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MEDICINAL PROPERTIES OF ARECACEAE PLANTS WITH SPECIAL REFERENCE TO CALAMUS ERECTUS: PHYTOCHEMISTRY AND PHARMACOLOGICAL INSIGHT

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Abstract
Arecaceae family is an integral part of cultures and traditional practices across the world. India has around 225 species across 25 genera and they are known for various bioactivities. This mini review focuses at the medicinal potential of the palms with a special insight into the less explored Calamus erectus. In the north east India, the leaves and the nut of this plant are consumed as food or used in preparation of traditional medicines. Preliminary studies show that it has antioxidant, antidiabetic and anthelmintic properties. We have briefly discussed the phytochemical profiles of some wellknown species like Areca catechu (which has arecoline rich alkaloids that can be both stimulant and toxic), Cocos nucifera (which has medium chain fatty acids and phenolics known to fight germs and protect the liver) and Phoenix dactylifera (which has phenolics, carotenoids and metabolic benefits). The ethnobotanical information on Arecaceae available has noticeable gaps. No standard extraction techniques are followed for preparing extracts, there is a lack of ADMET and clinical validation. C erectus itself is very under studied. We have discussed a framework for an integrated and holistic approach needed for translational research to unlock the therapeutic potential and Arecaceae palms, especially C erectus, for the development of novel nutraceutical drugs.

Keywords: Arecaceae, Calamus erectus, Ethnopharmacology, Phytochemicals, Traditional Medicine

Introduction

The Arecaceae family, commonly called palms have over 2600 species in over 181 genera. Found to thrive in both tropical and subtropical regions, plants from these family are known for its resilience and variations. In many traditional healing systems where different parts of plants from this family are utilized for ailments ranging from gastrointestinal issues, wounds and inflammation (Dubey, 2022).

Among the species of this family, Areca catechu, commonly known as betel nut palm is very well known. The nut from this plant has been consumed in Asia since time immemorial for its stimulating properties as well as to get rid of intestinal worms and move fluids in our intestine. (Peng et al., 2015). A rich profile of alkaloids, tannins, flavonoids and triterpenes has been found in plants of these species upon phytochemical analysis that contribute to its various pharmacological activities like antioxidant, anti-inflammatory, anti-parasitic and digestive promotion etc (Sun et al., 2024).

Cocos nucifera or coconut, is another species that has been well researched. Coconut water and virgin coconut oil has shown strong antioxidant, liver protective, metabolic and bone protective effects in in-vitro and in-vivo studies (Lima et al., 2015)

Some of the lesser known palms showed therapeutic potential in different studies. Arenga pinnata or sugar palm has anti-inflammatory and antinociceptive properties and it contains galactomannan

polysaccharides that is known to have anti-OA effect. Borassus flabellifer, commonly known as Palmyra palm has potential anti-inflammatory and anti-arthritis activity which may be due to steroidal as saponins in its flowers. The date palm or Phoenix dactylifera has been linked to a lot of therapeutic activities. Reducing CRP and homocysteine markers, analgesic and anti-inflammatory effects are some of them. (Sartinah et al., 2022). Elsayed Hamed et al. (2022) in their review covering studies between 2006-2021 have discussed a broad spectrum of metabolites present in the plants of this family This clearly shows its pharmacological potential overshadowing its ethnobotanical legacy

Ethnopharmacological Importance

People all over the world have used palms for their healing properties. In traditional healing practices and rituals their different parts like roots, fruits, oil, sap and fibre are known to be utilized. In the Americas more than 100 species of palm have been studied for their medicinal use, up from 48 a few decades age. This clears the increasing importance of the Arecaceae in ethno pharmacology. It includes medicines for diabetes, prostate, leishmaniasis in terms of both traditional medicine and new pharmacological discovery (Sosnowska & Balslev, 2009)

Extracts from husk and oil of coconut have been traditionally used as antiseptic in wound healing. These uses complement the reported antibacterial and antioxidant properties of the oil and good activity of husk extract against oral pathogens.

The oil of patawa palm (Oenocarpus bataua) has been long used by Amazonian communities for treating cough and bronchitis.

