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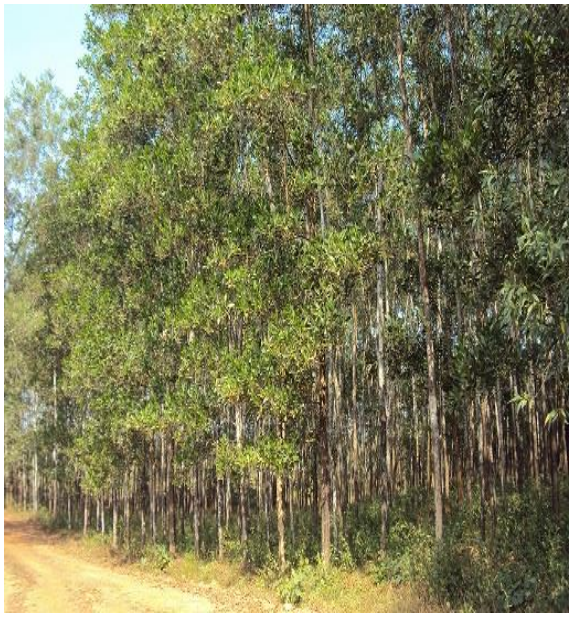
Study on The Utilization Potential of *Acacia mangium* and *Acacia auriculiformis* Based on Physical properties of wood



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သစ်ရူပဆိုင်ရာဂုဏ်သတ္တိများအပေါ်အခြေခံ၍ *Acacia mangium* Willd. နှင့် *Acacia auriculiformis* Cunn ex Benth.တို့၏ အသုံးချနိုင်မှုအလားအလာအား စူးစမ်းလေ့လာခြင်း

ဝင်းဦးနိုင်
လက်ထောက်သုတေသနအရာရှိ

စာတမ်းအကျဉ်း

ကြီးမြန်သစ်မျိုးစာရင်းဝင် အကေးရှားမန်ဂျီယမ်သစ်မျိုးနှင့် အကေးရှားအော်ရီသစ် မျိုးတို့၏ အသုံးချနိုင်မှုအလားအလာကို ယင်းတို့၏ သစ်ရူပဆိုင်ရာဂုဏ်သတ္တိများအပေါ် အခြေခံ၍ လေ့လာဆန်းစစ်နိုင်ရန် လိုအပ်သောသစ်နမူနာများအား မော်ဘီကြိုးဝိုင်း၊ မော်ဘီမြို့နယ်၊ ရန်ကုန်တိုင်းဒေသကြီးမှ သစ်မျိုးတစ်မျိုးလျှင် နှစ်ပင်စီရယူခဲ့ပါသည်။ စမ်းသပ်မှုလုပ်ငန်းစဉ် အားလုံးအား အမေရိကန် စံသတ်မှတ်ချက်များနှင့်အညီ *(ASTM D143-94)* ဆောင်ရွက်ခဲ့ပါသည်။ အကေးရှားမန်ဂျီယမ်သစ်မျိုးသည် လေးသောသစ်မျိုးဖြစ်ပြီး အသေးစား ဆောက်လုပ်ရေးလုပ်ငန်းနှင့် ပရိဘောဂများထုတ်လုပ်ရန်အတွက် သင့်လျော်ပါသည်။ အကေးရှား အော်ရီသစ်မျိုးသည် လေးသောသစ်မျိုးဖြစ်ပြီး သစ်ဆွဲလဲသစ်မျိုးနှင့်နီးစပ်ကာ အလယ်အလတ် တည်ဆောက်ရေးလုပ်ငန်းများတွင် အသုံးပြုသင့်ပြီး အဆောက်အအုံများ၏ ယက်မနှင့် တိုင်တို့အတွက် ပို၍သင့်လျော်ပါသည်။ သုတေသနရလဒ်များအရ အကေးရှား အော်ရီသစ်မျိုး၏ ရေချိန် သိပ်သည်းဆသည် အကေးရှားမန်ဂျီယမ်သစ်မျိုး၏ ရေချိန်သိပ်သည်းဆထက် ပိုမိုကြောင်း တွေ့ရှိရပါသည်။

