International Journal of Chemistry Studies
www.chemistryjournal.in
ISSN: 2581-348X
Received: 23-09-2025, Accepted: 23-10-2025, Published: 07-11-2025
Volume 9, Issue 2, 2025, Page No. 34-40

Natural dyeing cotton fabric with Hirda and Kamala fruit dye powder using different mordant– their colour fastness test & ftir analysis

Dr. Swaroopa Rani N. Gupta
Professor, Department of Chemistry, Brijlal Biyani Science College, Amravati, Maharashtra, India

Abstract
Hirda (Myrobalans / Terminalia Chebula) is a species of Terminalia, native to South Asia. The fruit also provides material for tanning leather and dyeing cloth. Terminalia chebula (Haritaki) is a main ingredient in the Ayurvedic formulation of triphala. A number of glycosides have been isolated from haritaki, including the triterpenes arjunglucoside I, arjungenin, and the chebulosides I and II. Other constituents include a coumarin conjugated with gallic acids called chebulin, as well as other phenolic compounds including ellagic acid, 2,4-chebulyl-β-D-glucopyranose, chebulinic acid, gallic acid, ethyl gallate, punicalagin, terflavin A, terchebin, luteolin, and tannic acid. Chebulic acid is a phenolic acid compound isolated from the ripe fruits. Luteic acid can be isolated from the bark. Terminalia chebula also contains terflavin B, a type of tannin, while chebulinic acid is found in the fruits. Kamala (Mallotus philippensis) is a plant in the spurge family. It is known as the kamala tree or red kamala or kumkum tree, due to the fruit covering, which produces a red dye. It occurs in South Asia, Southeast Asia. Yellow-brown flowers form on racemes. Fruit may appear at any time of the year, three months or so after flowering. Usually a three lobed capsule, 6 to 9 mm broad, covered in red powdery substance. This is soluble in alcohol, which produces a golden red dye suited to colouring of silk and wool. Mallotus philippensis is used to produce yellow dye and herbal remedies. It produces rottlerin, a potent large conductance potassium channel opener. Rottlerin (mallotoxin) is a polyphenol natural product isolated from the Asian tree Mallotus philippensis. Rottlerin displays a complex spectrum of pharmacology. Present paper deals with natural dyeing cotton fabric mordanted with Alum, Alum and Cream of tartar, Copper sulphate and Cream of tartar, Ferrous sulphate and Cream of tartar, Potassium dichromate, Stannous chloride and Cream of tartar, Tannic acid using Hirda and Kamala fruit dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis.

Keywords: Hirda, Kamala, alum, cream of tartar, copper sulphate, ferrous sulphate, potassium dichromate, stannous chloride, tannic acid, colour fastness test, ftir analysis

Introduction

Hirda (Myrobalans / Terminalia Chebula)

Hirda (Myrobalans / Terminalia Chebula) is a species of Terminalia, native to South Asia. Terminalia chebula is a medium to large deciduous tree. The dull white to yellow flowers is monoecious, and have a strong, unpleasant odour. The fruit is drupe-like, smooth ellipsoid to ovoid, 2–4.5 cm long and 1.2–2.5 cm broad, blackish, with five longitudinal ridges. They are yellow to orange-brown in colour, with a single angled stone [1-3].

Flowers

Green Fruit

Dried T. Chebula

Seven types of fruit are recognized (vijaya, rohini, putana, amrita, abhaya, jivanti, and chetaki), based on the region where the fruit is harvested, as well as the colour and shape of the fruit. Generally speaking, the vijaya variety is preferred, which is traditionally grown in the Vindhya Range of west-central India, and has a roundish as opposed to a more angular shape. The fruit also provides material for tanning leather and dyeing cloth. Terminalia chebula (called Haritaki) is a main ingredient in the Ayurvedic formulation of triphala [3-6].

A number of glycosides have been isolated from haritaki, including the triterpenes arjunglucoside I, arjungenin, and the chebulosides I and II. Other constituents include a coumarin conjugated with gallic acids called chebulin, as well as other phenolic compounds including ellagic acid, 2,4-chebulyl-β-D-glucopyranose, chebulinic acid, gallic acid, ethyl gallate, punicalagin, terflavin A, terchebin, luteolin, and tannic acid. Chebulic acid is a phenolic acid compound isolated from the ripe fruits. Luteic acid can be isolated from the bark. Terminalia chebula also

contains terflavin B, a type of tannin, while chebulinic acid is found in the fruits. The fruit extracts of Terminalia chebula also have antibacterial activity [5, 7-12].

