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WRIGHTIA TINCTORIA(ROXB) R.BR.: A POTENTIAL DYE YIELDING PLANT

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ABSTRACT

Wrightia tinctoria (Roxb.) R. Br., commonly known as Pala Indigo, is a versatile deciduous tree valued for its medicinal, craft and dye-yielding properties. In the present study, the dye extraction potential of *W. tinctoria* leaves was investigated by comparing dye liquids extracted from fresh and shade-dried *W. tinctoria*leaves with respect to dye yield, colour strength, and stability of dye liquids during storage. Dye liquids extracted form fresh leaves yielded greater dye material (1000 g; 20 litres) with higher colour strength (K/S = 61.35) compared to dye liquid extracted from dried leaves (600 g; 12litres; K/S = 49.65). The lower transmittance and L* values of fresh extracts indicated higher pigment intensity and darker shades, whereas dye liquid from dried leaves produced lighter shades. Owing to their higher dye strength, dye liquid extracted from fresh leaves were subjected to storability assessment. Results showed that dye liquids retained stability in colour strength, transmittance, and CIELAB colour coordinates up to six months, demonstrated their potential for storage and large-scale application. The findings of the study highlighted, *W. tinctoria* as a sustainable, eco-friendly, and stable source of natural dye suitable for textile coloration as an alternative to synthetic dyes. With the increasing demand for eco-friendly and sustainable alternatives to synthetic dyes, *W. tinctoria* provides an environmentally safe and renewable resource for textile coloration. Beyond its technical, ayurvedic medicinal and ecological benefits, promoting the cultivation and utilization of *W. tinctoria* for dye extraction can support rural empowerment by offering new avenues for livelihood, skill development, and employment generation, particularly for local communities engaged in small-scale dyeing and craft industries. Thus, this multipurpose *Wrightia tinctoria* plant, when integrated with traditional knowledge and modern processing not only contributes to sustainable textile practices but also offers a pathway to strengthen green economies while promoting sustainable rural development.

Key words: *Wrightia tinctoria*, Natural dyes, Dye storability, Eco-friendly textiles, Rural entrepreneurship, Sustainable rural development

Introduction

Wrightia tinctoria (Roxb.) R. Br., commonly known as Pala Indigo or Dyers Oleander, is a medium-sized deciduous tree belonging to the family Apocynaceae. Native to tropical and subtropical regions of India, Sri Lanka, and Southeast Asia, it thrives in dry deciduous forests, rocky terrains, and well-drained soils. The species is hardy, drought-tolerant, and fast-growing, making it suitable for cultivation in diverse ecological conditions.

This species has long been recognized in Ayurvedic, Siddha and Unani medicine for its therapeutic efficacy in treating a variety of ailments, including skin diseases, diarrhea, fever and rheumatism (Khyade *et al.* 2014). Various parts of the plant including, leaves, bark, seeds and roots contain bioactive compounds such as flavonoids, phenolics, indole derivatives, and alkaloids. These compounds contribute to its analgesic, anti-inflammatory, antimicrobial, antioxidant, and hepatoprotective activities. Beyond its medicinal and dye-yielding properties, *W. tinctoria* has practical applications

in traditional crafts. Its wood is lightweight, smooth-grained, and easily carvable, making it ideal for crafting toys, particularly in the renowned Channapatna toy industry of Karnataka, India. The wood's durability and ease of finishing allow artisans to produce brightly colored, intricately shaped wooden toys while maintaining eco-friendly practices.

The leaves of *W. tinctoria* are particularly rich in natural pigments, including indigoid and indirubin, alongside bioactive molecules. These not only offer medicinal benefits but also impart vibrant hues when used as natural dyes. Their high pigment content, mordant compatibility, and functional properties such as antioxidant and antimicrobial activities make them a sustainable and value-added alternative to synthetic dyes.

With growing concerns over the environmental hazards posed by synthetic colorants, interest has shifted toward biodegradable, eco-friendly, and non-toxic natural dyes. In this context, *W. tinctoria* has gained recognition as a promising dye plant due to its renewable availability, ability to produce aesthetically pleasing and durable shades on natural fibers, and additional functional advantages derived from its bioactive constituents.

