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Properties of potential wood carving species in Kenya

Abstract

This study compared the wood properties of five species as potential wood carving materials with those of five commonly used species. Five small logs each of potential and conventional wood carving species were randomly selected and cut into billets measuring 1.3m in length. Five smooth clear wood specimens of 20×20×100mm and 20×20×20mm for each of hardness and density determination respectively were obtained for each species and tested following procedures of BS 393: 1957. Wood working characteristics and other parameters desired in wood carving were determined using larger pieces derived from the five logs. Analysis of variance (ANOVA) was used to determine the effect of species on density and hardness. *Dalbergia melanoxylon* had the highest density and harness while Branchystegia spicioformis had the lowest density and *Afzelia quanzensis* the lowest hardness. Density and hardness were not significantly different between conventional and potential woodcarving species. Hardness for Terminalia prunoides and *Manilkara sansibarica* was not significantly different from that of conventional species such as *Dalbergia melanoxylon* and *Bracyhlaena huillensis*. A positive correlation between the species hardness and their densities was established (r=0.774). The planing, cutting and finishing characteristics of all the species was dependent on the density. However, some of the potential species had colour that is a contrast to that of conventional species. Since the five potential species do possess most of the characteristics desired in wood carving species and also a number of them have short rotation cycle, they can be considered as alternative raw materials for carving.

Keywords: wood carving, wood working properties

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Introduction

History of wood carving

Kenya is endowed with a rich plant genetic resource base that is a source of food, fuel, medicine, household implements and other products such as carvings. The wood carving industry was borne out of the carving traditions of the Makonde of Tanzania and Mozambique and become established in Kenya in the early 1920's (Elkan, 1958). It serves as significant source of income for many people with an estimated 50, 000 wood carvers in Kenya, working either independently or in cooperatives.[1] However the raw materials that form the foundation of the industry are being depleted fast. Kenyans who derive livelihood from woodcarvings are faced with reduced earning.

Overexploitation of selected tree species is leading to the widespread depletion of natural resources and increased cost of raw materials. In some cases, over harvesting has led to local extinction of valuable species.[1] Examples of tree species most valued by wood carvers are *Dalbergia melanoxylon* (mpingo) and *Brachylaena hullensis* (muhuhu) hence, are the most threatened by overexploitation. Wood carving is associated with certain cultural values among tribes of Kenya. For example, wood sculpture was not part of the Kamba culture[2] being a fairly recent development has been disrupted by many researchers and critics.[1] Although Stout contends that woodcarving was introduced after the World War I from Tanzania.[3,4]

Wood carving among the Kamba predated colonialism a time when wood for carving was in ample supply. Wood previously obtained close to wood carvers homes is now scarce and carvers must sometimes purchase their wood supplies from areas far removed from the carving centers, as is in the case of Wamunyu, Mombasa and Malindi.[1] There has been a remarkable decline in the amount of natural forest in Kenya and hence a decreased supply of wood for carving. This is partly due to the demand for certain species and competition for other uses including fuelwood, fencing post and posts, furniture and construction. Lack of a clear management strategy for timber resources further compounds the problems.[5] Though the harvest of dead and fallen timber in gazzetted forests is authorized with a permit, little attention has been given to specific management for value addition.[5]

Wood carving materials

Several species are preferred and subsequently are in great demand including Brachylaena huillensis (muhuhu), *Dalbergia melanoxylon* (mpingo), Combretum schumanii (Mkongolo), Cordia sinensis and Olea africana (African olive).[6] Brachylaena huillensis is the most important commercial tree species. The tree belongs to the family composition (astercea) and is the only dioecious wood species.[7,8]