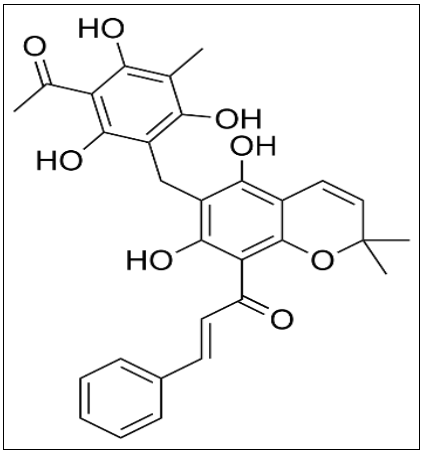
Kamala (Mallotus Philippensis)

Kamala (Mallotus philippensis) is a plant in the spurge family. It is known as the kamala tree or red kamala or kumkum tree, due to the fruit covering, which produces a red dye. It occurs in South Asia, Southeast Asia, as well as Afghanistan and Australia. Yellow-brown flowers form on racemes. Male and female flowers grow on separate trees.

Fruit may appear at any time of the year, three months or so after flowering. Usually a three lobed capsule, 6 to 9 mm broad, covered in red powdery substance. This is soluble in alcohol, which produces a golden red dye suited to colouring of silk and wool. One small black globular seed in each of the three parts of the capsule, seeds 2 to 3 mm in diameter. Fresh seed is advised for germination. It is a moderately growing tree. Mallotus philippensis is used to produce yellow dye and herbal remedies. It produces rottlerin, a potent large conductance potassium channel opener [14-15].

Kamala flowers [16]

Kamala fruit [17]



Rottlerin

Rottlerin

Rottlerin (mallotoxin) is a polyphenol natural product isolated from the Asian tree Mallotus philippensis. Rottlerin displays a complex spectrum of pharmacology [18].

The Kamala tree, also known as Mallotus philippensis, grows in Southeast Asia. The fruit of this tree is covered with a red powder called kamala, and is used locally to make dye for textiles, syrup and used as an old remedy for tape-worm, because it has a laxative effect. Other uses include afflictions with the skin, eye diseases, bronchitis, abdominal disease, and spleen enlargement but scientific evidence is not present [19-21].

The Kamala tree (Mallotus philippensis) has seed capsules which are the source of a yellow dye (Kamala dye) and were formerly a herbal remedy [22].

Present paper deals with natural dyeing cotton fabric mordanted with Alum, Alum and Cream of tartar, Copper sulphate and Cream of tartar, Ferrous sulphate and Cream of tartar, Potassium dichromate, Stannous chloride and Cream of tartar, Tannic acid using Hirda and Kamala fruit dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis.

Methodology

1. **Natural dyeing cotton fabric with alkanet and rhubarb root dye powder using different mordant**

Step 1: Cleaning Cotton Fabric for dyeing: Cotton Fabric is soaked in water and detergent (1 % weight of fabric) and heated for 30 minutes. After cooling soaked cloth rinsed with cold water then excess water is squeezed out and fabric is dried. This helps dye to penetrate fabric better.

Step 2: Mordanting Cotton fabric

Mordanting Cotton Fabric with Alum: Alum (15 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Alum and Cream of tartar: Alum (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Copper and Cream of tartar: Copper sulphate (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Iron and Cream of tartar: Ferrous sulphate (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Chrome: Potassium dichromate (15 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Tin and Cream of tartar

- Stannous chloride (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Tannic acid: Tannic acid (15 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Step 3: Making Natural Dye

Making Natural Dye using Hirda and Kamala fruit dye powder: 5 % weight of fabric Rhubarb root dye powder is taken in separate Glass beakers to it water is added and boiled for 1 hour. Then kept overnight as it is and strained. Filtrate is used as dye bath.

Step 4: Dyeing Mordanted Cotton Fabric: Mordanted cotton fabric is kept in Dye bath and heated for 1 hour. Then it is removed from dye bath and rinsed with water and bit of detergent and dried.

Step 5: Dye Fixing: 10 gm sodium chloride was added to 500 ml water. Dyed fabric is dipped in sodium chloride solution for one hour and then fabric is washed with tap water and dried in the shade.

Step 6: Ironing Dyed Cotton Fabric: Dyed cotton fabric is ironed.

Step 7: Measurment of colour: The obtained colours were measured and matched with the names of RAL Color Chart.

