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Diversity of colourant plants in Vietnam

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Abstract
Colourant plants play an essential role in life and bring many health benefits to users, product aesthetics, and are environmentally friendly. This article aims to systematize the species of colouring plants in Vietnam according to the current taxonomy for in-depth studies on the chemical composition, extraction, and separation of natural compounds to provide raw materials for food, textile, and handicraft industries. Reviewed scientific names from more than 60 documents combined with orientation interviews. A list of species of colourant plants in Vietnam has been provided according to the APG4 classification system. A total of 305 taxa of vascular plants belonging to 226 genera and 90 families were recorded. Seventy-two threatened species were listed in the Vietnam Red Data Book (2007) and the IUCN Red List (2021). Colourant plants primarily were found in naturalized. Six life forms were found: woody, shrubs, herbaceous, vines, and bamboo, the lowest being ferns. Thirteen parts were used for dyeing; leaves were the most, followed by peels and fruits, most species for dyeing were used from 1 part, followed by two parts, four parts only one species. Eleven colours were listed from colourant plants. Most species give monochromatic colours. Seven functional groups were found, fabric/fiber dyeing has the most species, followed by food, fishing nets, teeth dyeing, hair dyeing, tanning, and others (painting, wood, letter, tissue, ink). This study is a premise for future studies on chemical composition, organic compounds, extraction, and separation of natural compounds to provide dyeing materials for the food, textile, and garment industries.

Keywords: colorant plants, fabric, yarn, food, vietnam

Introduction

Plants bring direct and indirect values to the existence and development of human society. In particular, plants' direct value to humans can be mentioned as providing food, medicine, construction, and landscaping. Especially, plants provide natural colourants for foods, fabrics, fibers, clothing, tanning, etc. In general, most natural dyes are biodegradable, environmentally friendly, have few side effects to the user, kill bacteria, treat diseases, are cheap, and are easy to find. Besides, it also provides vitamins, trace elements, and nutrients the body needs. In terms of form, natural dyes increase the aesthetics, create accents, and increase the product's attractiveness.

Vietnam is a tropical country, including 12,000 flowering plant species in its flora (Luu *et al*., 2016) [1]. This will undoubtedly be a source of raw materials for dyes that are diverse and rich in species (Luu, 2005) [2]. Vietnamese people have used colourant plants for a long time, and, even now, they remain a part of daily life (Luu *et al*., 2016) [1]. Studies on dyes are very few, including Luu and Tran (1995) [3], Luu *et al*. (2002) [4], Luan (2015) [5], and Luu *et al*. (2016) [1]. However, these studies mainly focus on the group of natural food dyes. Besides, at this time, there is no document or evidence precisely recording and describing the appearance of these plants (Luu *et al*., 2016) [1]. Therefore, this study was conducted to comprehensively and methodically evaluate the composition of natural colourant plants for dyeing food, fabrics, yarns, nets, hair, teeth, and tanning leather in Vietnam.

Materials and methodology

Inheritance: Related documents, articles, websites, and reports on coloring plants nationally and internationally.

Interview: Collecting information through interviews with hairdressers, mangrove people, vendors, and consumers in Dong Nai, Lam Dong, Dak Nong province, and consultations with researchers and experts in colouring plants.

Data analysis: Comparative morphological and expert methods were used to treat and identify plant samples. The documents used include An Illustrated Flora of Vietnam, volumes 1-3 (Pham, 1999-2003) [7]. The scientific name of the plants was determined and updated by Plants of the World Online (2021) [8] and World flora online (2021) [9]. The plant species list was arranged according to the taxonomy of Brummitt (1992) [10] combined with APG IV (2016) [11]. The life form was evaluated according to documents An Illustrated Flora of Vietnam, volumes 1-3 (Pham, 1999-2003) [7]. Colour classification, function, and origin according to the results of data synthesis. The threatened species composition was determined based on the Vietnam Red Data Book (2007) [12] and IUCN Red List (2021) [13].