Thus, exploring *Wrightia tinctoria* as a dye-yielding plant not only strengthens the prospects of sustainable and green textile practices but also revives traditional wisdom while creating avenues for multipurpose economic utilization. The study aimed to evaluate the dye-yielding potential of *Wrightia tinctoria* leaves by comparing fresh and shade-dried leaf extracts in terms of colour strength and colour coordinates, and to assess the storability of dye liquids for long-term application in sustainable textile dyeing.

Materials and Methods

Fresh *Wrightia tinctoria* leaves were collected from the Western Ghats of Karnataka, thoroughly separated from stems, stalks, debris, and cleaned for further use. The dye liquids were extracted from both fresh and shade-dried leaves. Dye extraction was carried out by boiling 1 kg of leaves (fresh or dried) in distilled water under optimized material-to-liquor ratio, temperature, and extraction time, followed by filtration (plate 1). The extracts were quantified for dye material yield and total dye liquid volume. Colour strength (K/S), transmittance, and CIELAB colour coordinates (L*, a*, b*) were determined using a spectrophotometer (plate 2), and total colour difference (ÄE) was calculated between treatments. As dye liquid from fresh leave exhibited higher colour strength, they were selected for storability assessment. The fresh dye liquid was stored in sterilized glass containers under ambient conditions and analyzed at 2, 4, and 6 months for stability in colour strength and colour coordinates. All the experimental data was subjected to statistical analysis under Completely Randomized Design (CRD), with significance tested at the 5% level.

Plate 1: Dye liquids extracted from fresh and dried *Wrightia tinctoria* leaves

Plate 2 : Colour strength and colourcoordinates assessment of extracted dye liquids

Results and Discussion

Dye yield from *Wrightia tinctoria* leaves

The data in Table 1 presented the dye liquid yield obtained from 1 kg of fresh and dried *Wrightia tinctoria* leaves. Fresh leaves yielded 1000 g of dye material corresponding to 20.00 litres of dye liquid, while dried leaves yielded 600 g (60.00%) and 12.00 litres of dye liquid. The reduction in dye yield from dried leaves could

Table 1: Dye liquid yield from per kg *Wrightia tinctoria* leaves

Sl. No	*Wrightia tinctoria* leaf type	Dye material yield(g)	Dye yield (in litres)
1	Fresh leaves (1kg)	1000(100.00%)	20.00
2	Dried leaves (1kg)	600 (60.00%)	12.00

be attributed to the loss of moisture content and partial degradation of pigments during drying. Similar reductions in extractive yield due to leaf dehydration have been reported in other natural dye-yielding plants such as *Indigofera tinctoria* and *Bixa orellana* (Samanta & Agarwal, 2009; Yusuf *et al.*, 2017). This suggested that fresh leaves are more suitable for maximizing dye recovery.

Comparative analysis of dye liquids from fresh and dried leaves

The colour strength (K/S) and colour coordinates of dye liquids obtained from fresh and dried leaves are presented in Table 2. Dye liquids extracted from fresh leaves recorded significantly higher colour strength with lower transmittance (K/S = 61.35, TRN=0.01) compared to dried leaves (K/S = 49.65, TRN=0.08). The lower K/S value in dye extracted from dried leaves indicated a reduction in pigment concentration, possibly due to oxidative changes and pigment loss during drying.

The colour coordinates (L*, a*, b*) further supported these differences. Dye liquid from dried leaves exhibited darker, greener and yellower hue (L*=0.76, a*=-0.51, b*=0.33), while fresh leaves showed comparatively darker, less green and bluer hue (L* =-0.43, a*=0.47, b*=-0.27), corresponding to a darker shade of dye liquid.

The total colour difference (ÄE) between fresh and dried extracts was found to be 1.23, suggested perceptible but not drastic differences in shade. These results confirmed that dye liquids extorted from fresh leaves exhibited greater colour strength with darker, greener and bluish hue compared to dye liquids extracted from dried leaves. Comparable results were reported by Paul et al. (2014) in studies on *Indigofera tinctoria* extracts.

