COMBINED PROCEEDINGS OF THE NIGERIAN MATERIALS CONGRESSES (NIMACON-2010 AND NIMACON-2011)

NIGERIAN MATERIALS RESEARCH SOCIETY

NIMACON 2010

Held at:

Universal Hotel, Aguleri Street, Independence Layout, Enugu, Nigeria

November 23 – 26, 2010

NIMACON 2011

Held at:

Conference Hall, Engineering Materials Development Institute, Km 4 Ondo Road, Akure, Nigeria

November 21 – 24, 2011

COMBINED PROCEEDINGS

of the

NIGERIAN MATERIALS CONGRESSES

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And Meeting of the

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DR. A.T. OYELAMI, PROF. B.O. ADEWUYI AND PROF. D.A. PELEMO

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PRODUCTION OF *BAMBOO-LAM FROM* FLAT BAMBOO STRIP PREPARED FROM *BAMBUSA VULGARIS SCHRAD*

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ABSTRACT
This study addressed the problem of producing bamboo-lam from flat strips prepared from Bambusa vulgaris Schrad. Such bamboo-lam is suitable for making bamboo-based products for interior use. Bambusa vulgaris samples were sourced from 4 years old stock, at the time of harvest, from within the University of Ibadan, Oyo State, Nigeria. The harvested matured culms were reduced to 780mm long each with a minimum diameter and wall thickness of 30mm and 5mm respectively. The short culms were split, rough planed to remove nodal protrusion and green epidermal layer before soaked in hydrogen peroxide treated hot water for 24 hours to improve strips resilience to insect and fungal attack. The dried strips were dressed, glued, cured and finished to produce bamboo-lam. For the flat bamboo strips produced, the percentage recovery index (RI) after splitting was 75% and reduced to between 50 – 57% after surface planed. Untreated strip was prone to attack while soaking in hot hydrogen peroxide treated water for 24 hours improved their resilience to degradation and insect attack. The dimensions, percentage RI and durability of strips produced from Bambusa vulgaris thus depend on its culm features, handling skill, equipment and treatment. Bamboo laminates of width 25 x (5 – 8) mm were produced from the flat bamboo strips produced. This study has been able to produce durable bamboo strips and laminates from Bambusa vulgaris Schrad using common carpentry tools and machines. The bamboo-lam produced is suitable for manufacturing bamboo-based products for interior use.

Keywords: Bambusa vulgaris Schrad, Strips Preparation, Durability, Bamboo laminate

1.0 INTRODUCTION

Excessive timber harvest has caused a marked reduction in the supply of wood. This is due in part to the increasing demand of wood as a result of rapid population growth [1]. The extent of reduction is currently affecting wood position as a prime choice among conventional raw materials for varying applications. A significant contributor to the swaying of interest away from over dependence on wood is its escalating cost that has greatly reduces its affordability to all. In order to circumvent wood scarcity problem via abolition of over dependence for its sustainability, concerted efforts have been directed at re-engineering wood waste and other tree products to produce engineered wood-based products [2]. The 21st century appears to be witnessing a growing consensus to tap into potentials of Non-Timber Forest Products (NTFPs) that are also lignocellulosic materials **[3,4,5,6]**. The need to exploit NTFPs stemmed from the current drive to eradicate poverty and extreme hunger through expansion of employment opportunities particularly to the rural dwellers and low income earners.

From among the commonest NTFPs, bamboo and rattan potentials have made them to be most favoured. One of such potentials is availability in multiple varieties in many countries. Nigeria is also blessed with numerous species of bamboo and rattan [7] and their abundance was attested to by [8 and 9]. However, bamboo seems to have overriding advantages, enshrine in its versatility, over rattan. Bamboo a multifaceted non-timber plant is reported to have emerged as a valuable wood substitute for cushioning the pressure on wood raw material supply in the last 15-20 years [10]. And that the development of bamboo resources and industries worldwide promotes rural livelihood, economic and environmental growth, mitigates deforestation and illegal logging, prevents soil degradation and restores degraded lands [11]. With modern processing techniques, many of which are still quite new in Nigeria, bamboo can be transformed into many products that compete directly with wood products in price and performance.

