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Calidad del cepillado de maderas en las provincias de Pinar del Rio y Artemisa

Quality of wood liming in the provinces of Pinar del Rio and Artemisa

Reinaldo Hanói Valdés-Reinoso; **Brenda de la Caridad Delgado-Gil; Ibian Leyva-Miguel**

Ministerio del Turismo. Pinar del Río, Cuba
Universidad de Pinar del Río, Cuba
Centro de Investigaciones y Servicios Ambientales de Pinar del Río, Cuba
Correo(s) electrónico(s)
daniel@upr.edu.cu
cubamayca@gmail.com
brendac93@nauta.cu
ORCID: http://orcid.org/0000-0003-3582-0239
https://orcid.org/0000-0002-5986-9881
http://orcid.org/0000-0002-5850-1831

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Resumen

El trabajo se desarrolló en las provincias Pinar del Río y Artemisa en el año 2019, con el objetivo de determinar la calidad de los ensayos de cepillado en cinco especies maderables, pues se desconoce y se considera una de las operaciones más importantes utilizadas en los procesos industriales. El material de estudio se obtuvo en plantaciones y los ensayos se realizaron según las Normas ASTM D-1666-2004 e ISO 1302:2002. Las especies analizadas cuentan con un excelente cepillado y tienen potencialidades para ser utilizadas en la industria del mueble.
Palabras clave: Calidad; Cepillado; Rugosidad; Mueble

Abstract

The work was developed in Pinar del Río and Artemisa provinces in 2019, with the objective of determining the quality of planing tests in five timber species, since it is unknown and considered one of the most important operations used in industrial processes. The study material was obtained from plantations and the tests were performed according to ASTM D-1666-2004 and ISO 1302:2002 Standards. The species analyzed have excellent planing and have the potential to be used in the furniture industry.

Key words: Quality; Planing; Roughness; Furniture

Introduction

Forests worldwide cover 3 999 billion hectares and cover about 30.6 %, according to data from the Food and Agriculture Organization of the United Nations (FAO, 2018). From them, timber and its derivatives are obtained, which contribute 1 % to the Gross Domestic Product (GDP) and generate 54.2 million jobs in the world, according to data from the World Bank (2016).

Cuba has 4 093 thousand hectares, of which 3 241 thousand hectares are covered by forests, where 46 % are protective, 24 % conservation and 31 % production according to Labrador, Mercadet and Alvarez (2017).

The accelerated deforestation for timber harvesting purposes, associated with the intensive use of a reduced group of woods, causes enormous pressure on them, thus forcing the study of those species in abundance in forest ecosystems that meet the appropriate properties and can satisfy the market, in parameters of wood quality and ease of use to alleviate and release the impact suffered on forests.

In countries such as Mexico and Costa Rica, studies on wood surface finish have been developed. Works carried out by Machuca, Rosa and Villalba (2012), based on the criteria exposed by Aguilera, Rolleri and Burgos (2016), Hazir, Huseyin and Hizirroglu (2017) and Laina, et al. (2017), state that surface quality is a factor that directly influences different wood machining processes. However, in Cuba, existing information on wood machining characteristics is scarce or null for many species as stated by Alvarez, Bracho, Benigno and Momoli (2013).

Currently, the surface quality of the wood when planed is unknown, an important property that determines the industrial use for the manufacture of furniture of some forest species that have remained in secondary forests, as a result of the intensive use of precious species of high economic value throughout Cuba and particularly in the provinces of Pinar del Río and Artemisa, which has caused its decline in terms of frequency, abundance and dominance.

Therefore, the objective of this work is to determine the quality of wood planing trials of Pinus caribaea Morelet var. Caribaea Barret and Galfaro, Acacia mangium Willd. Gmelina arborea Roxb. Samanea saman (Jacq.) Merril and Eucalyptus saligna Sm in the provinces of Pinar del Rio and Artemisa.

Development

In the "Macurije" Agroforestry Enterprise, located in the westernmost region of Pinar del Río province and the "South Coast" to the west of Artemisa province, working properties were determined in the

facilities of the University of Pinar del Río and the workshops of the Cultural Goods Fund (BFC) of the same province.

