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Review Article

Acacia from a Breeding and Biotechnological Perspective: A Review

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Abstract

Members of genus Acacia comprises of trees used as fuelwood, timber and fodder. Moreover, some parts of plants are also used for their therapeutic properties. The development and applications of breeding and biotechnological tools are advancing at a significantly fast rate. Molecular markers and genomics offer vital information with regard to the inherited variation. The aim of this study to complied and discussed the developments in molecular maker technology, genomics and genetic engineering concerning genus Acacia. Overall, this information will be useful to gain awareness about the crucial trees in the genus Acacia from breeding and a biotechnological perspective.

Key words: Acacia, breeding, biotechnology, genetic engineering, genomics, molecular markers, tree

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INTRODUCTION

Acacias are the trees of semi-arid and arid regions, whereas species like *A. nilotica* is usually restricted below 450 m elevation and also increases on a range of soils. Its seeds display dormancy and mature pods are broken off by dry winds[1]. Owing to its large seed size, seeds aren't dispersed by means of long-distance dispersal[2]. Regeneration may occur near the parent tree resulting in an excessive degree of inbreeding. The *A. catechu* is among the few species that grow very well in the degraded land[3]. It's a useful multi-purpose tree producing energy wood, little fodder and timber. Probably the most critical industrial goods from *A. catechu* are Cutch and Kathha[4]. Katha is primarily utilized for chewing with betel nut and 'pan', plus have pharmacological and medicinal use, whereas the bi-product cutch used in tanning[5]. The black seed products pass through the bird's digestive system intact and are dispersed to brand new spots. There the colony eats the healthy elaiosome and discards the seed unharmed. This kind of dispersal is called myrmecochory[6].

The wood is sturdy, heavy to hefty, slightly rough and straight. The wood doesn't have a characteristic taste or smell. Its suitability as being a timber for different functions expressed as proportions of identical qualities of teak in India. The wood is liable and refractory highly to end splitting and surface area cracking during seasoning. The sapwood of Acacia species isn't durable[7]. The heartwood is extremely durable having a calorific value of 4950 kcal per kg and is called as one of the most long-lasting Indian woods[8]. The timber is sturdy, mainly if the wood is dry and old after seasoning. The wood can be finished to an incredibly smooth exterior and also takes polish well. Since immemorial time, plants and flowers are utilized to be a resource to provide mankind with medicines getting a substantial therapeutic opportunity for treating health problems and also to fight many pathogenic infections[9]. The therapeutic property of medicinal plants is commonly used in various traditional systems of medication like Ayurvedic, Unani and Chinese[10]. This healing ability is due to the existence of different sessions of ingredients contained in medicinal plants[11].

Although, this species is a huge variable with 9 subspecies having been recognized with more or perhaps less distinctive morphological, geographical and ecological capabilities. Most of the subspecies are tetraploids. Knowledge of the genetic structure of each subspecies is simple for a suitable genetic improvement programme. Although it was established that the morphological differences between Acacia species common to India and Africa are small hinting that their separation is geologically reasonably recent. In the recent past, genetic and molecular engineering methods are extensively used in forest tree analysis for effective, reforestation and forest management programs[12]. These methods would significantly help with developing elite and superior clones of Acacia species in the long-term future during a big scale. In this review article, an attempt was made to represent the breeding and biotechnological progress and prospects, on the *Acacia* spp.

Acacia origin and phylogeny: In recent years plant domestication studies continues to be assisted by molecular markers. In this direction, the variation detected by molecular markers (allozymes as well as DNA markers) has determined to devise better strategies for domestication cases as well as for deciding significant populations for conservation. Accordingly, seed options from this particular area would be the aim of breeding programs and are prevalent in plantations. A genetic linkage map has been built for *A. mangium* to find genes related to quantitative traits that may be utilized for marker-assisted selection[13].