Results and Discussion

Diversity of Colorant Plants

As a result of data synthesis, 305 taxa, 226genera, and 90 families belonging to 3 phyta gave dye coloration were recorded. Two hundred ninety-seven taxa were identified as species (97.38%), and eight only were identified as genera. The diversity of taxon is shown in Table 01.

Table 01: Diversity of taxon

No.	Phyta	Family		Genera		Species	
		Number	(%)	Number	(%)	Number	(%)
1	Polypodiophyta	2	2.22	2	0.88	2	0.66
2	Gymnospermae	2	2.22	2	0.88	2	0.66
3	Angiospermae	86	95.56	222	98.23	301	98.69
3.1	*Magnoliopsida*	*73*	*81.11*	*197*	*87.17*	*272*	*89.18*
3.2	*Liliopsida*	*13*	*14.44*	*25*	*11.06*	*29*	*9.51*
	Total	90	100	226	100	305	100

Most taxa were concentrated in Angiospermae with 301 species, 222 genera, and 90 families, accounting for 98.69% of species, 98.23% of genera, and 95.56% of families, respectively. Eudicots accounted for the majority, with 272 species (89.18%). Polypodiophyta, Gymnospermae, was a relatively small species with the same two species (0.66%).

We identified 72 species that had conservation value at different levels. Thirteen species were found in the Vietnam Red Data Book (2007), and 68 species were listed in IUCN Red List (2021) [13].

Eighteen most diverse families were counted (from 5 species or more), accounting for 61.30% of the recorded species. Species-rich families were represented by Fabaceae (40 species), Euphorbiaceae (17 species), Asteraceae (13 species), Rubiaceae, and Fagaceae (the same ten species), etc. (Figure 01).