For the materialization of the determination of the planing properties of the wood of the species P. caribaea, A. mangium, G. arborea, S. saman and E. saligna, 10 trees were used, from which logs were obtained and cut from a height of 1.30 m, each one with a length of 1 m; taking four samples, two on each side of the lateral section of each log, taking into account its homogeneity, for a total of 40 samples per species according to the ASTM D-1666-2004 Standard.

Three blades with cutting angles of 30° were used. To obtain the 20° angle it was necessary to bevel the blades, all this in combination with a feed speed of 7.32 , blade holder head speed of 6,200 revolutions per minute (rpm).

The number of marks per blade (NMC) was calculated using the formula described by the ASTM-1963 Standard, used by Zavala and Vázquez (2001):

$$NMC\ ) = \frac{A * B}{V_a * 12}$$

Where NMC = Number of blade marks per cm, A = Speed of the blade holder head or revolutions per minute in the head (rpm), B = Number of blades in the head, Va = Feed speed or feed rate (*mmmin*-1).

An evaluation of 100 % of the specimens was carried out by visual inspection to analyze their behavior in terms of the most frequent defects for this type of test, with the data obtained, the number of blade marks per centimeter was calculated, the behavior of the specimen of each of the species with the two angles studied was evaluated and it was defined which of the combinations studied is the most suitable for planing each of the species.

For the evaluation of planing defects and other wood treatment processes, reference was made to the ASTM D-1666-2004 Standard, which establishes the working procedure for planing tests. The quality of planing was determined by the sum of the percentage of excellent (E) and good (B) pieces for each of the tests.

For the materialization of the determination of roughness properties from the behavior of the Ra parameter in wood of the species P. caribaea, A. mangium, G. arborea, S. saman and E. saligna, 40

specimens per species are used according to the ASTM D-1666-2004 Standard; coinciding with Raabe, Menezzi and González (2016). Thus, the dimensions of the specimens used in the roughness tests are as follows: (2 cm x 10 cm x 90 cm). The same cutting regime was used as the one employed in the determination of the surface quality of the planing process.

To obtain the surface roughness measurements, a portable roughness tester model TM-TR200 was used, commonly used to measure the surface roughness of parts that have undergone the machining process, calculate the parameters according to the selected measurement conditions and display the measurement parameters and profile graphs on its LCD screen.

Data processing was performed with the help of IBM SPSS Statistics for Windows, version 22.0 and Microsoft Excel 2016, version 16.0.7167.2060, allowing comparison of the results of the four parameters: arithmetic mean roughness (Ra), total depth of roughness (Rt), height of the ten irregular points (Rz), and mean square roughness (Rq), obtained by the computer for each species and plotted on a bar graph.

A normality test was performed to determine whether the data obtained for the Ra variable follow a normal distribution, using the Kolmogorov Smirnov statistic. The Kruskall-Wallis non-parametric test was used to check the existence or not of a significant difference between the means of the results of the planing test variables and the Ra parameter.

Table 1 shows the results of the planing of the species rarely used in the furniture industry according to the different classification parameters. For the five species, the planing is classified as excellent, with the most frequent defect being the caked grain. These results correspond to those reported by Machuca, Rosa and Villalba (2012) for Pinus oaxacana Mirov. From a plantation in the State of Mexico.

Species	Moisture content (%)	No. of test tubes	Test tube classifications (E+B) %
Samanea saman	12	40	98 + 2
Eucaliptus saligna	12	40	98 + 2
Acacia mangium	12	40	97 + 3
Pinus caribaea	12	40	97 + 3
Gmelina arborea	12	40	96 + 4

Table 1. Analysis of brushing results.

Source: Own elaboration

In general, it can be said that the woods of the species analyzed responded positively to the workability of planing. All of which is corroborated when determining that they present a number of blade marks of 25.40/cm, which positively influences the quality of the surface finish.

