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Contamination and Adulteration in Arecanut (Areca Catechu L.) And Its Chewing Foms: The Less Focused Subject by Health Researchers

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Abstract: Arecanut, *Areca catechu* L., along with certain other ingredients is the oldest common masticatory in most of the countries. It is generally chewed as it is believed to have lots of medicinal properties. Several Scientific data are now available to support this. On the other hand, lots of reports are also there on the adverse effects of chewing such products on human health. Most of the data collected on the adverse effects of chewing arecanut were from the people who chewed betel quid or pan masala. Both these chewing products usually contain several other ingredients, generally undisclosed, along with arecanut. While reviewing the research papers it was found that several samples of arecanut and its chewing product like pan masala available in the market were either contaminated with cancer causing fungi or adulterated with dangerous chemicals, pesticides and heavy metals which are known to cause several health problems on human beings. In spite of such scientific reports, it is most unfortunate that most of the researchers who highlighted the ill effects of chewing arecanut products simply blamed arecanut for all the adverse effects without properly analyzing the chewing products for the actual chemical contents in them. An attempt has been made in this paper to review the works carried out on the contamination and adulteration of arecanut samples available in the market and urged the health researchers to look into such aspect also before blaming arecanut for all the consequences.

Keywords: areca catechu, aflatoxin, contamination

I. Introduction

Arecanut, the fruit of the oriental palm, *Areca catechu* Linn., is the oldest common masticatory used along with other ingredients among humans all over the world^[1]. Areca palm is distributed mainly in South and South East Asia, especially in India, China, Bangladesh, Indonesia, Myanmar, Thailand, Malaysia, Vietnam, the Philippines, etc.^[2]. The endosperm of areca fruit, which is commonly called as arecanut (misnamed as betel nut in some parts of the world as it is usually chewed along with the leaves of *Piper betle* vine) or *supari*, is generally marketed after processing. In India, two types of processed arecanut varieties are commonly available, one called 'red supari' and another 'white supari'^[3]. The former type is obtained by boiling and drying dehusked unripe arecanuts at different stages of maturity, whereas the latter type is obtained by drying ripe arecanuts and dehusking them later on. India ranks first in both area and production of this commodity^[4]. In India, the antiquity of chewing arecanut goes back to 650BC as mentioned in the work of Magha in 'Sisupala Vadha'^[5]. In other countries such as Vietnam, the antiquity of arecanut chewing goes back to the Bronze age^[6].

Arecanut, along with several other ingredients, is being chewed by many in several countries as it is believed to have numerous medicinal values^[7,8]. It has an important place in the ancient Indian system of medicine such as Ayurveda, Unani and Homeopathy^[9,10] and in clinical practices in certain other countries such as Philippines, China and other south and southeast Asian countries^[11-13]. The World Health Organization^[14] has listed out as many as 25 beneficial effects of *A. catechu*. It was also reported that all the alkaloids present in arecanut possess drug-like properties^[15]. Most of the folklore medicinal properties of arecanut are now validated and authenticated with proper scientific data. It has antioxidant, anti-inflammatory and analgesic^[16], anti-diabetic^[17], hypolipidemic^[18], antibacterial^[19], anti-fungal^[20], anti-malarial^[21], anti-viral^[22], anti-HIV and AIDS^[23,24], anti-aging by reducing wrinkles formation in skin^[25], learning and memory improvement^[26], wound healing^[27], anti-ulcer^[28], anti-migraine^[29], antihypertensive^[30], antidepressant^[31], anti-allergic^[32], anthelmintic^[33], aphrodisiac^[34], hepatoprotective^[35], cytoprotective^[36], and anti-cancer^[37], etc.