Study on The Utilization Potential of *Acacia mangium* Willd. and *Acacia auriculiformis* Cunn ex Benth. Based on Physical properties of wood

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Abstract

An assessment of the utilization potential of fast-growing species, as a *Acacia mangium* and *Acacia auriculiformis* based on physical properties in Myanmar. Two healthy trees of each species were sampled from community forestry plantation of Hmaw-bi Reserved Forest of Hmaw-bi township, Yangon region. The test were carried out in accordance with American Society for Testing Material- ASTM D143-94. *Acacia mangium* is heavy wood species with a specific gravity of 0.552. Thus, it is suitable for light construction and furniture making. Similarly, *Acacia auriculiformis* is heavy wood species, similar to Thitswele(basic specific gravity 0.710). Its specific gravity is somewhat higher than those of *Acacia mangium*. Therefore, it should be used in medium construction and more suitable for beams and posts in building. According to the research results, *Acacia auriculiformis* is higher than that of *Acacia mangium*.

Key Word: Plantation species, *Acacia mangium*, *Acacia auriculiformis*, Physical properties

Study on The Utilization Potential of *Acacia mangium* Willd. and *Acacia auriculiformis* Cunn ex Benth. Based on Physical properties of wood

1. Introduction

In Myanmar, Timber demand is still on the increase, especially for housing constructions and indoor furniture. Due to scarcity and high prices of timber, most of the rural people of Myanmar build their house with available materials like bamboos, palms, etc, which need repairs quite often. Thus, sufficient supply of timber required for housing and other value-added products at a reasonable price is essential to enhance their living standard. And also as in many other tropical countries, plantations of fast-growing species have become a necessity.

Nowadays, extensive private plantations have been established in Myanmar to provide timber and fiber for the pulp and paper industry. In those plantations, *Acacia mangiun* and *Acacia auriculiformis* species plantation were included. Actually those species were occurs naturally in Australia, Papua New Guinea and Indonesia. But in Myanmar, no recorded of the seed origin and also when they introduced to Myanmar.

However, those species were planted around house and road side for shade, shelter and amenity in Myanmar early 1980. And then, Forest Research Institute-FRI were established the research plantation with *Acacia mangium*, *Acacia crassicarpa* and *Acacia aulacocarpa* for seedling seed orchard and seed production area at Tarpa-thon nursery of Mu-don township, Mon state in 1998(Dr.Nyi Nyi Kyaw's report 2003).

In past time, *Acacia auriculiformis* and *Acacia mangium* are not widely used for construction due to its crooked stem and short clear bole. However, good form trees of these species with a long, straight clear bole and light crown were found in some plantation of Myanmar especially can be found in Yangon, Bago, Ayeyarwady Region and Mon State. And also widely planted in neighboring countries, not only pulp and paper making and but also sawn timbers for medium construction. Therefore, urgently need to know the wood properties of those species before used and future plan.

Moreover, yet the properties of those species have never been investigated before. Thus, with the intention of exploring a better and efficient use of those timber species, physical properties were investigated. Later on if situations are favorable its drying behavior and other properties would be tested for better understanding of their uses.

The objectives of this study were:

(1) To investigate the physical properties of *Acacia mangium* and *Acacia auriculiformis*
(2) To compare the investigated properties of those species with some Myanmar timber species.
(3) To compare the physical properties of *Acacia mangium* and *Acacia auriculiformis* of Myanmar and some other country and
(4) To afford reliable data for wood entrepreneurs, interest group, scholars, researchers, engineers and

2. Literature Review

Acacia mangium and *Acacia auriculiformis* are leguminous tree species in the family Leguminous, sub-family Mimosoideae. The genus Acacia includes more than 1,000 species of tree and shrub which occur in Africa, the Americas, Asia and Australia, with the majority of species

found in Australia (Anon. 1982). Those species are native to Australia, Papua New Guinea, and Indonesia. The assessment of the timber quality may involve the consideration of a large number of anatomical, physical and mechanical properties of wood. Nevertheless, certain features are good general indicators of timber properties and uses (Mohd Hamami Sahri, Zaidon Ashaari, Razali Abdul Kaderi and Abdul Latif Mohmod2, 1998).