In the sub Saharan region of Africa, palms have played an important role in traditional healings, mostly in ritualistic and symbolic roles. Borassus aethiopum, Elaeis guineensis, and Phoenix reclinata are documented to feature in spiritual practices while palm leaves are given as offerings and palm oils are used as carrier for other traditional medications (Gruca et al., 2014)

If we look into Asia, beetle nut palm is very commonly used in traditional medicines. It is generally consumed to aid in digestion, offer a fresher breath and rid the gut of intestinal worms. (Aga et al., 2023)

In certain communities of Brazil, mesocarp oil from palms like Acrocomia aculeate and Mauritia flexuosa have been used to treat ear ailments, toothaches, respiratory conditions as well as in making antivenoms (Martins et al., 2014)

Calamus erectus is a palm native to the parts of South and South East Asia. This erect rattan palm is used by the people of these regions both as food and traditional medicines. In places like Bangladesh and North-East India, young shoots and leaves are eaten as vegetables, the seen chewed as an alternative to betel nut. They also use the plant in traditional ways for their antidiabetic and antioxidant properties. C.erectus is one of the several understudied palms that are important for both food and medicine in remote and rural areas. (Calamus Erectus - Useful Tropical Plants, n.d.)

An Indian Perspective

Be it rituals, food or traditional medicines, palms are an integral part of the Indian life. Coconut is probably the best example to follow up the statement. It is not only used in making food, it is widely used in religious ceremonies and traditional medicines to treat wounds and aid in digestive complaints. Reviewing the ethnobotany and pharmacology studies of fruit corroborate its use in traditional medicine with proven antimicrobial, antioxidant and hepatoprotective activities (Devi & Ghatani, 2022). Betel nut palm (Areaca catechu) is widely chewed in the region to aid digestion and give a fresher breath. Modern studies have also highlighted the associated risk of chewing the same (Peng et al., 2015b).

Date palm and other edible palms are widely used as an active in traditional medicine and as a source of food. Phoenix dactylifera is known to be used in preparing nutritive tonics and community

medicines. Reviewing reports from the region show a consistent antioxidant, anti-inflammatory and metabolic effects.

Calamus erectus, a lesser known palm native to the north-eastern region of India has long been used as food and in local medicines while published experimental literature on C. erectus are very less. Bringing traditional knowledge of medicine to modern day drug discovery must be a research priority. Three important inferences can be drawn from the Indian ethno pharmacological records of Arecaceae. Many palms are both food and medicine making dosing and preparation techniques important. Common traditional claims of therapeutic properties have scientific validations and species specific safety studies are needed.

Phytochemical Constituents

Plants of arecaceae family are phyto-chemically rich. A lot of different types of secondary metabolites like alkaloids, flavonoids, terpenoids, phenolic acids, fatty acid derivatives and sterols have been reported in the palms (Mohammed & Fouad, 2022). These classes of compounds are responsible for various biological and therapeutic activities. Activities

Some species are known for their unique phytoconstituent signature like betel nuts have a group of four alkaloids. Arecoline together with tannins and polyphenols give the nut its distinct stimulating and anthelmintic effects along with it toxicity risk **(**Sun et al., 2024b)

Lipids are the most abundant fraction on coconut. Fatty acid rich triglycerides are present in the kernels as well as tocopherols and phenolic compounds in testa and oil. These phtyto constituents are responsible for a lot of reported activities of coconut extract and virgin coconut oil**.** (Lima et al., 2015b)

Previous studies of phytochemical profiles of C erectus leaf and fruit have found a mix of common secondary metabolites. Alkaloids, flavonoids, phenolics, tannins, saponnins, glycosides, oils and sterols are some of it. These qualitative profiles are similar to other Calamus spp and they provide a reasonable explanation for potential antioxidant and anthelmintic effects. It is also important to note that no proper work has been carried out to profile its phytoconstituents and most of the work are fragmented. (Sultana et al., 2022)

The abundance of phenolics (flavonoids,chlorogenic and protocatechuic acids) and carotenoids (especially β-carotene) are responsible for the strong antioxidant behaviour of extracts from the pulp and seeds. Other members of this family of plants have been found to have same phenolic-rich profiles (Silva et al., 2022) (Rincón-Cervera et al., 2023)

