No.	25 453	23 356	34 441	31 351
No habit	31.4	44.1	72.3	81.8
Chewing ^b	26.8	20.5	26.4	17.6
Smoking	55.8	43.9	2.4	1.0

From Sankaranarayanan *et al.* (2000)

^a Percentages do not add up to 100% possibly because some residents reported multiple habits.

^b Mostly betel quid with tobacco

(b) Children and adolescents

In 1992, a survey of 146 children and teenagers (84 boys and 62 girls) between the ages of 5 and 20 years was conducted in the coastal fishing community of Mariyanad, Kerala (George *et al.*, 1994). Chewing of betel quid with tobacco was by far the most prevalent habit in both boys and girls, and was inversely related to level of education (Table 20). Two boys both chewed betel quid with tobacco and drank alcohol. One boy, 17 years of age, chewed betel quid with tobacco and smoked.

A survey conducted in 1998 among 400 male medical students revealed that about 12.5% were regular users of *gutka* (Table 21) and 27.5% were occasional users of areca-nut products without tobacco (Sinha & Gupta, 2001). Among those with a regular habit, about half had smokeless habits, consisting of chewing *gutka* and *khaini*. Occasional users mainly chewed areca-nut products not containing tobacco, e.g. *pan masala*.

A number of surveys conducted in households in India have shown that *pan masala* and *gutka* are commonly chewed by children and adolescents, especially in Gujarat, Maharashtra and Bihar. In a survey of 1200 students from junior and degree colleges of Maharashtra, 9.9% chewed *pan masala* and 9.6% chewed *gutka*. In a survey of 95 boys and

girls in the 8th and 9th grades (13–14 years old) of a small-town private school in Anand, Gujarat, 16% used *gutka*. In a village community of Kheda District, Gujarat, 72% of men and 50% of women under 26 years of age used tobacco products. Men favoured bidis and *gutka* while women preferred *gutka* and tobacco toothpaste. Among high school students in classes 10–12 (15–17 years old) in Patna, Bihar, approximately 12% used *pan masala* (Gupta & Ray, 2002).

Table 20. Prevalence of tobacco and areca-nut habits of children and teenagers aged 5–20 years in a coastal fishing village in Kerala, India

Habit	Boys		Girls		All	
	No.	%	No.	%	No.	%
No habit	[44]	[52.3]	[52]	[83.9]	[96]	[65.8]
Betel quid with tobacco chewing						
Occasionally	12	14.3	7	11.3	19	13.0
Regularly	23	27.4	1	1.6	24	16.4
Bidi smoking						
Occasionally	–	–	2	3.2	2	1.4
Regularly	1	1.2	–	–	1	0.7
Alcohol drinking						
Occasionally	4	4.8	–	–	4	2.7
Regularly	–	–	–	–	–	–
Total	84	100.0	62	100.0	146	100.0

From George *et al.* (1994)

Table 21. Prevalence of tobacco and areca-nut habits of medical students in Patna, Bihar, India

Habit	No.	%
No habit	[78]	18.8
Tobacco (smoking and chewing)		
Regular	172	43.0
Smoking		20.7
Chewing		20.2
<i>Gutka</i>		12.5
Occasional	37	9.3
Areca-nut products without tobacco		
Regular	3	0.8
Occasional	110	27.5
Total	400	100.0

From Sinha & Gupta (2001)

1.3.2 *Pakistan*

In a study on dietary and chewing/smoking habits, data on 10 749 persons of low and middle socioeconomic status, aged 20 years and over, were collected from various districts of Karachi (Mahmood *et al.*, 1974). Overall, 27.9% of men and 37.8% of women chewed areca nut in the form of betel quid (Table 22). Of this group, 47.5% of men and 31.9% of women chewed betel quid without tobacco (Table 23).

Table 22. Prevalence of tobacco and areca-nut habits in a population sample in Karachi, Pakistan, 1967-72

Habit	Men (%)	Women (%)	Total (%)
No.	5802	4947	10 749
No habit	36.9	56.8	46.0
Pan	4.2	11.5	7.6
Tobacco chewing	2.6	1.9	2.2
Smoking	30.3	2.2	17.4
<i>Pan</i> + tobacco chewing	6.1	25.0	14.8
<i>Pan</i> + smoking	8.9	0.4	5.0
Tobacco chewing + smoking	0.7	0.1	0.5
All three habits	8.7	0.9	5.1
Unknown	1.6	1.2	1.4
Total	100	100	100

From Mahmood *et al.* (1974)

Table 23. Prevalence of *pan*-chewing habits in a population sample in Karachi, Pakistan, 1967-72

Habit	Men (%)	Women (%)	Total (%)
No <i>pan</i> habit	70.9	61.2	66.5
Without tobacco	13.3	12.0	12.7
With tobacco <i>qiwan</i> ^a	2.1	2.6	2.3
With tobacco leaf	12.3	22.5	17.0
With tobacco leaf + <i>qiwan</i> ^a	0.3	0.6	0.5
Other types	0.2	0.3	0.3
Unknown	0.9	0.9	0.9
Total	100.0	100.0	100.0

From Mahmood *et al.* (1974)

^a *Qiwam* (also spelt *kiwan*): paste prepared from processed tobacco leaves, from which the stalks and stems have been removed, that are soaked and boiled in water with flavourings and spices, macerated and strained. The paste is chewed.

A survey was conducted in a sample of 160 primary school students aged 4–16 years (98% were < 12 years) in a fishing community on Baba Island of Karachi, Pakistan (Shah *et al.*, 2002). Of the 159 respondents, 118 (74.2%) used areca-nut products in the form of sweetened areca nut or betel quid (Table 24).

Table 24. Prevalence of areca-nut habits among primary school children (4–16 years of age) on Baba Island, Karachi Harbor, Pakistan

Habit	No.	%
No habit	41	25.8
Sweetened areca nut only	63	39.6
Betel quid only	4	2.5
Sweetened areca nut and betel quid	51	32.1
Betel quid ^a with tobacco	10	[6.2]
Betel quid without tobacco	46	[28.9]
Total	159	100.0

From Shah *et al.* (2002)

^a Alone or in conjunction with sweetened areca nut

[The Working Group noted small inconsistencies between the text and table in the percentage of users of sweetened areca nut and the number of betel-quid users.]

1.3.3 Bangladesh

Prevalence patterns of use of tobacco and areca nut by Bangladeshi populations have not been published in the English language literature. Extrapolating from migrant populations originating from Bangladesh and living in the United Kingdom, it is clear that the habit of chewing areca nut with and without tobacco is very prevalent in this population (see Section 1.3.6) and may therefore be taken as evidence for the existence of the habit in the home country.

1.3.4 Sri Lanka

In Sri Lanka, the quid consists of fresh areca nut, slaked lime from seashells, fresh betel leaf and slightly dried (or processed) tobacco (Chiba *et al.*, 1998). Studies in the early 1970s (Senewiratne & Uragoda, 1973) indicated that, among a group of healthy people, 55.6% of the men and 42.7% of the women added tobacco to the quid.

In rural Sri Lanka, the habit of betel-quid chewing is widely practised. Stephen and Uragoda (1970) reported that 30.1% of 1088 persons (men, 27.9%; women, 32.3 %) chewed betel quid with tobacco. In a large-scale study in rural Sri Lanka, it was shown that [57%] of men and women were chewers, about half of whom included tobacco in