Its relatively good tolerance of very poor soil, rapid growth, resistance to disease, high biomass production and good wood properties make it attractive for use in plantation(Md Qumruzzaman Chowdhury, Md Iftekhar Shams and Mahbubul Alam, 2004). Thus, these species have been chosen as plantation species in some countries.

The density of *Acacia mangium* varies depending on the origin of the wood. It ranges from 420-483 kg/ m^3 based on green soaked volume; in dry condition it varies between 500-600 kg/ m^3 (Logan and Balodis 1982; Peh et all. 1982; Peh and Khoo 1984; Wang et al. 1989; Razali and Kuo 1991). National Research Council-NRC(1983) reported that *Acacia magium* wood has a specific gravity of 0.56 and the plantation-grown timber recorded slightly lower values(0.40 – 0.45). Basic specific gravity of *Acacia mangium* wood from the natural stands is normally about 0.6. However Sining(1988) reported a slightly higher specific gravity range from the plantation: 0.43-0.47 for 6 year-old *A.mangium* grown in Sabah, Malaysia.

Keating and Bolza(1982) noted that *Acacia auriculifromis* from Indonesia recorded higher mean values for most strength properties than *Acacia mangium,* which falls under the light hardwood classification with low to moderate strength properties. Peh et. al. (1982) reported that pulping of timber from a 9-year-old plantation is easy given high yield and good strength properties. Pulping with bark was readily done by a neutral sulphite semi- chemical process and the pulp exhibited very good paper-making properties (Logan and Balodis 1982).

Thus *Acacia mangium* and *Acacia auriculiformis* are necessary to investigate basic wood properties for exploration of end- uses of wood species. These properties comprise anatomy, durability, treatability, seasoning behaviors, physical and mechanical properties and workability. All these properties are important for efficient utilization of timber species.

In wood utilization, basic information on various aspects of wood is inevitably important for efficient utilization of log (Salang et. al., 1996). Shrinkage and swellings can result in warping, checking, splitting, and loosening tool handles, gaps in strip flooring, or performance problems that can detract from the usefulness of the wood products (USDA, 1999). Therefore, these phenomena must be understood and considered when they can affect a product in which wood is used. Density and specific gravity are the indicative of mechanical properties of the same wood. They can be assessed with simple equipment in a short time.

Wood properties are very considerably between and within species. Even pieces of same tree show variation. Variability or variation in properties is common to all material (USDA 1999). The variation of density and moisture content should affect the quality of sawn timber, seasoning of timber, seasoning of timber, preservation processes, working properties, mechanical properties and final products quality (Salang et. Al.,1996).Thus, the number of trees should be enough to cover the variability of properties between trees and the number specimens should take enough from each tree.

3. Materials and Methods

3.1 Materials

Two trees of 9-year old *Acacia mangium* and *Acacia auriculiformis* were collected from community forestry plantation of Hmawbi Reserve Forest in Hmawbi Township, Yangon region. The trees were authenticated from herbarium material. The collection was done based on criteria

such as bole straightness, absence of excessive defects and good cylindrical form. Their basic measurements data are shown in table 1.

Table 1. Girth at breast height, clear bole length and whole length of each species

Local Name	Scientific Name	GBH (cm)	Clear bole length (m)	Whole length (m)
Mangium-sha	*Acacia mangium* (Tree No.1)	63	7.3	18.3
	(Tree No.2)	51	6.1	17.1
Auri-sha	*Acacia auriculiformis* (Tree No.1)	66	4.0	16.8
	(Tree No.2)	79	4.3	19.8

3.2 Methods

Sample trees were tested for specific gravity, density, shrinkage and moisture content percent. Physical properties were investigated following American Society for Testing Material- ASTM D143-94.