The other species at the coast under trial are Azadrachta indica (mkilifi), Terminalia prunoides (mutoo), Afzelia quazensis (Mbambakofi), Brachystegia spiciformis (mrithi) and Manilkara sansibarika (mgambo). Kigomo[5] in his study on rates of Brachylaena huillensis in Ngong, Olowa and Karura forests estimated that without intensive management inputs, the rotation period for the species is very slow under natural condition with individual trees reaching merchantable diameter sizes of 40cm and 45cm dbh after 100 and 130 years respectively. From the foregoing, it is clear that at the current demand rate the supply of Brachylaena huillensis in all the 3 forests is not sustainable. In Malindi and Ukunda a good number of carvers were observed using *Afzelia quanzensis* (mbambakofi), Brachystegia

spiciformis and Erithylthrina abyssinica(mwambangoma).[1] *Afzelia quanzensis* is widely in the famous Lamu and Zanzibar carved doors as well as other Swahili furniture. Brachystegia spicifrmis is recognized by the carvers as one of the hardest and very durable and gives some of the best carvings with good finishing.[1] Erinthrinica abyssinica is an arid and semi arid species[5] among the species used for manufacturing of the early culture items of the Akamba,[2] and extensively used along the coast.[1] *Manilkara sansibarica* (mgambo) is also another species that is used along the coast especially Malindi.

The most popular species is *Dalbergia melanoxylon* marketed under the trade name ebony. It combines attributes of hardness, durability, resistance to insects, workability and density hence its products command the highest premium prices than products from the rest of the species.[1] The tree species valued for wood carving thus should have characteristic properties including closed grain, not easy to split or crack, vary in colour from being rather bright to dark brown or black, have resistance to insect attack and be durable. Because of the high value attached to its products, mpingo is the most overexploited among all the preferred species for wood carving and remains the most threatened. For instance, mpingo is remaining in a few stands at the coast province on individual farmers' plots and the government reserves such as Arabuko-sokoke. Other popular species are Olea africana and Combretum schumanii both marketed as teak and ebony with Olea africana being the main species used in Makindu Cooperative Society.[9] Other species indicated in table 1 are currently under trial and have been fully adopted including Azadirachta indica (Mkilifi).

Table 1 Analysis of variance (ANOVA) for species density and hardness

Source of variation	Degrees of freedom	Sum of squares	Mean SS	Fcalculated	Fcritical
Density					
Species	9	0.0248	0.0276	0.021	2.12
Error	40	5.2472	0.0131		
Total	49	5.272			
Hardness					
Species	9	14.64573	1.6273	0.083365	2.12
Error	40	780.80419	19.5201		
Total	49	795.44992			

Problem statement and justification

The problem of impending crisis caused by scarcity has long been realized by the carvers who have in turn began experimenting with alternative species with similar characteristics. In recent past carvers have successfully adopted Azadrachta indica (neem) as an alternative to B. huillensis and is being marketed under the name mahogany.[1] Besides the desirable physical properties of wood, it is relatively abundant along the coast and has a shorter rotation period of 15 to 20.[5] While the wood carving Industry is an important sector of Kenyan economy, its dynamics have not been extensively studied. In response to the growing problems facing its survival and that of the resource especially the most valued species there is need for specific management[1] to address not only the conservation issues associated with the wood carving industry but also the needs of the families who rely on revenue from wood carving. Due to the fact that there only a few stands still available of the most preferred species for wood carving, then there is need for the introduction of new species into the industry which possesses the desired characteristics. There are a few species among these, which possess the desired characteristics and abundantly found including Terminalia prunoides, Azandrachta indica, Brachystegia speciformis, Azelia quanzensis and Manilkara sansibrensis. Their properties were compared to those of five most commonly used species.

Objectives

The overall objectives of this study were to:-

i. determine the density, hardness, and working properties of the five wood carving species in Kenya.

ii. compare the properties of the five most popular wood carving species to those of five potential alternative species.