Step 8: Colour fastness test: Then colour fastness test are performed.

1. **Colour Fastness test for Water Fastness and Light Fastness to Hirda and Kamala fruit Dyed Fabric**

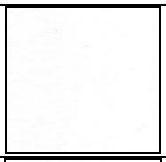
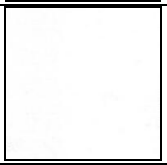
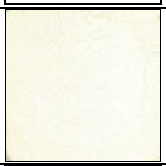
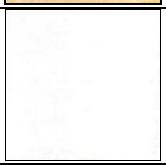
Gray Scales are used for assessing colour change and staining during colour fastness testing. Water fastness and light fastness test was performed by regular washing and drying fabric in sunlight.

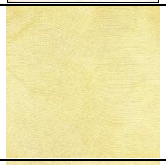
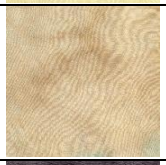
2. **FTIR Analysis of Hirda and Kamala fruit Dye Extract**

FTIR can be routinely used to identify the functional groups. FTIR spectra of Natural Dye made from Hirda and Kamala fruit dye powder are obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra are collected in range from 400 - 4500 cm-1.

Results and Discussion

1. **Natural Dyeing Cotton Fabric using Hirda and Kamala fruit dye powder**

Code No – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
00 - Cotton Fabric Not Mordanted and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 C - Cotton Fabric Mordanted with Alum and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Not Dyed		243	253	255	#F3FDFF Azure	98.64	-2.91	-2.09
0 F - Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Not Dyed		238	230	222	#EEE6DF White Chocolate	91.71	1.34	4.85
0 G - Cotton Fabric Mordanted with Potassium dichromate and Not Dyed		222	182	162	#DEB6A2 Pale Chestnut	77.04	11.48	15.61
0 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0

0 I - Cotton Fabric Mordanted with Tannic acid and Not Dyed		238	238	238	#EEEEEE Bright Gray	94.1	0	0
23 C - Cotton Fabric Mordanted with Alum and Dyed with Hirda		241	231	165	#F1E7A5 palegoldenrod	91.04	-6.34	33.42
23 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Hirda		243	236	185	#F3ECB9 palegoldenrod	92.82	-5.54	25.64
23 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Hirda		215	191	152	#D7BF98 tan	78.45	2.68	22.82
23 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Hirda		91	83	90	#5B535A dimgray	36.27	4.71	-2.89
23 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Hirda		236	225	188	#ECE1BC wheat	89.54	-2.11	19.48
23 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Hirda		246	243	212	#F6F3D4 cornsilk	95.35	-4.08	15.33
23 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Hirda		245	243	219	#F5F3DB beige	95.43	-3.34	11.82
24 C - Cotton Fabric Mordanted with Alum and Dyed with Kamala		248	237	186	#F8EDBA palegoldenrod	93.48	-4.07	26.11
24 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Kamala		248	232	180	#F8E8B4 moccasin	92.12	-2.33	27.31
24 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Kamala		245	235	200	#F5EBC8 blanchedalmond	93.01	-2.19	18.22
24 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Kamala		230	204	174	#E6CCAE peachpuff	83.48	4.54	18.3

24 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Kamala		244	227	176	#F4E3B0 moccasin	90.46	-1.81	27.06
24 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Kamala		249	244	200	#F9F4C8 emonchiffon	95.59	-5.29	21.85
24 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Kamala		236	217	176	#ECD9B0 wheat	87.29	0.32	22.61

2. Colour Fastness test for Water Fastness and Light Fastness to Hirda and Kamala fruit Dyed Fabric

Colour fastness test for water fastness and light fastness to Hirda and Kamala fruit dye powder using different mordant dyed fabric shows 4-5 range in gray scale method which indicates excellent to water fastness and light fastness.

