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LETTER TO THE EDITOR

Difference of Color Index of Toona Sinensis Wood Growing in Four Regions

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To explore the color index's differenece law of Toona sinensis wood from different provenances, we use 20 years old wood which is from Jiaozuo, Luoyang, Shangqiu, Nanyang area of Henan Province as the raw materials to survey and analyze the color index L*a*b* and chromatic value. The results are as follows: The greater color index a*, the greater the chromatic value. When combined with the actual visual perception, the chromatic value is closer to human visual perception than color index a*, which can express the change of red degree of Toona sinensis wood more comprehensive.
Toona sinensis, color index, chromatic value, difference

1 Introduction

The color, texture and glossiness of wood surface are significant characteristics of wood surface properties, which are closely related to the quality evaluation of wood products. The color is not only an important characteristic of visual physical quantity of wood surface, but also an important standard to evaluate wood quality and determine commodity value of wood products, and is of great significance for the processing and utilization of wood (Wang et al. 2012, Liu et al. 2012, Cheng et al. 2008, Liu 1994, Miao et al. 2003, Duan 1999, He and Luo 2016).

Toona sinensis which belongs to deciduous tree is a Meliaceae Plants. The wood native to the centre of China, is a unique, valuable and fast-growing tree species in China and has been listed as one of the top ten strategic tree species in Henan province. Toona sinensis which has straight trunk, russet and red wood color is the top cabinet-wood and it is regarded as the "mahogany of China" in foreign markets. It is also shine, hard, corrosion-resistant and has a beautiful texture with strong fragrance. The air-dry density is about 0.936 g/cm^3. There may be 10 - 15 years before the Toona sinensis grows into useful timber and the longer it grows the deeper the wood color will become (Peng and Liang 2005, Amiri et al. 2017). Wood, as a favorite decorative material from earliest times to the present day, appears that the greatest characteristic is its visual characteristics (Li and Dong 1992). The visual properties of wood are measured by visual physical quantity of wood surface. This study use L*a*b spatial color measurement value to quantificationally analyze the wood color of Toona sinensis from different regions, summarize the color index's differenece law of Toona sinensis wood from different provenances and provide the theoretical guidance for forest definite cultivating (Chang et al. 2012, Wang et al. 2017).

2 Wood and Method

2.1 Test Wood

Toona sinensis wood, 20 years old, whose diameter is more than 20 cm is from Jiaozuo (JZ), Luoyang (LY), Shangqiu (SQ), Nanyan g (NY) area of Henan Province. We only choose one sample tree from each provenance.

After cutting down the sample tree, we collected discs that is about 10 cm thick at 0, 1, 2, 3, 4, 5, 6, 7 and 8 meter of each tree. The four surfaces of each disc are smooth by planning without planning defect, and the planning level are required to be "good".

2.2 Test instrument

Automatic color difference tester: CR-400 color difference tester produced by Konica Minolta. The light source is the standard light source, D65. The color temperature is 6504 K, and the geometricl condition of observation and illumination is 0/d (vertical incidence/diffuse reflection). The range of vision is 10 degrees and the range of measurement is 20 mm.

2.3 Test method

2.3.1 Determination of Toona sinensis L*a*b* from different provenances.

L*a*b* color space is widely used in various industries, especially in the analysis of the material whose color is single, such as wood, floor, tile and so on. L* shows the lightness: Completely white object is looked as 100. Completely black object is looked as 0. a* is red and green color index, so the higher the positive value is ,the redder the color is and the higher the negative value is, the greener the color is. b* is yellow and blue color index, so the higher the positive value is, the yellower the color is and the higher the negative value is, the bluer the color is (Si and Qiao 2017, Deng et al. 2017).

After the samples are placed at room temperature to be air-drying, its surface is processed to be smooth with a small thicknessing machine and is cleaned. Then we measure them at a condition that the temperature is 20 degree and the air relative humidity is 65%. Next, Measure each disc's wood color data from the four provenances. cross section: The wood index value (L*a*b*) of four directions which includes East, South, West, North; radial section: measure the index value of two directions which includes South and north after cutting along the South and North directions through the heart-centre.