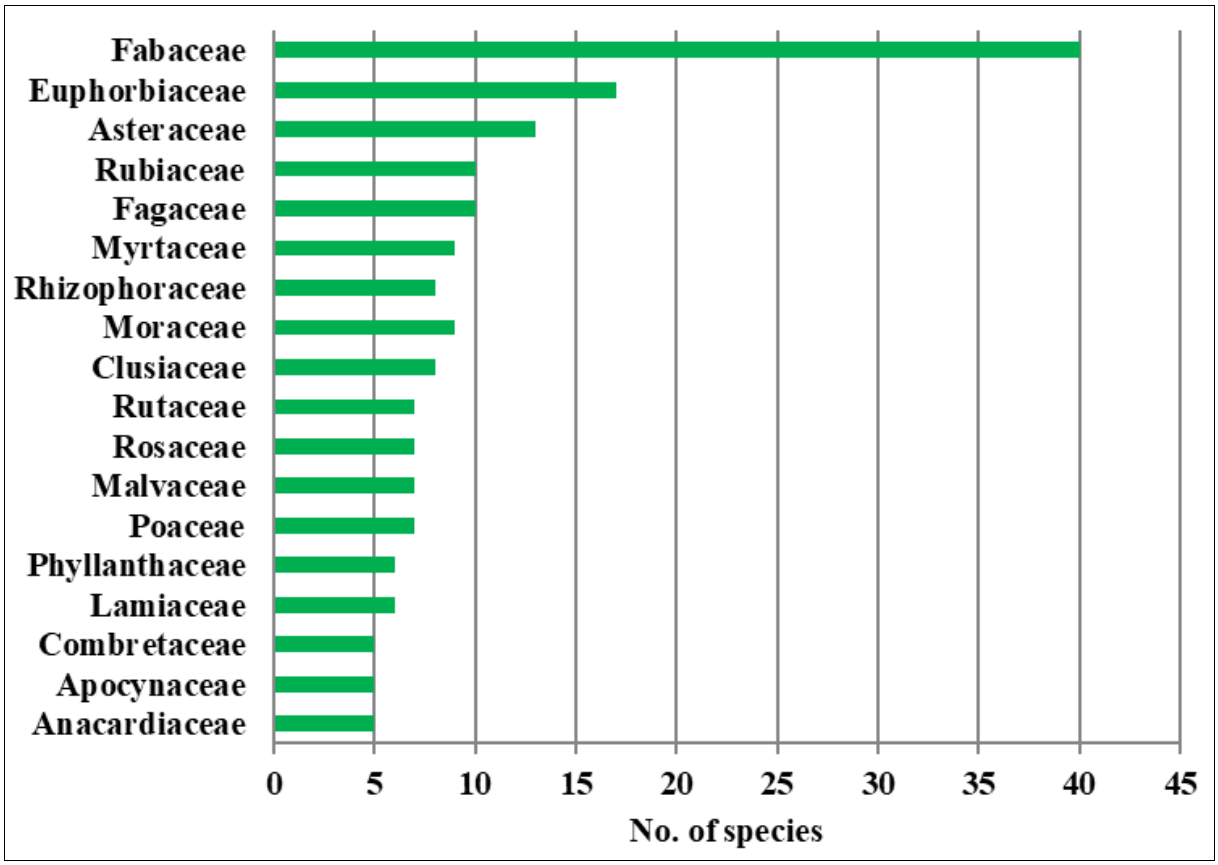

Fig 1: The most diverse families

Seven most diverse genera were counted (from 4 species or more), accounting for 11.64% of the total species found. Species-rich genera were represented by *Garcinia* (8 species), *Syzygium* (6 species), *Buddleja, Symplocos, Quercus, Indigofera, and Diospyros* (the same four species) (Figure 02).