1.1 Bamboo: Genera, Species and Uses

Bamboo is a group of woody perennial grasses in the true grass family *Poaceae* having 91 genera with over 1,000 species. It varies in size from small annuals to giant timber bamboo, a fastest growing woody plant in the world which sometimes grows up to 38.1-50.8 mm/hr [12]. One of the commonest genera is *Bambusa* and it has 85 species that are all clumper save Bambusa *ventricosa, the clumper/***runner /extinct status of which was yet to be verified.** Among *Bambusa genera* is *vulgaris* that consists of 4 species: the *Bambusa vulgaris Schrad, Bambusa vulgaris* Vittata, *Bambusa vulgaris* Wamin and *Bambusa vulgaris* Wamin Striata. The Bambusa *vulgaris* in general attained maximum height of 15.24m and 101.6mm diameter. It grows generally in the tropics with lots of branches and its new shoots appear in late fall. Some varieties of *Bambusa vulgaris* have been used in many countries of the world for food, gardening,

furniture, light structures and erosion control [12].

Some studies have buttressed the availability of ***Bambusa vulgaris*** **Schrad in** abundance **[13,14,]** in various parts of Nigeria while its strength adequacy, versatility and beauty in both natural and finished states had been reported by [15,16,17]. Up till now, ***Bambusa vulgaris*** **Schrad** culm is still been used in round in Nigeria. However, there are challenges in using *Bambusa vulgaris* Schrad in round form. The challenges are inherent in the culm's physical and chemical properties [4]. The culm has high sugar content that made it highly susceptible to insect attack and other biodegrading agents [16] while the hollow structure limits its use in the round form due to problems associated with jointing induced by discontinuity in the formation of its fibres as a consequence of numerous nodes and internodes.However, the round culm can be processed into strips with reduced starch content so as to enhance its durability [10]. Furthermore, the conversion of round culm into flat strips will further enhance its versatility and adaptability for producing modern bamboo-based products at cottage level.

Apart from these reasons, timber remains the major source of attraction to Nigerian forest exploiters and the over-dependency on timber has being the bane sustaining timber resource in the country. The development had encouraged the use of wood from hitherto fruit trees [18,8] for various end uses. The global consensus on the negative impacts of deforestation on climate change is promoting development of alternative raw material from numerous NTFPs to complement wood in various applications. This is belief to have mitigating capacity for over-dependency on timber while it will also ensure wood utilization sustainability. Therefore adaptation of appropriate technology for manufacturing bamboo-based products represents a step to unlocking the abundant bamboo supply and its effective utilization. This work is limited to the production of bamboo-lam from processed flat bamboo strips from bamboo species grown in the University of Ibadan.

2.0 MATERIALS AND METHODS

The bamboo species utilized for this study was harvested from the University of Ibadan premises. The species and age of the bambusa stock from where the samples were harvested had earlier been identified by [19]. The species used is *Bambusa vulgaris* Schrad while the age at the time of harvest was 4 years. There are four main stages involved in the production of bamboo-lam as shown in Figure 1 (Appendix I). Matured culms with minimum diameter and wall thickness of 30mm and 5mm respectively were harvested. The culms were reduced into 780mm length before splitting on circular saw. The strips were rough planned to remove both the nodal protrusion and green epidermal layer. The planned strips were later soaked in treated hot water for 24 hours to improve strips resilience to insect and fungal attack before drying. The dried stripes were prefinished, glued, cured and finished to produce bamboo-lam.

3.0 RESULTS AND DISCUSSION

Quite a number of challenges were encountered when harvesting the bamboo culms used for this study. The *Bambusa vulgaris* Schrad being a clustered type poses some difficult to access the matured culms. The traditional cut and withdrawal method used was time consuming and tedious. The details of the *Bambusa vulgaris* Schrad harvested for the study is presented next.