The chemical constituents of arecanut (both green and ripe) include 17–26% polysaccharides, 11–30% polyphenols, 8–15% fibres, 8–15% fats, 6–9% proteins, 1–2.5% ash and 0.11–0.24% alkaloids^[38] such as arecoline, arecaidine, guvacine, guvacoline, isoguvacoline, arecolidine and homoarecoline^[15]. Arecanut also contains Vitamin B6 (286.9mg%) and Vitamin C (416.2 mg%)^[39]. The Fatty acid compositions of arecanut are:

lauric acid (19.5%), myristic acid (46.2%), palmitic acid (12.7%), oleic acid (6.2%), linoleic acid (5.4%), hexadecenoic acid (7.2%) and minor proportions of stearic acid, decanoic acid and monoethylenic acids^[40]. Polyphenols were reported to decrease whereas polysaccharides, alkaloids, fats and fibres increase with maturity of the nut^[41]. All the major chemical constituents of arecanut, including arecoline decrease significantly when the nuts are dried and stored with husk as whole nuts and also while roasting, soaking and boiling^[42,43].

Chewing forms of arecanut

Arecanut or betel nut is generally chewed along with other ingredients in four different forms: one wet type called 'betel quid' and three other types are dry forms called 'pan masala', 'gutka' and 'sweet supari'^[44]. The constituents of betel quid differ in various countries. It generally contains ingredients such as the leaf of *P. betle*, slaked lime, catechu (*Acacia catechu*), certain spices, artificial sweeteners such as saccharin and essences in different proportions^[45]. In countries such as Taiwan, Papua New Guinea, etc., instead of the leaf of *P. betle* its inflorescence, fruits or stem are used in making the quid^[46,47]. The betel quid is either chewed as such or chewed with the addition of a piece of tobacco (*Nicotiana tabacum*) as per individual preference^[44].

Pan masala is a packaged form of chewing product containing arecanut, lime, catechu, condiments and certain flavoring agents and artificial sweeteners. Generally pan masala does not contain tobacco. When tobacco is mixed with pan masala it is called as gutka, zarda or khaini. Sweet supari is another form of packaged arecanut which is processed and flavored^[44]. All the dry forms of these chewing products are manufactured industrially and available in market in small (four to five gram) sachets in different brand names. Though the chewing habit varies among people in different regions, the betel quid or its commercial preparations are kept chewing inside the mouth for about 15 min to an hour and repeated five to six times a day. In most of the cases the chewed substance is spit out and rarely consumed^[44].

Contaminations and adulterations in arecanut

As the arecanut products are available in the market in several types of ready to chew forms, there is every possibility that such forms are adulterated with cheaper materials and preservatives irrespective of their health hazards. Reports are already available that most of the arecanuts available in the market were of substandard and contaminated with cancer causing fungus^[48-50] and also adulterated with several hazardous phytochemicals, toxic metals and even pesticides^[51]. Chewing of such poor quality and adulterated arecanuts would definitely pose severe health problems on human beings in long time^[48,52]. An attempt has been made in this paper to review the extent of contaminations and adulterations of betel quid and pan masala available in the market and how serious the health researchers are on such aspects.

Contamination of arecanut with 'aflatoxin' producing fungus

Aflatoxins are fungal toxins inducing acute toxicity, carcinogenicity and several other adverse effects on human health^[52]. The fungi responsible for the production of aflatoxins are mainly *Aspergillus flavus* and *A. parasiticus*. Four types of aflatoxins, B1, B2, G1 and G2 commonly infest food items. Among them aflatoxin B1 is considered to be the most potent one accounting for nearly 70% of the total aflatoxin content in food. Children are affected most by aflatoxin ingestion leading to stunted growth, liver damage and even liver cancer. Adults are also at risk but have a higher tolerance limit^[52]. It was reported that arecanuts, with high moisture content and if not processed and dried properly^[53] or harvested prematurely and allowed to dry in heaps^[49] are invariably attacked by such fungi. The central core portion (pith) of arecanut, which is soft and sweet is mostly preferred as the site of infection and the infection by these fungi gives a dark patchy appearance to the inside core^[49]. Contamination of arecanut with such cancer causing fungi is reported in several countries. Continuous consumption of such aflatoxin contaminated food, even if they are in small doses can lead to many human health problems^[54].