Materials and methods

Specimen preparation

The various wood species were obtained from Kitui district and Malindi. In order to determine their suitability for wood carving a preliminary test was carried out using forty species of varying properties and characteristics. Some were very fibrous, coarse, porous and light and light in weight hence, unsuitable while others were of high density, hardness and good texture, characteristics, which make them desirable for carving. The preliminary test narrowed the number to ten potential species for the study. Five of these are the commonly used species while the other five are the alternative species. The samples collected were small logs measuring 1.3m in length, and in varying diameters. These were sawn into smaller pieces from which five dressed clear wood specimens measuring 20×20×100mm were obtained for each species for a total of fifty. After the preparation of specimens, they were labeled as illustrated below;

DM/K/C1. . . DM/K/C5

where; the first two letters stand for initials of species name e.g. DM – *Dalbergia melanoxylon* the third place of origin e.g. K, for Kitui and the last group of species e.g. C for conventional and the numeral the specimen number.

Experimental design

The experimental design used in this study is complete random design (CRD), in which only one factor is under analysis in each experiment. The following statistical model was employed;

$Yij=\mu ij + tij + eij$

Yij=response value (hardness)

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μij=mean hardness for species

tij=species density

eij=error

i=No. of species groups (i=1,2)

j=No. of species in each group (j=1,2, …, 5)

Testing

Hardness testing

Hardness was determined by using the Janka test while density was determined by using the nominal weight and computed volume of the specimen. Wood working properties such as moulding, planning, sanding and finishing characteristics were determined. The radial and tangential faces were determined by observing the direction of the growth rings and labeled R and T respectively. The Janka hardness test was carried out on each of these faces using a Universal strength testing machine according to BS 393. The average ultimate load for the two faces was recorded for each specimen.

Density determination

Small clear-wood 20×20×20mm specimens for each species dried in an electric drying kiln for three days to about 12% moisture content. After attaining a constant weight they were weighed and the respective dimensions measured using a vernier caliper (±0.01mm). Density was determined by computing the volume from the dimensions obtained and then dividing the weight by the specimen volume (g/cm3).

Data analysis

Mean comparisons and one-way ANOVA for the density and hardness of the two groups of species were performed at 5% level of significance. Regression analysis was carried out to determine specific relationships.

Results and discussion

Density and hardness

The analysis of densities and hardness between the commonly used the potential alternative species showed that they are not significantly different (Table 1). The means of hardness of the commonly used species and the alternative species as wood carving materials are not significantly different. The analysis of densities and hardness between the commonly used species as wood carving materials and the alternative species as potential wood carving materials showed that they are not significantly different. Figure 1 shows the trends in variation of density and hardness of common and alternative species. The general trend in the two curves points to a correlation between the two properties. There were extreme high values of hardness and density in Dalbergia melanoxylon, factors that contribute to the great demand and high premium for *Dalbergia melanoxylon* products.

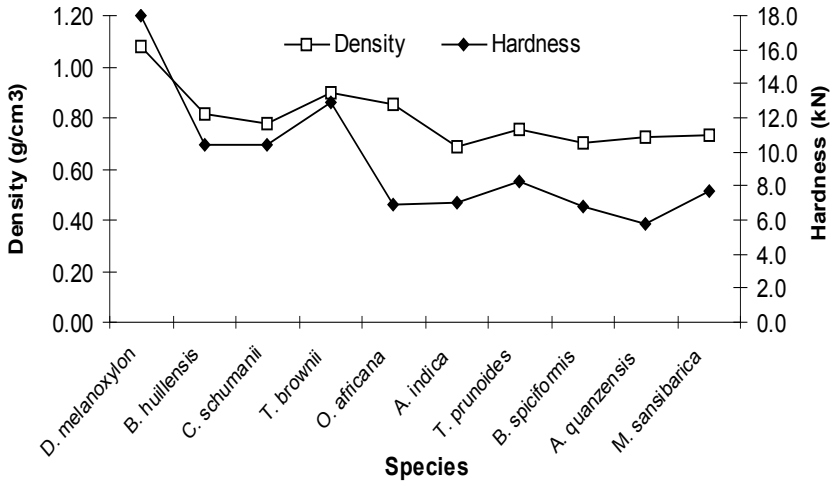

Figure 1 Relationship between density and hardness for wood carving specie.