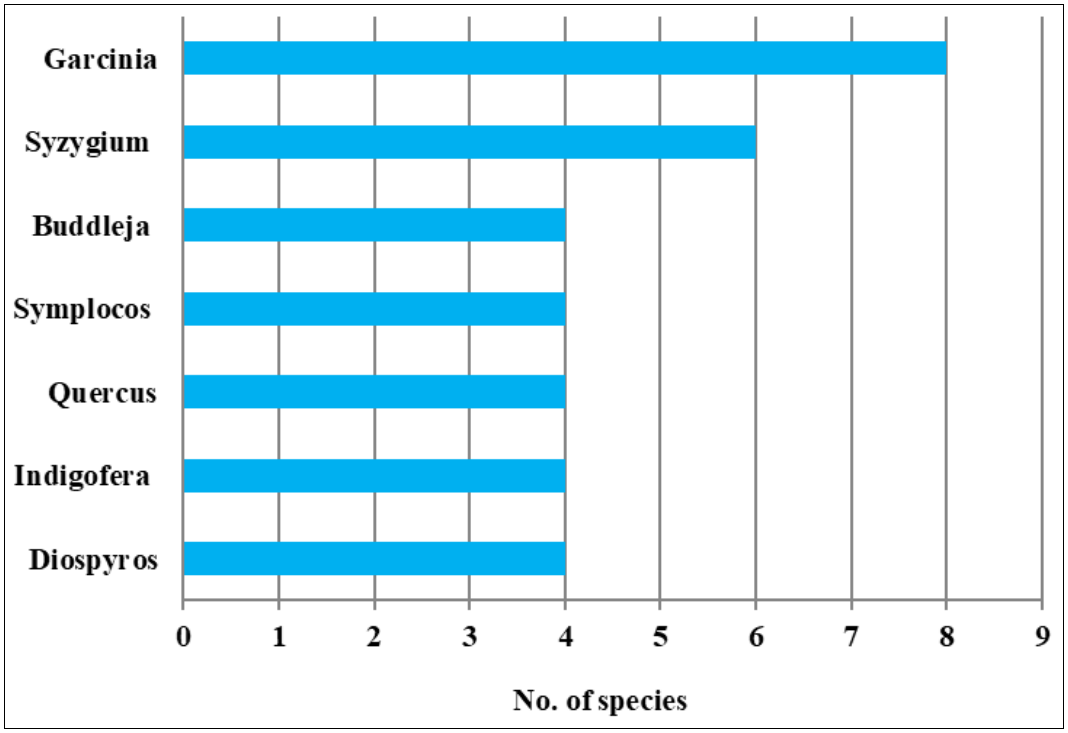

Fig 2: The most diverse genera

We also identified 76 species (25.25%) that were cultivated, 51 species (16.72%) cultivated or nativized to the wild, and 178 species (58.36%) were found native to the wild.

In this study, the number of species is higher than in previous studies conducted in Vietnam. The first study was conducted by Luu and Tran (1995) [3], who recorded over 200 plants that give dyes of 57 genera in Vietnam, belonging to 28 families. Luu *et al*. (2002) [4] discovered 114 plants used for food colouring in Vietnam. In which, Luu (2005) [2] found 46 species of higher plants belonging to 27 families used by ethnic minorities in the northern provinces of Vietnam to dye food. In 2005, Luan [5] also identified 34 species of food colouring plants in 9 northern mountainous provinces of Vietnam. Le *et al*. (2018) [6] found 49 species in 30 families for food in Vietnam.

Diversity of life-forms

We identified six life forms for dyes. The results are summarized in Figure 03.

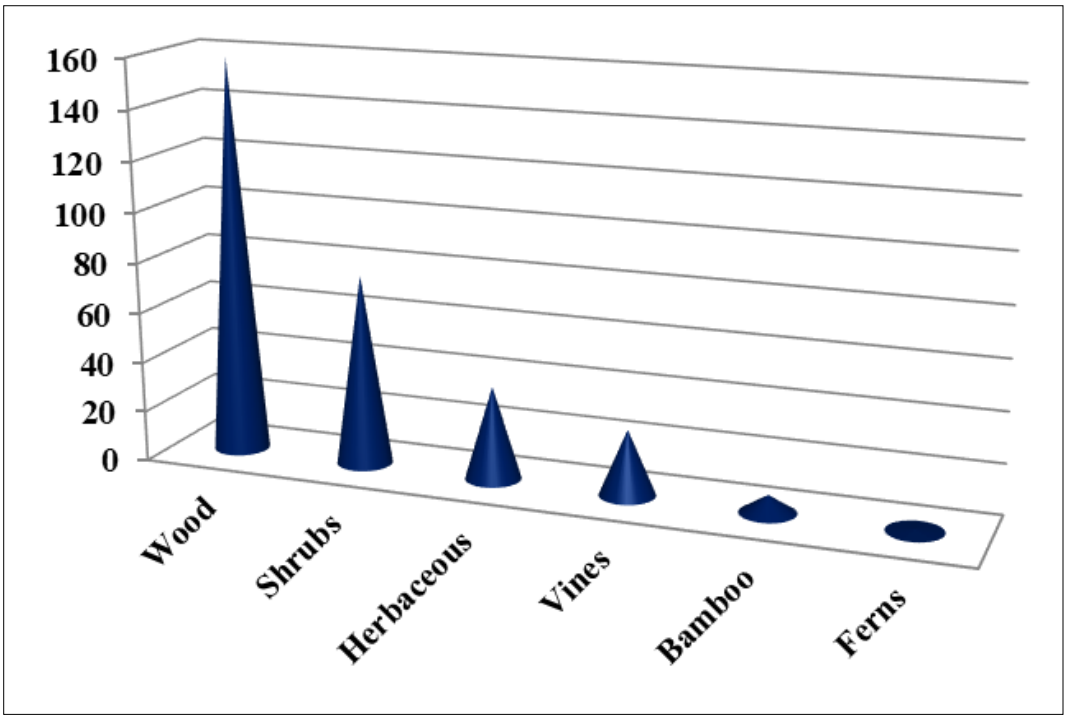

Fig 03: Life-form of Colorant Plants

Wood predominates with 158 species (51.80%), followed by Shrubs with 76 species (24.92%), Herbaceous with 37 species (12.13%), Vines with 26 species (8.52%), Bamboo (2.30%), the lowest was Ferns (0.33%).