3. FTIR Analysis of Hirda and Kamala fruit Dye Extract

FTIR spectra of Natural Dye made from Hirda and Kamala

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
394.46	Weak	-	-
414.71	Weak	-	-
427.25	Weak	-	-
458.11	Weak	-	-
520.8	Weak	-	-
632.68	Weak	-	-
755.16	Weak	-	-
873.79	Weak	-	-
1087.9	Weak	-	-
1218.1	Weak	-	-
1346.37	Weak	-	-
1439.92	Weak	-	-
1521.9	Weak	-	-
1615.45	Weak	-	-
1717.68	Strong	C=O Stretching	Carboxylic acid
2053.31	Weak	-	-
2136.26	Weak	C≡C Stretching	Alkyne
2935.78	Weak, Broad	O-H Stretching	Alcohol
3381.36	Strong, Broad	O-H Stretching	Alcohol
3404.51	Strong, Broad	O-H Stretching	Alcohol
3974.5	Weak	-	-
4286.98	Weak	-	-
4395	Weak	-	-

Interpretation of IR spectra of Natural Dye made from Kamala is done as follows

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
399.28	Weak	-	-
529.48	Weak	-	-
621.11	Weak	-	-
680.9	Weak	-	-
759.99	Weak	-	-
1022.32	Weak	-	-
1122.62	Weak	-	-
1352.16	Weak	-	-
1443.78	Weak	-	-
1621.24	Strong	C=C Stretching	α, β-unsaturated Ketone
1856.57	Weak	C-H Bending	Aromatic compound
1975.19	Weak	C-H Bending	Aromatic compound
2935.78	Medium	C-H Stretching	Alkane

3349.53	Strong, Broad	O-H Stretching	Alcohol
3852.98	Weak	-	-
3974.5	Weak	-	-
4027.54	Weak	-	-
4337.13	Weak	-	-
4630.32	Weak	-	-

Conclusion

Hex # & Color obtained are Fabric Not Mordanted and Not Dyed #F3F3F3 White Smoke, Fabric Mordanted with Alum and Not Dyed #F3F3F3 White Smoke, Fabric Mordanted with Alum and Cream of tartar and Not Dyed #F3F3F3 White Smoke, Fabric Mordanted with Copper sulphate and Cream of tartar and Not Dyed #F3FDFF Azure, Fabric Mordanted with Ferrous sulphate and Cream of tartar and Not Dyed #EEE6DF White Chocolate, Fabric Mordanted with Potassium dichromate and Not Dyed #DEB6A2 Pale Chestnut, Fabric Mordanted with Stannous chloride and Cream of tartar and Not Dyed #F3F3F3 White Smoke, Fabric Mordanted with Tannic acid and Not Dyed #EEEEEE Bright Gray, Fabric Mordanted with Alum and Dyed with Hirda #F1E7A5 Palegoldenrod, Fabric Mordanted with Alum and Cream of tartar and Dyed with Hirda #F3ECB9 Palegoldenrod, Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Hirda #D7BF98 Tan, Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Hirda #5B535A Dimgray, Fabric Mordanted with Potassium dichromate and Dyed with Hirda #ECE1BC Wheat, Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Hirda #F6F3D4 Cornsilk

Fabric Mordanted with Tannic acid and Dyed with Hirda #F5F3DB Beige, Fabric Mordanted with Alum and Dyed with Kamala #F8EDBA Palegoldenrod, Fabric Mordanted with Alum and Cream of tartar and Dyed with Kamala #F8E8B4 Moccasin, Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Kamala #F5EBC8 Blanchedalmond, Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Kamala #E6CCAE Peachpuff, Fabric Mordanted with Potassium dichromate and Dyed with Kamala #F4E3B0 Moccasin, Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Kamala #F9F4C8 Lemonchiffon, Fabric Mordanted with Tannic acid and Dyed with Kamala #ECD9B0 Wheat

Colour fastness test for water fastness and light fastness to Hirda and Kamala fruit dye powder using different mordant dyed fabric shows 4-5 range in gray scale method which indicates excellent to water fastness and light fastness.

Interpretation of FTIR Spectra of Natural Dye made from Hirda fruit dye powder shows presence of various functional groups such as O-H Stretching Alcohol, C=O Stretching Carboxylic acid, C≡C Stretching Alkyne. Interpretation of FTIR Spectra of Natural Dye made from Kamala fruit dye powder shows presence of various functional groups such as C-H Bending Aromatic compound, C-H Stretching Alkane, O-H Stretching Alcohol, C=C Stretching α, β-unsaturated Ketone