Importance and Significance Acacia is a significant genus of trees and shrubs in the subfamily Mimosoideae of family Fabaceae[14]. A variety of species are bared to different areas of the planet and also 2 million hectares of industrial plantations are established. Acacia differs significantly in the pattern, from subshrubs to canopy forests. In Australia, aboriginal Australians harvested the developing seeds for making flour and consumed as a paste and baked directly into a cake. Together with utilizing the edible seed (as it is rich in proteins) as well as gum, the timber is used for making wooden equipment, weapons, fuel as well as musical instruments. Species, especially, *A. nilotica* and *A. catechu* are considered economically essential and therefore, broadly planted around the world for Timber wood, tannin, logs and fodder. Acacia gum is utilized as an emulsifier in the food industry. The genus Acacia includes 1450 species with species in Africa, the Americas, Asia and Australia[15,16]. Acacia comprises probably the largest genus of crops in the Australia continent[17]. No species currently happen in New Zealand, though fossil research indicates that the genus used to prevail there. Therefore, it's not surprising that a team of plants seen from such first times has such much and complicated systematic history. The name Acacia happens to be utilized since the Linnaeus used in the 14th century and also recognized as a Genus since 1747[18]. Molecular analyses have significantly improved the phylogeny of Acacia.

The genus Acacia is positioned in the legume subfamily Mimosoideae, in tribe Acacieae[18]. Some recent morphological and molecular datasets have backed the monophyly of the

Mimosoideae, actinomorphic flowers with valvate petals characterize that. The distinction between taxa in the Mimosoideae and Caesalpinioideae is not adequately defined and also further phylogenetic examination is necessary to describe this particular boundary; they are particularly different in wood anatomy[19,20]. Mimosoideae is composed of five tribes: Parkieae, Mimoseae, Mimozygantheae, Acacieae and Ingeae[21]. In reality, no individual morphological character distinguishes Acacieae from various other tribes in subfamily Mimosoideae, which has called into doubt the monophyly of Acacieae as well as the different other tribes in the Mimosoideae.

Species of Acacia are shrubs; or trees a few American and African species, nonetheless, possess a scandent practice. Many have free staminal filaments, although many American and African species have filaments that happen to be shortly united at the starting. In the past decade, it started to be apparent that any effort to solve the associations of Acacia must include members of additional Mimosoideae tribes, particularly the Ingeae. Much more recently, with a higher sampling of diversity in the tribes Ingeae and Mimoseae and Acacieae and the use of several chloroplast DNA areas, greater Congruence was discovered. The tribe Ingeae and members of subgenus. In the recent past and several analyses, likely, the technique of examining the phylogeny of smaller organizations of taxa will incrementally enhance understanding. The relative informativeness of molecular markers just limits this method of various taxonomic levels. Several conclusions on relationships within Acacia could now be made, though it's currently premature to undertake proper taxonomic changes[19].

The genus Acacia might be contained in the landscaping. The pollen grains are quite heavy and most likely not capable of long-distance travel, as well as also anywhere they take over the vegetation, their pollen is tremendously underrepresented. Molecular systematics belongs to a monumental change in both philosophy and ways of plant classification since it fundamentally challenges the bodily experiences and observations which most popular or maybe folk methods and also conventional botanical methods, have depended on and used. Taxonomic rules and practices for naming plants might state they be based upon systematic objectivity and run above the subjectivity of regional and local traditions. Still, they can't stay away from the sentiments of their very own practicing members. Taxonomists, it appears, are equally emotional as non-scientists with regards to naming plants. Overall, the acacia name controversy along with other prospective naming crises emerging from molecular systematics may just be solved by recognizing and also including the interpersonal histories of connection in place names in tasks of botanical nomenclature.

Molecular markers and its prospects for Acacia: Molecular markers are used to learn the levels, structure and origin of genetic variation within and also among species in both naturally regenerated and planted forests[22]. Molecular marker scientific studies suggested that healthy populations of most tropical tree species contain higher degrees of variation than many other plant lives[23]. However, the amount of genetic diversity in exotic forest species remains in forest inventories through comprehensive cataloging will require good linkages process guidebook on molecular marker solutions[24,25]. Genetic deviation info offers essential insights for decision making in forest genetic resources conservation[26]. Molecular markers were utilized to recognize all those teak populations which really should be given the most severe concern for in situ conservation and also build seed zones to shield today's genetic information of teak in Myanmar[27]. Accurate taxonomic identification combined with the capacity to discriminate hybrids from pure species. Molecular markers or microsatellite markers are utilized to help resolve the phylogenetic relationship of tree species that are hard to characterize according to the morphological attributes alone[28].

Genomics and its prospects for Acacia: While biotechnology established the tools needed to change genes, genomics provided a brand-new platform for the high-throughput genetic analysis of forest trees. Genomics was created on two technologies: genetic mapping and DNA sequencing. The genetic mapping provided the location of genes, allowing the association of the place to function[29]. Sequencing technologies are active in tree science for quite a while now and the first tree sequenced was *Populus trichocarpa* (black cottonwood tree[30]. After that, it was followed by several other important tree species. The application of genomics for trees is mainly focused on the improvement at the genetic level of the short duration forest trees and management of the existing wealth of resources of the trees in the forests. The genetic improvement produces the trees varieties with improved quality of timber and other essential forest product. At the same time, the management activities based on population structure changes over time as a result of human actions or climate change.