Figure 1. Photo showing wood sample preparation

Figure 2. Photo showing wood samples

Figure 3. Photo showing measurement of dimensions of wood sample

3.2.1 Physical properties

Four disks, each about 80 mm thick were cut from the base of each log. They were used for preparation of specimens for testing physical properties such as radial, tangential, longitudinal and volumetric shrinkage, density and specific gravity. The sizes of specimens for this research were shown in Table 2.

Table 2. Number and size of specimens for physical tests

Sr. No	Tests	Size of specimen (mm^3)	No. of specimens
1	Radial shrinkage	25 x 25 x 50	15
2	Tangential shrinkage	25 x 25 x 50	15
3	Longitudinal shrinkage	25 x 25 x 100	15
4	Volumetric shrinkage, Density, Specific gravity	25 x 25 x 100	15

3.2.2 Testing procedures

After preparation of specimens for testing physical properties, they were sanded and cleaned to remove the loose material so that they could not affect the moisture content. They were weighed

and measured for determination of shrinkage and moisture while green and the data were recorded. Then they were air-dried. When the specimens had attained constant weights and measurements under air-drying, the data was recorded. They were then oven-dried at a temperature of 103±2°C. On attaining constant weights, they were measured and data recorded again. For determination of specific gravity, the volume was determined by water displacement method and measurements were read nearest to the thousandth of a millimeter (mm) and weighted to the thousandth of a gram (g). The moisture contents were determined by the oven-dry method.

4. Data analysis

In this research, the minimum, maximum, mean, standard deviation and coefficient of variation of physical properties were calculated by using Microsoft Excel 2010.

5. Results and Discussion

5.1 Physical Properties of *Acacia mangium*

The physical properties of *Acacia mangium* are presented in table 3.

Table 3. Physical properties of *Acacia mangium*

Property	Minimum	Maximum	Mean	SD	CV%
Green MC%	76.35	99.49	87.92	6.88	8
Basic specific gravity	0.520	0.584	0.552	0.015	3
Specific gravity 12%	0.560	0.643	0.601	0.022	4
Basic density(Kg/m^3)	520	584	552	14	2
Density 12%(Kg/m^3)	627	720	673	66	10
Oven-dry density(Kg/m^3)	571	651	611	56	9
Shrinkage (green to air dry):					
Radial (%)	1.45	1.53	1.49	0.06	4
Tangential (%)	3.38	3.68	3.53	0.21	6
Longitudinal (%)	0.089	0.290	0.189	0.14	7
Volumetric (%)	5.40	5.77	5.58	0.26	5
Shrinkage (green to oven-dry)					
Radial (%)	2.41	2.56	2.48	0.11	4
Tangential (%)	5.64	6.13	5.88	0.35	6
Longitudinal (%)	0.149	0.480	0.314	0.23	7
Volumetric (%)	9.00	10.21	9.60	0.85	9

The mean moisture content of *Acacia mangium* is 87.9%. The minimum and maximum moisture content are 76.3 % and 99.5%. The basic specific gravity of *Acacia mangium* range from 0.520 to 0.584 and the mean basic specific gravity is 0.552. It is higher than those of Sagawa (0.426), Taung-panne (0.435), Myaukngo (0.464), Yemane (0.469), Pyinma (0.529) and Kokko (0.538). It is comparable with the basic specific gravity of Laza (0.553) and Binga (0.554). However it is somewhat lower than Pyaukseik (0.580), Tawthayet (0.582), Thingadu (0.589), Zaungbale (0.597), Kyun (0.598), Hnaw (0.601) and Chinyok (0.601) (Table 4). The mean basic density and oven dry density are 552 kg/m^3 and 611 kg/m^3, respectively, while the mean density of *Acacia mangium* at 12% moisture content is 673 kg/m^3. The coefficient of variation can be high up to 10% ,(USDA, 1999).These values of *Acacia mangium* is found less than 10%. According to the Win Kyi (2006), *Acacia mangium* is heavy wood species.