Infestation of *A. flavus* was commonly reported in Indian arecanuts. It was found in stored and marketed indigenous^[50,53,55,56] as well as imported arecanuts to this country^[57]. This fungus was also reported to be the predominant one among several other fungal species identified in arecanut samples found in the markets of Lucknow and Gulbarga cities of India^[48,50]. Seven species of *Aspergillus*, including *A. flavus* and *A. niger* were isolated from the arecanut samples in Lucknow market and the concentration of aflatoxin B1 was found to be 51.09 µg/kg, much higher than the tolerance limit fixed by WHO. *A. flavus* and *A. niger* were also isolated from the arecanut samples from Gulbarga. The concentration of aflatoxin in such arecanut samples of Gulbarga were not given in the report. In another study conducted on the infestation of aflatoxin in arecanut in India it was noticed that out of 32 arecanut samples, 12 (37.5%) were found to be contaminated with aflatoxins with an average aflatoxin B1 content as high as 94 µg/kg (range: 18-208) and average total aflatoxin (B1+B2+G1+G2) content of 137 µg/kg (range 18-293)^[58].

Aflatoxin contamination in arecanut was also noticed in several other countries. Both aflatoxin B1 and G1 were recovered from the arecanut samples in Malaysia^[59]. In a study on the prevalence of aflatoxin B1 (the most potent among the aflatoxins group) in 278 arecanut samples imported to Pakistan from other countries during 2010-2011 (India-21 samples, Indonesia-51, Sri Lanka-34 and Thailand-172 samples), all samples (100.0%) of arecanuts of Indian origin showed aflatoxin B1 contamination ranging from 11.7-267.0 µg/kg with a mean of 92.5µg/kg^[60]. The figures for Indonesia, Sri Lanka and Thailand were 80.4%, 73.5% and 30.2% with aflatoxin B1 ranging from 3.3 – 39.2 (mean 11.6), 6.5 - 103.4 (mean 35.0) and 3.3 – 77.0µg/kg (mean 6.65µg/kg), respectively. A rapid cross-sectional study conducted at Bangladesh on the extent of aflatoxin contamination in several human food items and poultry feed revealed the presence of aflatoxin at 30.6ng/g level in the samples of their arecanuts^[61]. In Nepal, it was reported that as many as 25% of arecanut samples were found to be contaminated with aflatoxin B1 or B2^[54]. They further presumed that intake of aflatoxin contaminated food might be an important unrecognized risk factor to public health which could have long-term health implications if not attended properly.

In South Africa it was noticed that nearly 40 to 60 % of dried arecanut samples (sliced or whole) imported were found to be contaminated with *A. flavus*, and the concentration of aflatoxin B1 in such arecanuts was found to be in excess of the commonly accepted food limit^[62,63]. Based on the arecanut consumption data it was also calculated that chewers of un-boiled dried arecanuts in South Africa may consume a total aflatoxin (B1+B2+G1+G2) content of 3.6-1080 ng per 24h^[62]. They also presumed that in countries such as India and Taiwan where the people mostly chew similar type of arecanut, the concentration of aflatoxins consumed may even go up and potentially contribute to the reported carcinogenic effects of different chewing products of arecanut on human oral tissue. In spite of such widespread presence of aflatoxin in arecanut, the health researchers did not take care of this aspect seriously, but simply blamed arecanut for all the ill effects.

