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ANTIBACTERIAL PROPERTIES OF ARECANUT (*Areca catechu* L.) AND CERTAIN ARECANUT PRODUCTS

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Plants have been used for their medicinal properties since the beginning of human civilization. Such medicinal plants are well described in several text books and scientific literature (Tavera, 1901; Kirtikar *et al*., 1918; Chopra and Chopra, 1955). Areca palm, *Areca catechu* L. (Family: Palmae) is one such medicinal plants whose pharmacological and medicinal properties are studied for certain extent (Patil *et al*., 2009; Jaiswal *et al*., 2011; Amudhan *et al*., 2012; KeshavaBhat, 2019). The World Health Organization (2009) has listed out as many as 25 beneficial health effects of *A. catechu*.

The utility of arecanut is well mentioned in the ancient system of Indian medicine such as Ayurveda, Unani and Homeopathy (Aman, 1969; Shankara Bhat, 2008) and in several other South and Southeast Asian countries (Tavera, 1901; Li Shizhen, 2003; Rahmatullah, 2009; Peng *et al*., 2015). In India, the use of arecanut has been quoted as early as 1300 BC (Bhat and Rao, 1962) and the practice of its chewing from 650 BC (Rao, 1982). The evidences of arecanut chewing in certain other countries even go back to Bronze age of human civilization (Oxenham *et al*., 2002).

Phenols, alkaloids and essential oils are important groups of plant metabolites which are not necessarily essential for the survival of plants but are required for their defence, primarily against microbial pathogens. Among such compounds, the polyphenols (Coppo and Marchese, 2014) and alkaloids (Yan *et al*., 2021) are reported to be promising natural antibacterial agents. Areca palm is very rich in polyphenols (up to 47.94%) and certain amount of alkaloids (up to 0.22%) in its nut (Mathew *et al*., 1964). Ample scientific evidences are now available on the antibacterial properties of these nuts. Certain commercial products containing arecanuts also show antibacterial properties. Such reports are retrieved and presented in this compilation.

1. Antibacterial properties

1.1. Arecanut extracts:

Almost all types of arecanut extracts showed antibacterial properties. The hot water extract of arecanut was antibacterial against both gram negative and gram positive bacteria. The concentration needed for 100% inhibition of gram negative bacteria was 3.3 - 7.0 µg/ml with *Klebsiella* sp. and *Proteus* sp. as more susceptible followed by *Pseudomonas* sp., *Salmonella typhimurium* and *Escherichia coli*, whereas for gram positive bacteria such as *Streptococcus mutans* and *Streptococcus viridians* 100% inhibition was achieved at 16 µg/ml concentration (Anthikat and Michael, 2009). The authors speculated that arecanut chewing might have significant disinfective properties. In another study, it was reported that such extract of arecanut at a concentration of 50 µg/3 ml (17µg/ml) inhibited the growth of another bacterium *Staphylococcus aureus* by 90% (Anupama *et al*., 2021). Nisreen and Al-bayati (2016) also reported effective antibacterial activity of such extract against *S. aureus* and *Streptococcus pyogenes*.

Acetone extract of arecanut also exhibited potent antibacterial activity with the zone of inhibition of 20.17 ± 1.04 mm and 17.33 ± 1.53 mm to gram positive bacteria like *S. aureus* and *Micrococcus* sp, respectively and 18.00 ± 1.00 mm, 20.17 ± 0.76, 18.17 ± 0.76, 20.83 ± 1.26 and 15.50 ± 0.50 mm against gram negative bacteria like *Vibrio cholerae*, *Salmonella typhi*, *Salmonella paratyphi*, *E. coli* and *Pseudomonas aeruginosa*, respectively at a concentration of 100µl/well with the minimum inhibitory concentration

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(MIC) of 0.625µg/ml for *S. aureus*, 1.25µg/ml for *Micrococcus* sp., 0.625µg/ml for *E. coli* and 2.5µg/ml for *P. aeruginosa* (Khan and Akhter, 2020). In another study, the zone of inhibition noticed by the acetone extract of arecanut at a concentration of 250 µg/ml was 10.0 ± 1.0 mm against the gram positive bacterium like *Staphylococcus epidermidis* and 12.0 ± 1.0 mm and 11.0 ±1.0 mm against the gram negative bacteria like *E. coli* and *Proteus mirabilis*, respectively (Hazarika and Sood, 2015).

The ethanol extract of arecanut also showed antibacterial activities against *Bacillus cereus, S. aureus, E. coli* and *S. typhimurium* with a MIC ranging from 0.78 to 1.56 mg/ml (Karphrom *et al*., 2009). In another study, such extract showed antibacterial action against several gram negative bacteria such as *E. coli, Proteus vulgaris, P. aeruginosa, Salmonella non-typhi, S. typhi, Shigella flexneri* and *V. cholerae* with zone of inhibition ranging from 7 mm to 18 mm at 30 to 70% concentrations (Chin *et al*., 2013). The authors reported highest antibacterial activity against *P. vulgaris* with the zone of inhibition of 18 mm at 70% concentration of such extract and found comparable to that obtained for the common antibiotic Ciprofloxacin which showed a zone of inhibition of 16 mm. Against *E. coli*, the zone of inhibition noticed with 70% extract was 13 mm, whereas it was only 8 mm with Ciprofloxacin.