Table 4. Comparison of Basic specific gravity of *Acacia mangium* and some Myanmar Timber Species

Local Name	Scientific Name	Basic Specific Gravity
Mangium-sha	*Acacia mangium*	**0.552**
Sagawa	*Michelia champaca* Linn.	**0.426**
Taung-peinne	*Artocarpus chaplasha* Roxb.	**0.435**
Myaukngo	*Duabanga grandiflora* (Roxb.)Walp.	**0.464**
Yemane	*Gmelina arborea* Roxb.	**0.469**
Pyinma	*Lagerstroemia speciosa* (L.) Pers.	**0.529**
Kokko	*Albizzia Lebbek* Benth.	**0.538**
Leza	*Lagerstroemia tomentosa* Presl.	**0.553**
Binga	*Mitragyna rotundifolia* (Roxb.) Ktze.	**0.554**
Pyaukseik	Holoptelea integrifolia Planch.	**0.580**
Tawthayet	*Mangifera caloneura* Kurz.	**0.582**
Thingadu	*Parashorea stellate* Kz.	**0.589**
Zaungbale	*Lagerstroemia villosa* Wall	**0.597**
Kyun	*Tectona grandis* L.f.	**0.598**
Hnaw	*Adina cordifolia*	**0.601**
Chinyok	*Garuga pinnata*	**0.601**

The mean of wood shrinkage from green to air-dry condition are 1.49% and 3.53% for the radial and tangential shrinkage, respectively. The corresponding values from green to oven dry are 2.48% and 5.88%. The values of coefficient of variation for radial and tangential shrinkage can be high up to 15% (USDA; 1989,1999).It is found that these values for both properties are much less than 15%.Its shrinkage is comparable with that of Taungthayet (2.7% and 5.9% from green to oven dry).

Like other wood species, the longitudinal shrinkage of *Acacia mangium* is very small. The mean longitudinal shrinkage from green to oven dry condition is only 0.314%. The different between the longitudinal and horizontal (radial and tangential) shrinkage is due to the alignment of wood cells (Anonymous 1992). As water is removed from the cell walls, the cells move closer together. Movement in the horizontal is greater than in the longitudinal direction.

5.1.1 Comparison of basic density of *Acacia mangium* (Myanmar) and *Acacia mangium* from some other countries

In general, basic density of 9-years old *Acacia mangium* from Myanmar is 552 kg/m^3. It is somewhat higher than 10-years old *Acacia mangium* (520 kg/m^3) of Bangaladesh and 7, 16 years old *Acacia mangium* (464 kg/m^3, 500 kg/m^3) from Malaysia. But somewhat lower than 15 and 20 years old *Acacia mangium*(560kg/m^3, 600kg/m^3) of Bangaladesh and 20 years old *Acacia mangium*(560 kg/m^3) of Malaysia as show in figure 4.