Diversity of parts used

A total of 291/305 species (95.41%) with parts used for natural colourants were identified. The number of species with one part used for dyeing was dominant with 216 species (74.23%), followed by two parts used with 58 species (19.93%), and the lowest was four parts used with only one species (0.34%) (Figure 04).

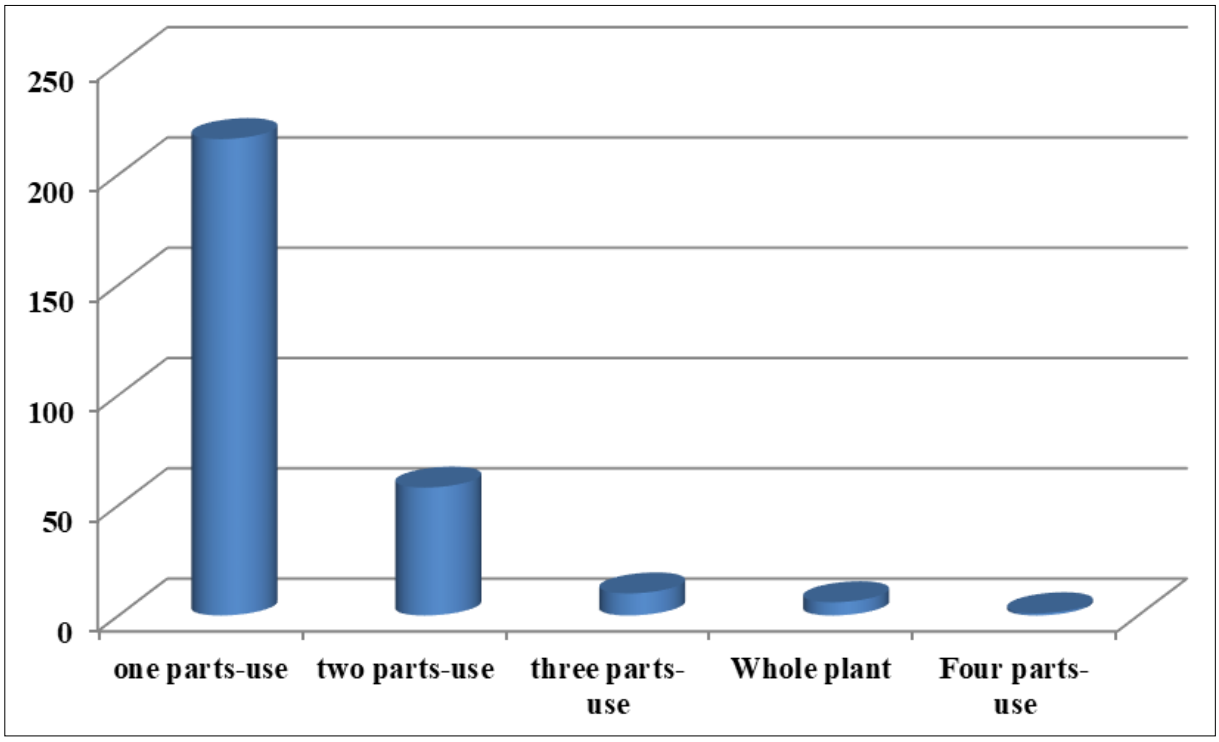

Fig 04: Species distribution by number of parts-used

We also identified 13 plant parts used that produce dyes. Leaves are the part used with the highest number of species with 110 species (37.80%), followed by Bark with 75 species (25.77%), Fruit with 51 species (17.53%), and the lowest was young treetop with only two species (0.69%) (Table 3.2).