Regression of densities and hardness yielded correlation coefficients (r2) of 0.774 for the alternative species and 0.827 for the conventional species. This shows there is a positive correlation between the species hardness and their densities. The values of R are also very close to each other hence the alternative species are very close substitutes of the commonly used species as wood carving species.

Wood working properties

The criteria for preference are based on multiple attributes such as colour variation from bright to dark brown or black, closed grain, resistance to splitting or checking, durability, resistance to insect attack and weathering. The characteristic for the potential wood carving species are shown in Table 2. The grains of *Dalbergia melanoxylon* tend to be parallel and straight to the planning surface, the wood tend to be less porous and compact. It was observed that as these two properties increase, wood working properties also improve. For example, *Dalbergia melanoxylon* is easy to cut, plane, mould, chisel and finish giving a very smooth surface which utilize less finishing materials. When such species are stained or polished, a nice finishing is obtained. However, as density increases, the speed of machining reduces thus requiring very sharp tools for cutting. Terminalia prunoides (Mutoo) is also another species used by the Kamba in Eastern province, especially in Wamuyu. It grows fast hence it can be the best alternative to the extensively used Mpingo (Dalbergia melanoxylon) and Muhuhu (Brachylaena huillensis) which are under threat in Eastern and Nairobi provinces.

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Table 2 Alternative species and their characteristics

Species	Characteristics	Sources	Status / remarks
Azadrachta indica	Durable, resistant to insects, easy to work, beautiful finish, heavy, grows fast, good colour when stained.	Kilifi, Mombasa, Kwale.	Abundant supply, for large carvings
Terminalia prunoides	Easy to work, durable when treated, grows very fast, light brown in colour.	Kitui	Abundant supply, appropriate for large carvings
Afzelia quanzensis	Resistant to insects, hard, heavy, good finish.	Kilifi, Mombasa, Kwale	Along the Coast
Branchylaena spicioformis	Durable very hard.	Common as above	Along the Coast
Manilkara sansibarica	Durable very hard.	Common as above	Along the Coast

One drawback has been observed with the high values of hardness of *Dalbergia melanoxylon* is that when wood dries off, it tends to be extremely hard to carve. High density and hardness values and its dark colour makes it be an exception as there is no close substitute for it though it is under threat of extinction. Another drawback also seen in the alternative species is that they are light coloured hence need to be stained to reflect the colour of the commonly used species and to add value. Some of these species are also prone to attack by insects hence have to be chemically treated. *Afzelia quanzensis* was widely recognized for its hardness and its durability against degraders. Brachystegia spiciformis and *Manilkara sansibarica* are among the hardest and difficult to work with. However, they gave good finish and are also very durable. Erithrynna abyssinica was relatively soft and easy to work with and produced a good finish, is durable and hard, factors that account for its highly priced products. Terminalia prunoides (mutoo) was easy to work with and is recognized as being durable and fast growing hence it can be the best alternative to the extensively used D. melanoxylon and Brachylaena huillensis. The rationale for selecting the above species as alternatives is that they are believed to possess the desired hardness, density, colour and workability and are in abundance within the same areas. It is therefore necessary to quantify their physical and strength properties in relation to carving.[10–12]

Conclusion

This study showed that there are no significant differences between the densities and hardness of potential and conventional wood carving species. The results further point to a strong positive correlation between density and hardness with *Dalbergia melanoxylon* having highest density and hardness. An improvement in wood working properties was noted at higher densities although this requires very sharp tools. None of the species has colour attributes close to those of *Dalbergia melanoxylon* since the alternative species are light coloured hence need to be stained to reflect the colour of the commonly high value species which are in the market. Some of these species are also prone to attack by insects hence have to be treated. These are factors that have to be tackled in order for them to qualify as substitutes. Research on the growth characteristics will also enable fast establishment of plantations which will act as a source of wood carving material as the wood carving industry is currently faced with inadequate resource in Kenya. Thus from the above fact, there is a great need for investigations and research to be carried out to find a species which has a close attributes to those of mpingo in order to be its substitute for conservation purpose.

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None.

Conflicts of interest

Author declares that there is no conflicts of interest.

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