The roughness study for each species was carried out using the roughness meter, establishing a measuring point in each of the planed segments from the four combinations established for the experiment, as shown in Figure 1. The results for each roughness indicator (Ra, Rz, Rq and Rt) of all the samples analyzed are shown below:

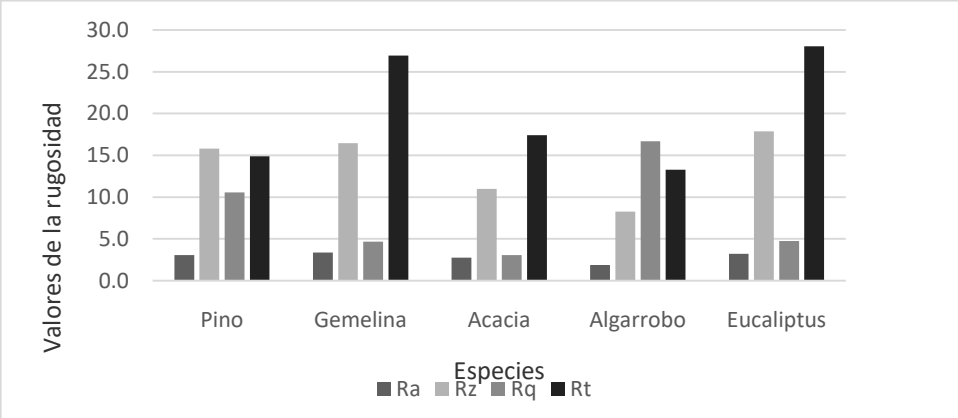

Figure 1. Roughness parameters for each of the species.

Source: Own elaboration

The five species presented, according to the ISO 1302-2002 Surface Quality Standard, Ra values within the ranges established for planing, S. saman 1.86, A. mangium 2.74 and P. caribaea 3.05 occupying an infrequent zone, but favorable for its good behavior in the machining process, E. saligna 3.20 and G. arborea 3.36 are among the best results in the zone of the most frequent values of specifications in the aforementioned standard.

Taking into account the results obtained and the normalized parameters of Ra according to ISO 1302-2002, it can be inferred that timber species in the country with Ra values lower than 3.50 can be valued by the furniture industry as production alternatives due to the good surface finish they can achieve. The resulting Ra result shows the behavior of the surface, but what defines its quality is the final use of the product, in this case the production of furniture.

From the results obtained from the average of the roughness parameters of the different specimens for each species, it is observed that S. saman has the best performance in three (Ra, Rz and Rt) of the four parameters studied, indicating that of the five species analyzed, S. saman has the best characteristics to be used in the furniture industry with very good results from the quality of its surface finish. Although the five species can be used by the Cuban furniture industry, specifically in Pinar del Río and Artemisa, which is important for the country since it can reduce the pressure on the precious and most demanded species.

Correlation between the planing variables and Ra of surface finish

Since the assumption of normality of the variables Ra, Feed rate (VA), Cutting angle (AC), number of knives (NC), Speed (VGC) was not met, the Kolmogorov Smirnov test was used for a P≥0.05 and the Spearman's nonparametric correlation matrix is obtained (Table 2).

Roughness parameters, Ra	Species									
	Pn Eu		Ga		Am		Ss			
	R	*p*	*R*	*p*	*R*	*p*	*R*	*p*	*R*	*p*
Ra-Va	,387	,000	,000	,375	,000	,463	,430	,459	,000	,458
Ra-AC	-,500	,000	,000	-522	,005	-,553	,001	,539	,000	,513
Ra-NC	-,387	,000	,000	-375	,000	-,563	,430	-459	,000	,-458
Ra-VGC	-387	,000	,000	-375	,000	-,563	,430	-459	,000	,-458

Table 2. Correlation analysis between brushing variables and surface finish.

Source: Own elaboration

As can be seen, Spearman's nonparametric correlation is showing that all the planing variables are related to the Ra parameter, with the cutting angle having the greatest influence. This behavior is supported by a 50 % probability.

The knowledge of the characteristics of the wood processing allows to know the surface quality obtained in the machining operations, specifically in the planing of the wood. For this reason, the species studied are an alternative for the elaboration of furniture not only in the companies where the research was carried out, but also in other companies in the country, by farmers, carpenters, among other producers of wood articles. It will also reduce the pressure on precious species that have been overexploited for years.

Conclusions

The species Pinus caribaea, Eucalyptus saligna, Samanea saman, Gmelina arborea and Acacia mangium have an excellent planing, which indicates that they have the potential to be used in the furniture industry in Pinar del Río and Artemisa.

The analyses of roughness when planing the wood have results lower than 3.50, therefore, the analyzed species have a good surface finish for the elaboration of wooden articles.

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