References

1. Jump up to: [a] [b] "Terminalia chebula Retz". Germplasm Resources Information Network. Agricultural Research Service, United States Department of Agriculture. Retrieved 6 Aug 2016.
2. ^ Jump up to: [a] [b] [c] [d] Flora of China: Terminalia chebula
3. ^ Jump up to: [a] [b] "The Ayurvedic Herb that Supports Immune Gut Health". Dr. Axe. Retrieved 16 November 2023.
4. ^ Jump up to: [a] [b] "Terminalia chebula". efloras.org.
5. ^ Jump up to: [a] [b] [c] "Todd Caldecott | Haritaki". Archived from the original on 2013-12-03. Retrieved 2014-05-18.
6. ^ Tewari D, Mocan A, Parvanov ED, Sah A N, Nabavi SM, Huminiecki L Ma, et al. "Ethnopharmacological Approaches for Therapy of Jaundice: Part II. Highly Used Plant Species from Acanthaceae, Euphorbiaceae, Asteraceae, Combretaceae, and Fabaceae Families". Frontiers in Pharmacology, 2017, 8 519. doi:10.3389/fphar.2017.00519. PMC 5554347. PM ID 28848436.
7. ^ Saleem A, Husheem M, Härkönen P, Pihlaja K. "Inhibition of cancer cell growth by crude extract and the phenolics of Terminalia chebula retz. Fruit". Journal of Ethnopharmacology,2002:81(3):327–336. doi:10.1016/S0378-8741(02)00099-5. PMID 12127233.
8. ^ Lee HS, Jung SH, Yun BS, Lee K W. "Isolation of chebulic acid from Terminalia chebula Retz. And its antioxidant effect in isolated rat hepatocytes". Archives of Toxicology,2007:81(3):211–218. doi:10.1007/s00204-006-0139-4. PMID 16932919. S2CID 25751621.
9. ^ Lee HS, Koo YC, Suh HJ, Kim KY, Lee KW. "Preventive effects of chebulic acid isolated from Terminalia chebula on advanced glycation endproduct-induced endothelial cell dysfunction". Journal of Ethnopharmacology,2010:31(3):567–574. doi: 10.1016/j.jep.2010.07.039. PMID 20659546.
10. ^ Nierenstein M Potter J. "The distribution of myrobalanitannin". The Biochemical Journal,1945:39(5):390–392. doi:10.1042/bj0390390. PMC 1258254. PMID 16747927.
11. ^ Han Quanbin, Song Jingzheng, Qiao Chunfeng, Wong, Lina; Xu, Hongxi. "Preparative isolation of hydrolysable tannins chebulagic acid and chebulinic acid from Terminalia chebula by high-speed counter-current chromatography" (PDF). J. Sep. Sci,2006:29(11):1653–1657. doi:10.1002/jssc.200600089. PMID 16922284.
12. ^ Prathibha S, Jenitta EPE, Rama Bhat P, Jayadev K, Shetty Shrinidhi. "Green synthesis of silver nanoparticles from fruit extracts of Terminalia chebula Retz. and their antibacterial activity". International Journal of Research in Biosciences,2015:4(2):29-35.
13. ^ Anderson, Thomas. "On the Colouring matter of the Rottlera tinctoria". The Edinburgh New Philosophical Journal,1855:1: 296–301.

14. ^ "Factsheet - Mallotus philippensis". Archived from the original on 2016-03-01. Retrieved 2016-03-04.
15. ^ "Banato / Mallotus philippensis / Kamala: Philippine Medicinal Herbs / Philippine Alternative Medicine".
16. https://upload.wikimedia.org/wikipedia/commons/9/93/Mallotus_philipensis_flowers.jpg
17. https://upload.wikimedia.org/wikipedia/commons/e/e7/MallotesPhilipensis.jpg
18. ^ Jump up to: **a b c d e f g h** Soltoff SP (September 2007). "Rottlerin: an inappropriate and ineffective inhibitor of PKCdelta". Trends in Pharmacological Sciences,2007:28(9):453–458. doi: 10.1016/j.tips.2007.07.003. PMID 17692392.
19. ^ Jump up to: **a b** Gschwendt M, Müller HJ, Kielbassa K, Zang R, Kittstein W, Rincke G, Marks F (February 1994). "Rottlerin, a novel protein kinase inhibitor". Biochemical and Biophysical Research Communications,1994:199:(1):93–98. doi:10.1006/bbrc.1994.1199. PMID 8123051.
20. ^ Rao VS, Seshadri TR. "Kamala dye as an anthelmintic". Proceedings of the Indian Academy of Sciences,1947:26(3):178–181. doi:10.1007/BF03170871. S2CID 81455004.
21. ^ Mitra R, Kapoor LD (November 1976). "Kamala--the national flower of India--its ancient history and uses in Indian medicine". Indian Journal of History of Science,1976:11(2):125–132. PMID 11610202.
22. ^ "Banato / Mallotus philippensis / Kamala". Philippine Medicinal Herbs. Retrieved 2024-06-22.