A MIC of 1.56 to 6.25 mg/ml was reported against *B. cereus, S. aureus, E. coli* and *S. typhimurium* with ethyl acetate extract of arecanut (Karphrom *et al*., 2009). In another study, the ethyl acetate extract of arecanut at 1% concentration produced a zone of inhibition of 8.3 mm against *E. coli* and 7.5 mm against *S. aureus* (Saluthan and Billakura, 2015). The hydroalcoholic extract of arecanut was also reported to be antibacterial. The zone of inhibition of *S. aureus, E. coli* and *Bacillus subtilis* at a concentration of 200 mg/ml of such extract was 17 mm, 18 mm and 15 mm, respectively (Pahadia *et al*., 2013). The methanol extract of arecanut showed potent antibacterial activity against *B. subtilis* and *E. coli* with the MIC values of 1.25 mg/ml and 5.0 mg/ml, respectively (Vaghasiya *et al*., 2019).

The aqueous extract of arecanut was also reported to be very active against *Enterococcus faecalis,* the most common and dominant anaerobic bacteria responsible for human endodontic infections and even found better than that of Chlorhexidine (CHX) the chemical disinfectant presently used during root canal treatment of tooth. With arecanut extract, the growth inhibition was noticed at a concentration of as low as 0.062mg/disk whereas with CHX the inhibition was not noticed at such a low concentration and the inhibition with CHX commenced at a concentration of 0.25mg/disc only (Arathi *et al*., 2015). The authors even suggested that arecanut could be developed as an antibacterial agent during root canal treatment.

Nursidika and Rachmawati (2022) reported that the extract of arecanut even inhibited the growth of Vancomycin-resistant *Enterococcus* sp. The ethyl acetate extract of arecanut at a concentration of 256 µg/ml was found to be equal to that of Tetracycline at 128 µg/ml concentration in inhibiting the growth of Vancomycin-resistant *Enterococcus* sp.

The 'chogaru' obtained while preparing red type of arecanut also reported to be antibacterial in action. Nethravathi *et al*. (2010) tested the antibacterial activity of such liquid on four bacterial strains and found that it had very potent antibacterial activity against *Enterobacter aerogenes* but slightly less against *S. aureus, E. coli* and *B. subtilis.*

1.2. Nanoparticles of arecanut:

The nanoparticles of arecanut faired substantially better than its ordinary extracts in their antibacterial activities. The inhibition zones obtained with the copper nanoparticles of arecanut against *B. subtilis* and *P. aeruginosa* were 25.0 ± 0.59 mm and 23.0 ± 0.62 mm, respectively, whereas the figures obtained with the plain aqueous extract of arecanut were only 11.0 ± 0.74 mm and 13.0 ± 0.69 mm, respectively (Pradeep *et al*., 2019). In another study, it was observed that the zone of inhibition of *S. aureus* with silver nanoparticles of arecanut was 34.0 ± 0.68 mm, even greater than that of the standard

Ciprofloxacin which was 24.00 ± 0.40 mm (Hossen *et al*., 2015). These authors also observed a zone of inhibition of 35.0 ± 0.48 mm for *E. coli*, 19.0 ± 0.30 mm for *S. typhimurium* and 29.0 ± 0.35 mm for *P. aeruginosa* with silver nanoparticles of arecanut. Bhat *et al*. (2015) also reported the superiority of silver nanoparticles of arecanut in their antibacterial activities than its aqueous and methanol extracts against several species of bacteria.

2. Arecanut products

2.1. Antibacterial activity of arecanut based ointment:

Studies on the antiseptic effects of certain arecanut based ointment (containing the extracts of arecanut 3.5 g, betel leaf 8.0 g, gambier 2.5 g and lime 2.0 g) on lip mucosal wound of rats at three different concentrations (5%, 10% and 20% of the extract) showed significant decrease in the number of bacterial colony in all these concentrations (Pambayun *et al*., 2018). The ointment containing 20% of such extract had antiseptic effect similar to that of 0.2% hyaluronic acid, the antiseptic gel commonly used for the treatment of wounds.

2.2. Antibacterial activity of arecanut soap:

When the antibacterial activities of different soaps, prepared by using powder as well as extract of arecanut separately, were compared with two brands of antiseptic soaps X and Y available in the market, it was reported that both arecanut powder as well as arecanut extract mixed soaps exhibited good antibacterial activity, whereas the brands tested from the market did not (Rahman and Purwakanthi, 2021). In their study, the soaps weighing 50g each were prepared by using three different doses of arecanut powders (1.5 g, 2.3 g and 3.0 g) and one dose of arecanut extract (1.2 g) and tested against *S. aureus*, the common skin infecting bacterium. The inhibition zones against *S. aureus* in all arecanut soap treatments were almost same ranging between 23.08 ± 1.52 mm to 24.28 ± 7.95 mm whereas in the two antiseptic soap brands X and Y no antibacterial effect was noticed.

2.3. Antibacterial activity of arecanut tooth paste:

The toothpaste prepared by incorporating arecanut extract prepared from unripe nuts using 70% ethanol showed effective antibacterial property against the primary cariogenic bacterium, *S. mutans*. The MIC value for such tooth paste against this oral pathogen was reported to be 1.95% with an inhibitory growth zone of 20 ± 0.4 mm (Triastuti *et al*., 2015).

3. Conclusion

It is observed that arecanut has great potential as antibacterial agent. The action differs from one solvent to another and from one species to the other. The nanoparticles of arecanut were reported to be even more effective than its normal extracts against several bacteria. Hence, arecanut could be better utilized as valuable biological source for developing safe and effective pharmaceutical products and herbal medicines for mankind.

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