2.3.2 Determination of Toona sinensis'chromatic value from different provenances

The partial dark red component in the material color gives a person the feeling of luxury, elegance and nobility (which also explains one of the reasons why rosewood and Dal bergia cochin chinensis are think of as high-grade furniture) (Huang et al. 2009, Li et al. 2018). The "luxury" of the wood is related to the red and green color index a *, and is negatively correlated with lightness L. It turns out (Christine and Graeme 1987).

Chinese people often think that the "red" color is more likely to reflect the value .The formula of chromatic value can reasonably reduce the effect that "yellow, blue" color have on "red" color (Liu et al. 1995, Liu 1995), and is more likely to explain comprehensive sense of vision, which is the reason why only chromatic value is analyzed in this thesis.

3 Results and analysis

3.1 The color index L*a*b* of Toona sinensis from different provenances

The way of determining the color of surface with an automatic chromaticity can turn out brightness L*, red-green color index a* and yellow-blue color index b*. They are all shown below with Tables 2-1, 2-2 and 2-3.

Table 2-1 Average value L*of the transverse and radial section of four different regions

	NY L*average value		**LY** L*average value		**SQ** L*average value		**JZ** L*average value	
height (m)	Cross section	Radial section	Cross section	Radial section	Cross section	Radial section	Cross section	Radial section
0	53.24	66.35	54.44	58.08	48.97	51.84	49.13	54.54
1	53.54	60.45	52.71	55.38	56.81	62.24	54.65	62.43
2	56.21	68.76	56.49	59.59	51.51	63.39	54.80	59.23

3	57.35	63.97	51.39	57.66	56.05	62.45	49.71	57.16
4	54.63	59.61	52.36	56.70	55.66	61.47	50.59	61.92
5	50.36	56.86	48.49	52.58	56.29	61.31	52.38	57.93
6	53.84	60.70	48.89	53.85	44.03	53.96	52.95	59.08
7	51.72	59.68	47.10	51.45	51.81	58.29	60.82	60.95
8					55.32	59.95	54.61	56.49
9					51.10	55.04		

Table 2-2 Average value a* of the transverse and radial section of four different regions

	NYa*average value		**LY** a*average value		**SQ** a*average value		**JZ**a*average value	
height (m)	Cross section	Radial section	Cross section	Radial section	Cross section	Radial section	Cross section	Cross section
0	11.12	13.26	13.48	15.67	14.16	16.26	12.53	15.12
1	12.55	15.25	14.04	16.85	12.30	15.73	12.13	13.80
2	12.47	13.47	13.73	16.10	11.23	14.92	12.38	13.02
3	12.10	14.60	14.94	16.39	12.66	15.98	12.82	14.62
4	13.05	14.89	14.61	16.13	13.11	14.95	12.81	13.65
5	13.30	16.54	14.17	15.59	13.11	15.93	12.15	14.20
6	13.01	15.84	15.08	17.23	12.72	16.93	12.43	14.76
7	12.74	15.56	14.73	16.31	14.17	16.41	10.95	12.73
8					13.64	15.72	11.07	14.65
9					16.05	16.52		
average value	12.54	14.92	14.35	16.28	13.31	15.93	12.14	14.06

Table 2-3 Average value b^* of the transverse and radial section of four different region

	NYb*average value		**LY** b*average value		**SQ** b*average value		**JZ**b*average value	
height (m)	Cross section	Radial section	Cross section	Radial section	Cross section	Radial section	Cross section	Radial section
0	17.2117	19.0917	14.36	16.5533	15.8033	17.4183	15.8033	17.4183
1	12.0308	14.625	14.8283	16.7775	14.9125	16.66	14.9125	16.66
2	14.1592	17	15.0008	16.3267	13.5417	15.9533	13.5417	15.9533
3	13.5083	15.92	14.3925	15.935	13.8617	15.2733	13.8617	15.2733
4	13.1767	17.3233	14.3425	16	13.7117	15.375	13.7117	15.375
5	12.8458	15.3017	14.615	16.9317	13.2833	15.1433	13.2833	15.1433
6	11.34	14.72	14.2175	16.4125	12.2042	14.6183	12.2042	14.6183
7	11.895	14.9867	13.69667	16.2617	12.7725	14.38	12.7725	14.38
8					12.8408	14.0333	12.8408	14.0333
9					12.o9092	14.63667		
average value	13.27	16.12	14.43	16.40	13.58	15.35	21.88	20.44