Table 02: Diversity of parts used

No.	Parts-used	No. of species	%
1	Leaves	110	37.80
2	Bark	75	25.77
3	Fruit	51	17.53
4	Wood	37	12.71
5	Flower	27	9.28
6	Root	19	6.53
7	Seed	10	3.44
8	Resin	8	2.75
9	Tuber	7	2.41
10	Whole plant	7	2.41
11	Branches	7	2.41
12	Rhizomes	4	1.37
13	Young treetop	2	0.69
	Total	291	

Diversity of colours

A total of 283/305 species (92.79%) for natural colourants were identified. The number of species was one colour dominated with 214 species (75.62%), followed by two colours with 51 species (18.02%), the lowest for five colours (0.35%) (Figure 05).

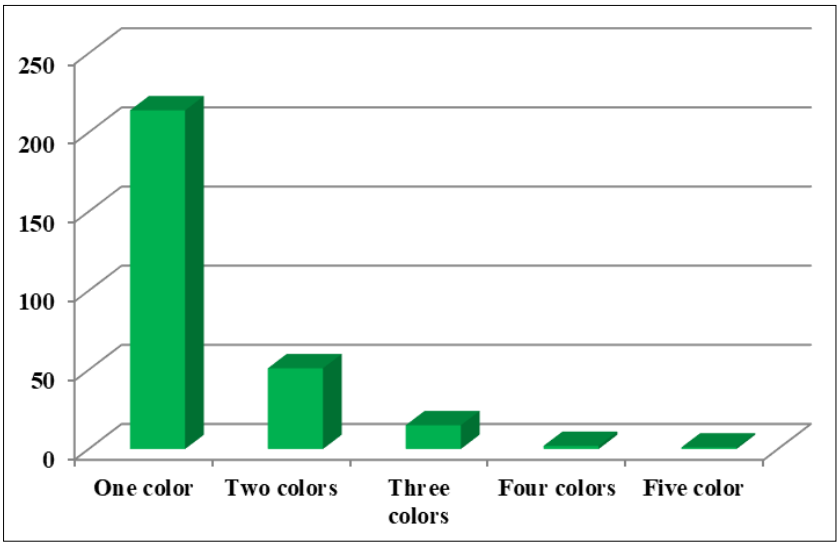

Fig 05: Species distribution by number of colors

Eleven colours created from plants were discovered. Yellow, Black, Brown, Red, and Green dominated species composition, accounting for 30.39%, 24,38%, 21.91%, 19.79%, and 14.49%, respectively. The remaining percentage was small (from 1.06% to 5.30%) (Table 03).

Table 03: Diversity of colors

No.	Colours	No. of species	Percentage (%)
1	Yellow	86	30.39
2	Black	69	24.38
3	Brown	62	21.91
4	Red	56	19.79
5	Green	41	14.49
6	Purple	15	5.30
7	Grey	14	4.95
8	Pink	9	3.18
9	Orange	4	1.41
10	Light Blue	5	1.77
11	Avocado	3	1.06
	Total	283	

Diversity of function

Seven functional groups were identified: fabric/fiber, food, fishing net, tooth dyeing, hair dyeing, tanning, and others (Painting, furniture, letter, plant tissue, ink). The composition of plant species for dyeing fabrics and yarns accounted for the most significant number with 212 species (69.51%), followed by Food with 81 species (27.87%), fishing nets with 17 species (5.57%), lowest was the other group (2.62%) (Figure 06)