Adulteration in Pan masala

Though the label in pan masala sachets gives an impression that they contain arecanut along with certain other condiments and flavouring agents, most of the brands neither revealed all the contents nor mentioned the actual quantity of each ingredient in them. There was no proper quality control on these products either in several countries. In such circumstances, there is every possibility that substandard / spurious / adulterated materials which are dangerous to human being might have been incorporated for some reason or the other in different brands. The chemical composition of the food material is primarily responsible for its biochemical activity and related health implication. Presence of polycyclic aromatic hydrocarbons (PAH) and certain toxic metals such as lead, cadmium and nickel were already reported in all the five common pan masala brands tested in Ahmadabad, India^[64]. Though the actual levels of these compounds in the products tested were not given in this report, in another laboratory study on the chemical composition of several common brands of pan masala, it was found that most of them were adulterated with PAH, certain insecticides such as DDT and BHC isomers, in addition to toxic metals such as copper, zinc and magnesium (all these are known to possess carcinogenic, tumorigenic, teratogenic and mutagenic potentials), in higher concentrations than permissible limits^[51]. High concentrations of toxic metals such as lead, arsenic, cadmium and copper, much above the permissible limits prescribed by the WHO, were also detected in several Indian brands of tobacco blended pan masala^[65]. Several dangerous volatile aldehydes, such as formaldehyde, acrolein, crotonaldehyde, propionaldehyde and isobutyraldehyde have also been detected in the studies conducted on the chemical analysis of pan masala in the Cancer Research Institute of Tata Memorial Centre, Mumbai, India^[64]. The adulteration in pan masala was so common that certain brands of these products which claimed that they were 'tobacco free' contained up to 13.28g of nicotine (a known carcinogen) per 100g of the content (The Tribune, Feb 21, 2011). It was also reported that certain other brands of pan masala contained 'menthol', an organic compound mainly used against colds and throat irritation as topical application, in more concentration than the acceptable limit for food stuffs fixed by the Food Adulteration Act of India. Though this act fixed the maximum level of menthol in pan masala at 0.1% (1.0mg/g), it was noticed that as many as 75% of samples of branded pan masala contained 1.1-6.5mg of menthol per gram of the product and in non branded pan masala up to 92% of the samples contained 1.1-6.5mg of menthol per gram of the product^[66]. There were reports to show that chronic intake of menthol was injurious to human health^[67]. Most of the pan masala and pan flavorings found in Indian market were reported to contain artificial sweetener, saccharin, a known urinary bladder carcinogen, in several folds higher than the maximum levels permitted by the Prevention of Food Adulteration (PFA) Act of India^[68]. Hence, it is highly necessary for the concerned Government Departments to make regular and surprise chemical analysis of different brands of pan masala available in the market and curb such illegal activities for the benefit of mankind. The researchers should also consider all these factors before labeling only one constituent of pan masala as carcinogenic or dangerous. In spite of such dangerous reports on the widespread contamination and adulteration of arecanut and its chewing products, it is strange that most of the research papers which reported the harmful effects of chewing arecanut products did not either analyzed the

actual contents of the chewing products they dealt with, or took note of the harmful effects of other ingredients or the contaminations and adulterations found on such ingredients, but simply tagged arecanut for all the adverse consequences developed by chewing these products^[69-83]. Ample number of review articles^[45,84-92] have also emerged blaming arecanut, but none took care to pinpoint or discuss the contaminations or adulterations found on such chewing products in their articles.

II. Conclusion

These observations clearly shows that ample quantity of arecanuts in the market are contaminated with the cancer causing fungus, *Aspergillus flavus* which produce the toxic chemical 'aflatoxin'. Nearly 37.5% of arecanut samples in India were found infested with such fungus. Several brands of pan masala were also reported to be adulterated with toxic chemicals like polycyclic aromatic hydrocarbons and dangerous insecticides such as DDT and BHC isomers in addition to toxic metals such as copper, zinc and magnesium. Certain 'tobacco free' pan masala brands were even contained nicotine in very high concentration and certain others contained menthol and saccharin in much higher concentration than the maximum levels permitted by the Prevention of Food Adulteration (PFA) Act of India. Most of the health researchers did not analyze the chewing products of arecanuts they studied for such contaminations and adulterations, but simply blamed arecanut for all the ill effects. Hence, there is an urgent need to evaluate and detect the actual harmful substance responsible for the ill effects of the arecanut chewing products commonly available in the market before pin pointing a particular substance for the outcome. If found necessary, strict action may be taken on the manufacture and sale of such products for the benefit of both areca farmers and chewers of such products.

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