3.1 Bamboo and Its Strip Characteristics

The characteristics of the *Bambusa vulgaris* Schrad used for the study is presented in Table 1. Maximum stripe length of 760 mm was produced with single nodal point. The dimension conforms to the minimum acceptable dimension recommended for stripe to be used for structural purposes [20, 21]. From length 780 mm lengths, the details of the **Laminate Recovery Index (LRI)** after both splitting and rough planning are presented in Table 2.

Table 1: Statistics of the Harvested Culms

Parameters	Values (range)
Age	3 – 4 years
Internode (length)	360 – 380mm
Moisture content	Fresh (? 42%)
Culm circumference	240 – 270mm
Inner culm diameter	60 – 70mm
Culm thickness	10 – 14mm

Four stripes each were produced from each length with average width of 35mm before planning and 25mm wide after planning. Thus the LRI of the stripes from Bambusa vulgaris Schrad was 75%. Variation in culm curvature markedly reduces the recovery index after planening. It was observed that the wider the strip the greater the curvature and the higher the resulting material wasted.

Laminate Recovery Index (LRI) after Splitting	
Parameters	**Values**
No of short culms	12
Total no of strips	96
Recovered lam. (38 – 43cm)	72
Recovered laminates (%)	75
Wasted laminates (%)	25
Laminate Recovery Index (LRI) after Planning	
Parameters	**Values**
Thickness before planing	10 – 14mm
Thickness after planing	5 – 8mm
Percentage recovered	50 – 57 %

Table 2: Laminate Recovery Index (LRI) after Splitting and Planning

3.2 Strip Treatment for Durability

Bamboo is highly susceptible to deterioration due to its high sugar content [22]. Within the first week after harvesting, infestation was noticed on the unprocessed culms (Plate 1). This could be due to insipient attacks before harvesting or mere direct contact with bare ground. After six weeks of abandonment in the workshop in contact with floor as shown in Plate 2, there has been considerate deterioration by powder post beetle. The split bamboo also becomes infested on surface after three days and the rate of

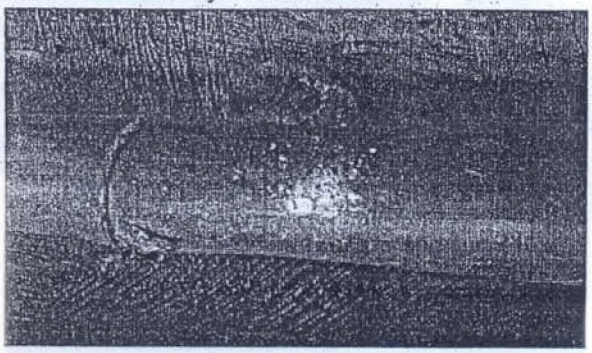

Plate 1: Unprocessed Bamboo Infested

Plate 2: level of infestation after 6weeks

infestation increases in the order presented in Table 3. The increase in the rate of infestation after splitting may be attributed to the exposed sections of the epithelial layer which is soft and rich in sugar content. The planning of the epithelial section of the inner part further exposes it to unrestricted access by agent of bio-deterioration to infest the strips. But the condition changes after **boiling the strips in hydrogen peroxide treated water for 24 hours.** This action appears to preserve the strips against bio-deteriorating agents as none of the strips is attacked after four weeks of drying. The strips are dried with air for four weeks. The average maximum moisture content of the *Bamusa vulgaris* Schrad samples used for the study is 93.4% and this agrees with the range of values quoted for the base moisture

Table 4: Rate of Strip Infestation

Parameters	Value (days)
After harvesting	7
After splitting	3
After planening	2
After boiling	Not available

content of cultivated Bambusa vulgaris Schrad by [22]. The strip was air dried as shown in Plate 3 under ambient temperature 29 ± 50 and 65± 50 % relative