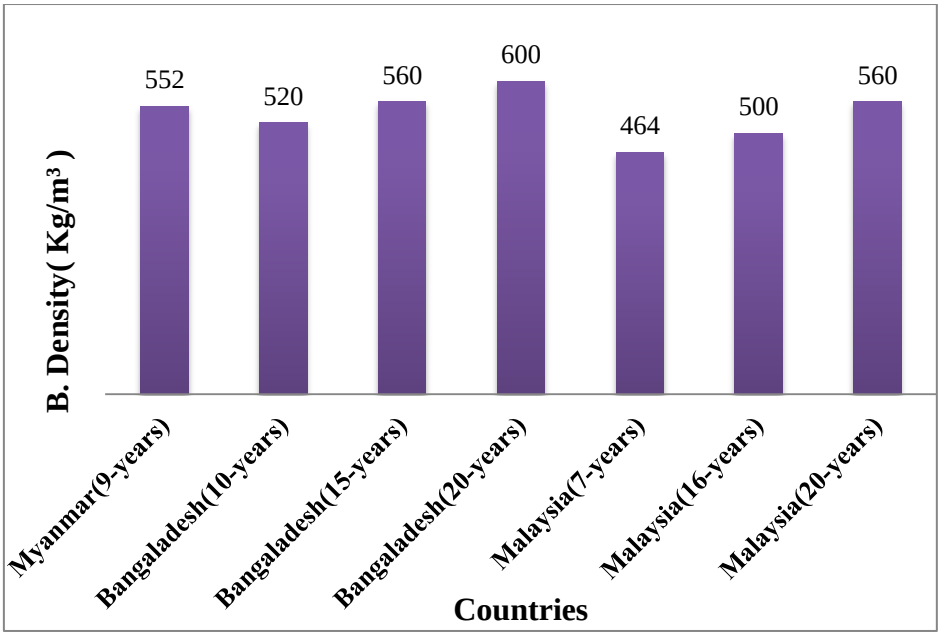

Figure 4. Comparison of basic density of *A. mangium* (Myanmar) and *Acacia mangium* from some other countries

5.2 Physical Properties of *Acacia auriculifromis*

The physical properties of *Acacia auriculifromis* are presented in table 5.

Table 5. Physical properties of *Acacia auriculifromis*

Property	Minimum	Maximum	Mean	Standard deviation	CV%
Green MC%	43.29	51.53	49.2	1.97	4
Basic specific gravity	0.638	0.744	0.710	0.026	4
Specific gravity 12%	0.710	0.843	0.800	0.033	4
Basic density(Kg/m^3)	638	744	710	26	4
Density 12%(Kg/m^3)	875	944	896	36	4
Oven-dry density(Kg/m^3)	751	805	767	27	3
Shrinkage (green to air dry):					
Radial (%)	0.93	1.34	1.08	0.144	13
Tangential (%)	2.74	3.43	3.04	0.203	7
Longitudinal (%)	0.166	0.285	0.22	0.032	14
Volumetric (%)	4.23	4.79	4.42	0.157	4
Shrinkage (green to oven-dry)					
Radial (%)	1.55	2.24	1.80	0.241	13
Tangential (%)	4.56	5.72	5.06	0.338	7
Longitudinal (%)	0.277	0.475	0.361	0.053	15
Volumetric (%)	7.05	7.99	7.37	0.263	4

The mean moisture content of *Acacia auriculiformis* is 49.2%. The minimum and maximum moisture content are 43.3% and 51.5%. The basic specific gravity of *Acacia auriculiformis* range from 0.638 to 0.744 and the mean basic specific is 0.710. The coefficient of variation can be high up to 10%, (USDA, 1999).These values of *Acacia auriculiformis* is found less than 10%. According to the Win Kyi (2006), *Acacia auriculiformis* is heavy wood species. It is higher than those of Kanyin-ni (0.655), Kyana (0.670), Nabe (0.672), Thabye (0.674), Thadi (0.697), but lower than those of Dwani (0.719), Sit (0.720), Petthan (0.726), In (0.726), Yon (0.739), Myaukchaw (0.755). It is quiet similar to Thitswele (0.710) and also comparable with the basic specific gravity of Kanyaung (0.706) and Thitsein (0.717) as shown in table (6).

The mean basic density and oven dry density are 710 kg/m^3 and 767 kg/m^3, respectively, while the mean density of *Acacia mangium* at 12% moisture content is 896 kg/m^3. The coefficient of variation can be high up to 10% ,(USDA, 1999).These values of *Acacia auriculiformis* is found less than 10%. According to the Win Kyi (2006), *Acacia auriculiformis* is heavy wood species.