According to results in Table 2-1, the value L * of the Toona sinensis from the four different provenances turns out: Lightness L* ranges in 42 - 65.The lightness ismaximum in Nanyang and minimum in Jiaozuo. The wood color in Nanyang is dark red. From that we can know the reflection degree of visible light is stronger, so the brightness is the highest.

According to results in Table 2-2, value a*of the Toona sinensis from the four different provenances turns out: red-green color index a* ranges in 10 - 18. For Toona sinensis wood, the color index a* of cross section a is maximum in Luoyang. The order is LY>SQ>NY>JZ. The a* value of the radial section is higher than the transverse section. That is to say, the wood of rift sawing is redder than the wood of crosscut. There is a significant difference between the mean value a*of the transverse section and the radial section (*F*=164.39**).The analysis is as follows:

Table 2-4 variance analysis of value a* of the transverse and radial section of four different region

Difference source	SS	df	MS	F	P-value	F crit
Crosscutting and rift sawing a*	9.814214	1	9.814214	164.3855	0.001024	10.12796
regions	5.701582	3	1.900527	31.83334	0.008941	9.276628
error	0.179107	3	0.059702			
In total	15.6949	7				

3.2 Chromatic value of Toona sinensis

3.2.1 Results

According to the results of color index and chromatic value formula, calculate the average shade value of the transverse and radial section of four different regions.

Table 2-5 average shade value of the transverse and radial section of four different regions

Value	NY	LY	SQ	JZ
the average shade value of the transverse section	22.04	25.38	24.55	19.34
the average shade value of the radial section	25.64	27.53	26.26	19.84

3.2.2 Analysis

The variance analysis showed that the chromatic value of the transverse and radial section from different height are significant different in the three provenances NY, LY, SQ, but there is no significant difference in JZ. As for the four directions, north, south, west, east of cross section from various regions and the two directions west, north of radial section, the differences in chromatic value are not significant. There is no significant difference between the chromatic value of transverse section and radial section in the same wood, but they differ extremely in four regions. (*F*=22.26511**). As for the color index a* and chromatic value, It's the same as the conclusion above. That is: LY>SQ>NY>JZ. The chromatic value is closer to human visual perception.

4. Conclusion

We use L*a*b spatial color measurement value to quantificationally analyze the wood color of Toona sinensis from different regions, summarize the color index's differenece law of Toona sinensis wood from different provenances. The results are as follows:

(1) For Toona sinensis wood, the color index a* of cross section: LY=14.35>SQ=13.31>NY=12.54>JZ=12.14, the color index a* of radial section: LY=27.53>SQ>NY> JZ. There is a significant difference between the mean value a* of the transverse section and the radial section (*F*=164.39**). The a* value of the radial section is higher than the transverse section. That is to say, the wood of rift sawing is redder than the wood of crosscut.

(2) For Toona sinensis wood, the chromatic value of radialsection: LY=25.28>SQ>NY>JZ the chromatic value of transverse section: LY=27.53>SQ>NY> JZ. There is no significant difference between the chromatic value of transverse section and radial section in the same wood, but they differ extremely in four regions (*F*=22.26511**).

(3) As for the color index a* and chromatic value, It's the same as the conclusion above. That is: LY>SQ>NY>JZ. So it has been proved that the color index a* is positively related to chromatic. That is: The greater color index a*, the greater the chromatic value. When combined with the actual visual perception, the chromatic value is closer to human visual perception than color index a*, which can express the change of red degree of Toona sinensis wood more comprehensive.

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