Genomic tools have proved their worth by providing detailed information regarding the complex traits that were difficult to predict otherwise[31]. Most of the trees are undomesticated and therefore exist as a natural population in their respective ecosystem and represent a wealth of genetic diversity this diversity is quite useful for breeding trees for various vital traits of interest[31,32]. The genome sizes of trees have a considerable variation with the genome size of some conifers being the largest of any life farm on the planet. The coding and non-coding regions of the genome are quite crucial for the expression of a particular phenotype by the forest trees. RNA-seq has been an important alternative in the tree genomics, where genome sequencing is restricted due to the cost and genome size[32,33].

With the availability of microfossil of pollen deposit of trees and their wild relatives, it has become evitable to track the changes in population structure with the help of genomic tools. The genomic databases of tree species play a crucial role as the amount of data generated via various NGS platforms is increasing daily. A steep increase was determined in the amount of the data stored in the databases like Dendrome. The specialized databases relating the genomic and phenotypic diversity are vital for the improvement of the tree species. In this post-genomic era, computational biology is a way to analyze structure, function, evolution of genes and genomes. High throughput technology characterizes genome structures, gene expression, metabolite abundances, lncRNAs, circular RNAs genome mapping, protein among the environmental conditions and developmental stages[34]. The study of gene expression, metabolite (transcriptomics and metabolomics), complex biological systems (metagenomics and epi-genomics), genomic structure and function (Functional genomics), protein structure and function (proteomics) are considered to understand tree growth and development. Advance high throughput technologies are capable of exploring plasticity, molecular variation among and within the species. The genome sequencing of model tree *Populus trichocarpa* (blackwood) enlightened the new path of genomics in forest trees. The genome sequence revealed the evolutionary aspects, relationship of phenotypic changes with the environment.

Genetic engineering and its prospects for Acacia: In recent years, genetic engineering at investigation quantity has been effectively applied to an increasing, but still limited, the number of placed forest trees to transfer an increasingly broad spectrum of traits, which includes biopolymer and biochemical manufacturing; wood quality; biofuel production and development[35]. Insect-resistant poplars planted in China are still the only transgenic forestry forests sanctioned for commercial use[36]. The recent developments of innovative molecular breeding technologies discovered an application for enhancing crop and show considerable promise in forest biotechnology[37]. Genetic engineering precise gene integration and other genetic manipulations useful to grow trait variation[38]. Discovery and improvement of economically relevant traits, including development, yield, product quality, pathogen resistance and herbicide tolerance. Cisgenics that enables the generation of new plant varieties without insertion of international DNA into the multitude genome has also achieved some momentum like the demonstration in poplar, *Populus* spp.[39,40].

Many developing countries presently have biosafety regulations for farming crops, including fruit trees, even though many others lack the capacity and such frameworks to apply them[41]. The GM trees employed for forest plantations pose minimal risk for human health and food security[42]. Risk analysis is created more complex by the lengthy rotation time frame of forest forests and also from the scarce information of tree physiology and family genes[43]. The fact complicates decision-making that forests are often viewed as all-natural systems, crucial not only for the processing of a range of products but also for the provision of services, which includes the preservation of biodiversity and for social and cultural values[44]. The utilization of GM forest forests is, therefore, more a socio-political and environmental issue than as a technical or perhaps trade issue[45].

CONCLUSION

Overall, it can be concluded that biotechnology and its applications in Acacia characterization and conservation, Acacia breeding, mass propagation and its biomass utilization are growing extremely fast. However, forest trees plant species have received much less attention than crop plants and domestic animals. The application and development of biotechnology are progressing at a significantly lower speed in developing countries and in the tropics as compared to the industrialized places and temperate areas. Furthermore, molecular markers and genomics provide information that is important on inherited variation within and between forest management strategies.

SIGNIFICANCE STATEMENT

This work will help the researchers to uncover the critical areas of breeding and biotechnology for the Acacia. Biotechnology offers vital insights into the Acacia. Further, developments in the breeding methods and the biotechnological tools can be successfully employed for the improvement of Acacia.

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