Plate 3: Air Drying Process of the Strips

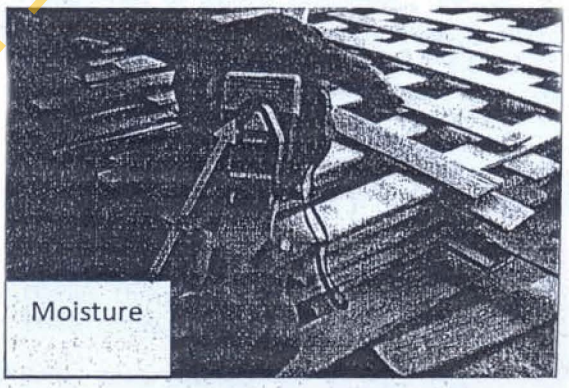

Plate 4: Drying Strips Moisture Content Monitoring

humidity while the rate of drying of the samples were monitored using the moisture meter shown in Plate 4.

3.3 Bamboo-lam Production

The final product created from the dried B. vulgaris strips are two sizes of bamboo-lam: 300x300x15mm and 450x60x35mm. An unfinished sample of the bamboo-lam is shown in Plate 5. The two sizes of bamboo-lam produced can be used as raw material in the manufacturing of decoration and novel items, chair's rails, stretchers and seat, other furniture parts and mixed bamboo furniture.

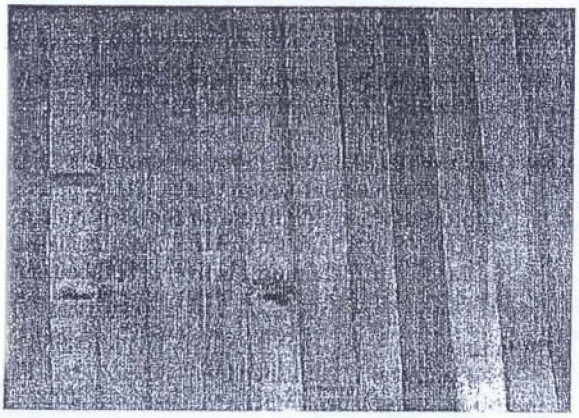

Plate 5: Unfinished Bamboo-lam

4.0 CONCLUSION AND RECOMMENDATION

The use of newer bamboo products like laminated furniture, bamboo ply among others is at present not common in our society. This is due to the notion that bamboo products are not durable and are only meant for temporary applications. Specifically in Nigeria, production of bamboo modern products is thought of as been difficult to attainable due to wide perception that high technical knowhow and sophisticated machineries are required to process bamboo to these products. This study has been able to produce bamboo laminates from *Bambusa vulgaris* Schrad using common carpentry tools and machines. Bamboo havesting with crude tools is tedious and time consuming. The characteristics of the laminates depend on the features of the harvested culms while soaking of the bamboo strip in hot water treated with hydrogen peroxide for 24 hours improved the resilience of bamboo strips to deterioration and insect attack. The bamboo-lam produced is durable and can sufficiently be used to complement wood in the production of furniture, interior decoration, novel and structural items.

Based on the observations recorded during the study, it is advisable to stalk bamboo vertically in a less humid place while waiting to begin its processing to reduce rate of infestation. Appropriate splitting and planning machines will reduce time required for processing and increase maximum recovery index. Also there is need to develop further means of harvesting bamboo.

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APPENDIX I

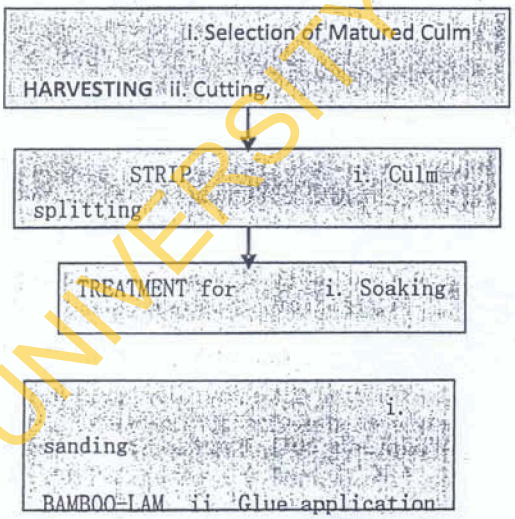

Fig 1: Flow Process for Producing Bamboo-lam

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