Table 2: Comparative analysis of dye liquids extracted from fresh and dried *Wrightia tinctoria* leaves

Colour co-ordinates	Fresh leaves	Dried leaves	S.Em. ±	CD (5%)	CV %
K/S	61.35	49.65	0.27	0.88*	2.89
Transmittance	0.01	0.08	0.02	0.06*	3.61
L*	0.43	0.76	0.04	0.13*	1.14
a*	-0.47	-0.51	0.02	0.06*	3.31
b*	-0.27	0.33	0.02	0.05*	2.47
dE	-	1.23	0.02	0.06*	4.64

K/S- Colour strength TRN- Transmittance
L-The lightness/darkness co-ordinate
a*- The red/green co-ordinate with +a* indicating red –a* indicating green
b*- The yellow/blue co-ordinate with +b* indicating yellow and –b* indicating blue

Note: As the higher colour strength was obtained from fresh leaves, the dye liquid prepared from fresh leaves was further used for storability assessment.

Effect of storage on dye liquid properties

The data in Table 3 presented the colour strength and colour coordinates of stored *Wrightia tinctoria* dye liquids at 2, 4, and 6 months of storage. The colour strength (K/S) remained relatively stable, with values ranging between 60.83 and 61.83, showing no significant reduction over 6 months. This indicated good stability of the pigments in stored dye liquids. Similar stability of indigoid pigments during storage was reported by Bechtold & Mussak (2009) in natural dye systems.

Table 3: Colour strength and colour coordinates of stored *Wrightia tinctoria* dye liquids

Colour co-ordinates	Storage intervals			S.Em. ±	CD (5%)	CV %
	2 mont.	4 mont.	6 mont.			
K/S	60.83	60.91	61.83	0.034	0.103*	0.997
Trans-mittance	0.03	0.03	0.01	0.006	0.020*	4.279
L*	0.67	0.67	0.43	0.012	0.038*	3.207
a*	-0.47	-0.10	-0.24	0.009	0.029*	1.817
b*	-0.27	-0.28	-0.27	0.020	0.061*	4.647

K/S- Colour strength TRN- Transmittance
L-The lightness/darkness co-ordinate
a*- The red/green co-ordinate with +a* indicating red –a* indicating green
b*- The yellow/blue co-ordinate with +b* indicating yellow and –b* indicating blue

Transmittance values were low across all storage intervals, with a slight reduction at 6 months (0.01), suggested that pigments remained intact and well-dispersed in the medium. Similarly, the L* values showed only minor changes, with a slight decrease (0.43) at 6 months compared to 2 months (0.67) and 4 months (0.67) indicated marginal lightening of the shade.

The a* and b* coordinates did not vary considerably around 2 months 4 months and 6 months (a*=-0.47,-0.10,-0.24 and b*-0.27,-.28,-0.27 respectively) demonstrated that greener and bluer hue of dye liquids remained stable throughout the storage period. Overall, these results confirmed that *W. tinctoria* dye liquids possess excellent storage stability, retaining both colour strength and over 6 months.

Conclusion

The present study demonstrated that *Wrightia*

tinctoria leaves as a promising source of natural dye, with fresh leaves yielding higher colour strength (K/S) compared to dried leaves. The storability assessment of fresh leaf dye liquid further confirmed its stability over six months with minimal variations in colour strength and colour coordinates, highlighted its potential for large-scale use in natural dyeing. With the increasing demand for eco-friendly and sustainable alternatives to synthetic dyes, *W. tinctoria* provides an environmentally safe and renewable resource for textile coloration. Beyond its technical, ayurvedic medicinal and ecological benefits, promoting the cultivation and utilization of *W. tinctoria* for dye extraction can support rural empowerment by offering new avenues for livelihood, skill development, and employment generation, particularly for local communities engaged in small-scale dyeing and craft industries. Thus, this multipurpose *Wrightia tinctoria* plant not only contributes to sustainable textile practices but also to the socio-economic upliftment of rural populations.

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