Arecaceae species are hydrophilic and lipophilic bioactive rich that together make them a good target for nutraceutical studies. Moreover the phytoconstituents that are present in Areca have been frequently studies for different therapeutic properties and applications

Reported Medicinal Properties

Palms from this family have a wide range of biological activities that can be justified for their traditional uses. Scanning through experimental and review literature have repeatedly discussed their antimicrobial, antioxidant, anti-inflammatory, antioparasitic, metabolic, wound healing properties. In some studies their anticancer and neuroprotective activities were also studied along with exploring their scope in dermatology. These actions are mainly due to the secondary metabolites that we have discussed in earlier parts that differ from species to species. (De Lacerda Coriolano et al., 2021)

Most common property that has been reported is their antimicrobial activity. If we look into coconut, particularly extra virgin coconut oil that is high in lauric acid can neutralize a wide ramge of bacteria and fungi. This support the use of coconut oil for oral hygiene and wound care. Other neotropical palms have also shown similar activities from their profile (De Lacerda Coriolano et al., 2021b) (Dubey, 2022)

Palms having a high carotenoids and phenolics show strong anti-inflammatory and antioxidant properties. Muritia flexuosa and other fuits with a lot of β-carotenes and phenolics constistently show

antioxidant activity in-vitro. People use these antioxidant rich pools of the phytoconstituents to reason their hepatoprotective, phytoprotective and general cytoprotective functions (Freire et al., 2016)
Metabolic effects have been documented in numerous species. Date palm and other edible palms in various preclicinal studies have been found to lower blood sugar, alter lipid profiles and protect the heart from damages. This explains well their use in the food culture. Coconut and patawa's lipid sections contain medium chain-fatty triglycerides that can modulate metabolic endpoints (Raish et al., 2025) (Mat et al., 2022)

Experimental studies on C erectus has shown antioxidant activity. Methanolic extracts of the leaf can scavenge free radicals and inhibit enzyme actions. A comparative work across the species have shown a dose dependent anthelmintic effects. A lot of scope is there in exploring this palm for its potential therapeutic activities
Traditionally some palms were used for both anti parasitic and anthelmintic purposes. We can cite the example of Areca catechu or betel nut that has been traditionally used to as a digestive stimulant as well as for its anthelmintic effects. However modern studies have flagged the potential risk of toxicity associated with arecolin. (Peng et al., 2015b) Wound healing properties and uses in the field of dermatology are also widely discussed and studied. Preparation from the kernel and the husk of coconut have shown analgesic, antimicrobial and wound healing prompting properties. Some studies of palm extracts point towards its anticancer potential along with neuroprotective and hepatoprotective functions. It is also worth noting that most of these studies were done in the preclinical stages and seeks clinical validations. Overall we can say that Arecaceae species are a hot pot of promising bioactive leads (De Lacerda Coriolano et al., 2021c) (Hamed et al., 2025)

Bioavailability, Safety, and Toxicity
The two most common question that arise out from the therapeutic studies of Areaceae plants is the variability in bioavailability in their phytoconstituents and toxicity concerns that are species specific and can range from low to high. Most of the bioactive of interest are either lipophilic in nature or they are found in the fruit pulp or oil as complex matrices. β-carotenes known for their strong anti-oxidant behaviour does not adsorb well in the human gut unless consumed with fat or processed to make their uptake easier. (De Souza Aquino et al., 2023)Reviews have suggested non-thermal techniques or formulations to improve the carotenoid bioaccessibilty. The medium chain triglycerides found in coconut oil are absorbed and metabolised much faster than long chain fats. This changes how the body is exposed to the oil and how it interacts in the body. When developing drugs or nutraceuticals factors effecting bioavailability like species, matrix and processing must be taken into consideration (Barboza et al., 2022)

There is a lack of published information about the pharmacokinetics and clinical safety of C. Erectus. As this species like other palms contain similar bio actives, the bioavailability will mostly depend on the compound and affected by the matrix and processing techniques. This plant also lacks toxicological studies. Concentrated extracts of isolated compounds must go through standardized ADMET analysis before they are used in clinical studies.
In our practical view edible palms are safe as long as they are taken as food. They can be a good source of energy, minerals, micronutrients and antioxidants. But from an extract point of view, even if it is of food-grade, must be dealt with caution because they are dose dependent and affect the host's metabolism. While looking into drug development potential the toxicity of the safe palms should also be studied properly. Betel nuts are already associated with increasing the risk of oral squamous-cell carcinoma due to the presence of arecoline. Palm oils contain high doses of saturated fatty acids. Some of the functionalities like lauric acid's antimicrobial activity and the medium chain triglycerides ability to boost energy can sound appealing while masking the risks associated with rising LDL when consumed as food. For further nutraceutical usage, clinical effects on human lipid profiles must be understood. (Sekhar et al., 2022)