Table 6. Comparison Basic specific gravity of *Acacia auriculifromis* and some Myanmar Timber Species

Local Name	Scientific Name	Basic Specific Gravity
Auri- sha	*Acacia auriculiformis*	**0.710**
Kanyin-ni	*Dipterocarpus turbinatus*	**0.655**
Kyana	*Xylocarpus moluccensis*	**0.670**
Nabe	*Lennea grandis*	**0.672**
Thabye	*Eugenia spp*	**0.674**
Thadi	*Protium serratum*	**0.697**
Yinzat	*Dalbergia fusca*	**0.704**
Kanyaung	*Shorea argentea*	**0.706**
Thitswele	*Schrebera swietenioides*	**0.710**
Thitsein	*Terminalia bellerica*	**0.717**
Dwani	*Kydia calycina*	**0.719**
Sit	*Albizzia procera*	**0.720**
Petthan	*Heplophrogma aderophyllum*	**0.726**
In	*Dipterocarpus tuberculatu*	**0.726**
Yon	*Anogeissus acuminate*	**0.739**
Myaukchaw	*Homalium tomentosa*	**0.755**

The mean of wood shrinkage from green to air-dry condition are 1.08% and 3.04% for the radial and tangential shrinkage, respectively. The corresponding values from green to oven dry are 1.80% and 5.06%. The values of coefficient of variation for radial and tangential shrinkage can be high up to 15% (USDA; 1989,1999).It is found that these values for both properties are much less than 15%.Its shrinkage is comparable with that of Taungpanne (1.8% and 4.3% from green to oven dry).

Like other wood species, the longitudinal shrinkage of *Acacia auriculiformis* is very small. The mean longitudinal shrinkage from green to oven dry condition is only 0.361%. The different between the longitudinal and horizontal (radial and tangential) shrinkage is due to the alignment of wood cells (Anonymous 1992). As water is removed from the cell walls, the cells move closer together. Movement in the horizontal is greater than in the longitudinal direction.

5.2.1 Comparison of basic density of *Acacia auriculiformis* (Myanmar) and *Acacia auriculiformis* from some other countries

In general, basic density of 9-years old *Acacia auriculiformis* from Myanmar is 710kg/m^3. It is higher than those of 2-years old *Acacia auriculiformis* (480 kg/m^3) of Thailand, 4 years old *Acacia auriculiformis* (400 kg/m$^{3)}$ from Taiwan, 7 years old *Acacia auriculiformis* (579 kg/m$^{3)}$ from Malaysia, 10, 13 years old *Acacia auriculiformis* (497 kg/m^3), (516 kg/m^3) from Papua New Guinea, 12, 20 years old *Acacia auriculiformis* (579 kg/m^3), (685kg/m^3) from Sarawak and Malaysia as show in figure 5.