Gaps, challenges and future prospects

Even though a lot of ethnobotanical and phytochemical research has been done, there are few gaps that are worth noting slowing down the move from traditional knowledge to evidence. A lot of the literature covering Arecaceae are based on ethnobotanical surveys or in-vitro and animal studies. All the meta analysis and systematic reviews oiubt at the lack of controlled human trials or standardized clinical data to back up the claims related to treatments. Finding the right dose, their safety and understanding the clinical end points are still missing. (Sosnowska & Balslev, 2009b). As different parts of plants and solvent system combinations have been used in studies, it is hard to compare the results. As a standard extraction protocol and chemical fingerprinting technique is not followed, reproducibility is a big challenge (Tow et al., 2021). Most of the palms are safe to eat. Some species like betel nut have been linked to certain risk factors (Huang et al., 2024). Even though it has been used as a traditional medicine for a long time, the mechanistic risk leading to oral sub mucous fibrosis cannot be overlooked. Drug development including these kind of species must look at toxic substances, how people are exposed to it and the risk at meta-level. Toxicology and mechanistic studies should be given importance in such cases and focus should also be given to find ways to lower risk. (Warnakulasuriya & Chen, 2022).

The bioactive present in palms differ in their bioavailability depending upon its type, the matrix and formulations. A formal ADMET (absorption, distribution, metabolism, excretion and toxicity) profiling is still lacking for the majority of it. It is hard to guess that dosing for people or carry forward candidates into clinical testing without the necessary pharmacokinetic data and formulation work (Salhi et al., 2024).

Local livelihoods, sustainable harvesting and downstream supply are the biggest challenge for a number of palms, especially those that are important in Amazonian and African regions. Literatures surrounding oil palm discusses the effect of climate and pest on the quality and quantity of products. These are important factors and must be considered in pharmaceutical studies and explorations. Hence it is important to include fair trade guidelines and environmental conservation in the development of these drugs (Teixeira et al., 2022) (Murphy et al., 2021)

Calamus erectus an important Arecaceae species from an ethnic point of view. Lot of gaps can be easily notices while going through the literature detailed scientific studies regarding this plant is lacking. There is a need for a complete phyto chemical profiling to complement its use. It also needs purification and fractional studies to identify the components responsible for its bioactivity followed by their ADME and toxicology studies. GLP must be maintained in these studies for maintaining data integrity. There is also a scope and need for small and controlled human pharmacology or biomarker studies if associated safety parameters are established. In the end, we must keep in mind the sustainable harvesting practices and engaging local communities during any scale up.

To move the Arecaceae bioactive leads from forest to clinical research will need a lot of coordinated approach in term of interdisciplinary approach. Most the current studies are done in silos and there is a clear lack of system pharmacology methods in these studies. This needs to be addressed to speed up the process.

Conclusion

The Arecaceae family has a lot of plants with medicinal properties like Cocos nucifera, Pheonix dactylifera, Area catechu and Borassus flabellifer. These plants are known to have antioxidant, antimicrobial, anti-inflammatory, metabolic and wound healing properties. These can be corroborated in both traditional knowledge and experimental studies. If we focus on Calamus erectus, little has been scientifically documented in respect of its cultural importance. Referring to findings of other members of the family, this species too may have some or all the bioactivities. Still the process of utilizing them for novel drug therapeutics is a long way to go. Most of the studies suffer from lack of standardization in extract preparations, limited safety and pharmacokinetic profiling and lack of clinical trial. This exactly states the importance of phytochemical

characterization and translational research. A holistic approach involving ADMET evaluations, formulation strategies, clinical validation based on sustainable sourcing and community involvement will be of utmost importance in unlocking the therapeutic potential of Calamus erectus and other Arecaceae species.

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