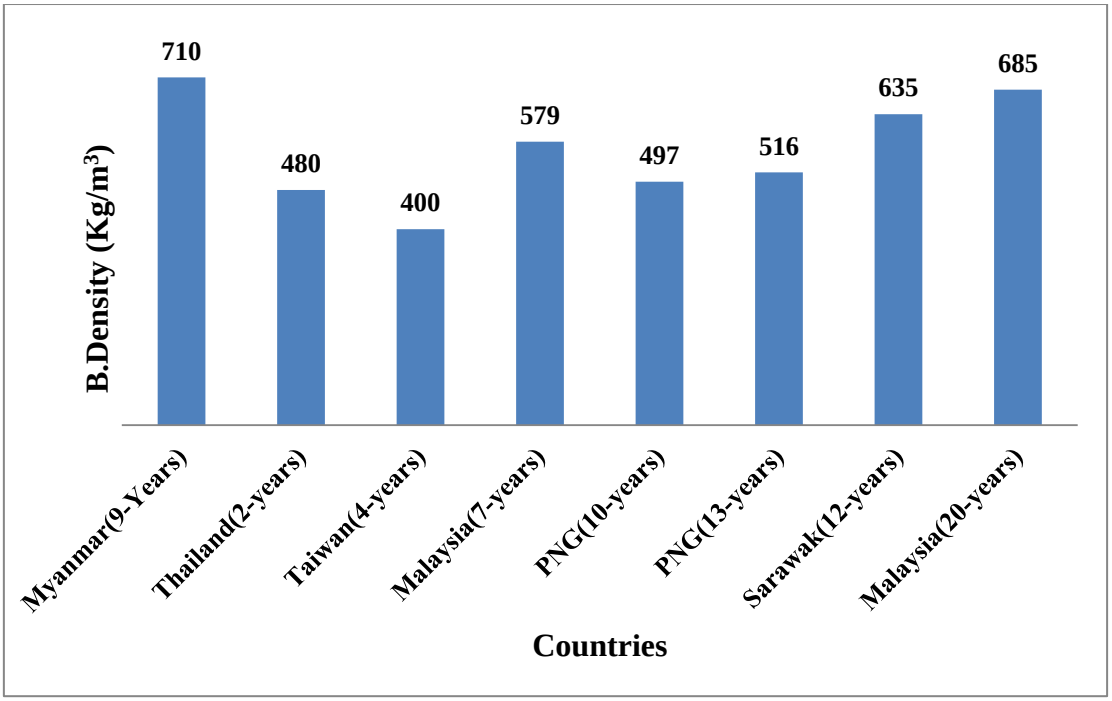

Figure 5. Comparison of Basic density of *A.auriculiformis* (Myanmar) and *Acacia auriculiformis* from some other countries

5.3 Comparison of Physical Properties of *Acacia mangium and Acacia auriculifirmis*

The physical properties of *Acacia mangium* and *Acacia auriculiformis* are presented in table 7.

Table 7. Basic specific gravity, shrinkage and dimensional stability of *Acacia mangium* and *Acacia auriculifirmis*

Species Name	Basic Specific gravity	Shrinkage				Dimensional Stability
		LS(%)	RS(%)	TS(%)	VS(%)	
A.mangium	0.552	0.314	2.5	5.9	9.6	2.4
A.auriculiformis	0.710	0.361	1.8	5.1	7.4	2.8

Legend:
LS = Longitudinal shrinkage (%), RS = Radial shrinkage (%), TS = Tangential shrinkage (%)
VS = Volumetric shrinkage (%)

According to the research results**,** basic specific gravity of *Acacia auriculifirmis* is somewhat higher than that of *Acacia mangium*. But radial and tangential shrinkage are found significantly different between species. Concerning with the dimensional stability, it is the ratio of tangential to radial shrinkage of the same species. It is also called the coefficient between tangential and radial shrinkage. The wood having a low ratio is best suited for use (Panshin et.al, 1980). Those timbers, which have dimension stability less than or equal to 2.0 and dimension changes i.e radial shrinkage and tangential less than or equal to 3.5 and 7% are found to be suitable for making high quality wood products (Kyi, 2000). The dimensional stability of *Acacia mangium* and *Acacia auriculifirmis* are somewhat higher than 2. Thus, should be carefully before making the high quality wood products.

6. Conclusion

Acacia mangium is a heavy wood species (basic specific of 0.552), which is very similar to those of Leza and Binga. But, its shrinkage value is lower than those of Leza and Binga. It is

comparable to many other lesser known species in wood quality. According to the research results, its dimensional stability value is somewhat high. However, its tangential shrinkage value is less than 7%. Therefore, it can be used for making furniture as cabinet and side-table also it should be used in light construction as a floor and indoor decoration.

The basic specific gravity of *Acacia auriculiformis* is 0.710. So, it is a heavy wood species. It is nearly similar to Kanyaung and Thitsein. But, its tangential shrinkage value islower than those of Kanyaung and Thitsein. However, its dimensional stability values are somewhat high. Therefore, should be properly dry before making the high quality wood products. It can be used in medium construction and more suitable for beams and posts in building.

Further study on mechanical properties, anatomical feature, natural durability, treatability, and seasoning behaviors should be conducted. Its availability will be more important from the production point of view.

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