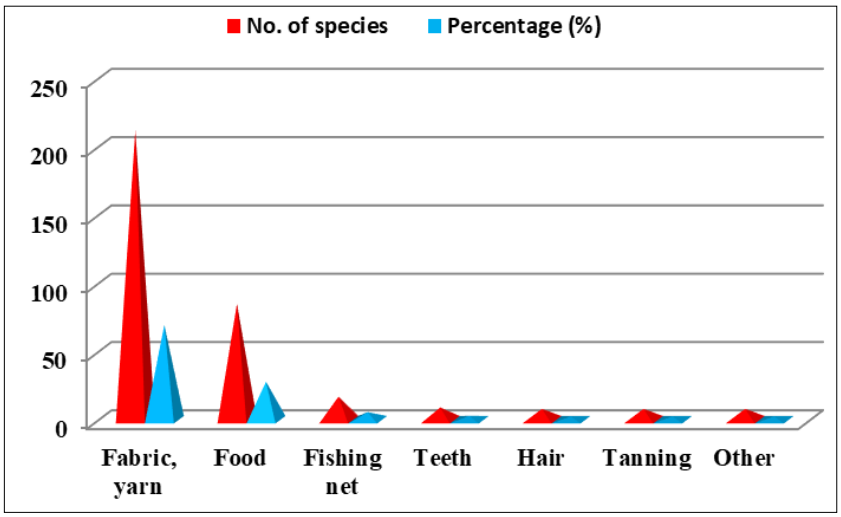

Fig 06: Diversity of function

Conclusion

A total of 305 taxa belonging to 90 families of 3 phyta were recorded. Seventy-two were listed in the Vietnam Red Data Book (2007) and the IUCN Red List (2021). Colouring plants were primarily found in nature. Six life forms, 13 parts, 11 colour types, and seven functional groups were counted. This study showed Vietnam's richness and diversity of colourant plant species composition. This valuable resource needs to be discovered to maximize its potential and the value and benefits it brings. Future studies must delve deeper into the chemical composition and organic compounds as the foundation for providing natural colouring materials for the food, textile, and handicraft industries.

References

1. Luu Dam NA, Ninh BK, Sumimura Y. Ethnobotany of Colorant Plants in Ethnic Communities in Northern Vietnam. Anthropol,2016:4:158. doi:10.4172/2332-0915.1000158
2. Luu DC. Study on extracting food dyes from the experience of using plants of ethnic minorities. Summary of scientific research topics. Center for Asian Studies. Ha Noi national university, 2005.
3. Luu DC, Tran MH. Commonly dyed plants in Vietnam. Collection of research works, Institute of Ecology and Biological Resources, 1995.
4. Luu TC *et al*. Distribution pigments in some plant species and study applicability in industry and live. Reports of Scientific Conferences of the Vietnam Union of Science and Technology Associations. Hanoi, 2002, 45-54.
5. Luan TD. Conservation and preservation of food colouring plants of ethnic minorities in the northeastern mountainous region of Vietnam. Ministry-level scientific research project. University of Agriculture and Forestry - Thai Nguyen University, 2015.
6. Le QU, Lay HL, Wu MC, Nguyen THH. Natural plant colourants are widely used in Vietnam's traditional food culture. Journal of Food, Nutrition, and Agriculture,2018:1(1):40-46. http://dx.doi.org/10.21839/jfna.2018.v1i1.220
7. Pham HH. An Illustrated Flora of Vietnam (Volume 1-3), 2nd ed, Youth Publishing, Hanoi, Vietnam. 1999-, 2003.
8. Plants of the World Online. < https://powo.science.kew.org/>. Accessed September 2021.
9. World flora online. < http://www.worldfloraonline.org/>. Accessed September 2021.
10. Brummitt RK. Vascular Plant Families and Genera, Royal Botanic Garden, Kew, 1992.
11. James W, Byng, Mark W, Chase, Maarten JM, Christenhusz *et al*. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society,2016:181:1-20.
12. Ministry of Science and Technology. Vietnam Red Data Book, Part: Plants. Natural Science and Technology Publishing House, Hanoi, 2007.
13. The IUCN Red List of Threatened Species. <www.iucnredlist.org>. Accessed September 2021.
14. Doθan, Y *et al*. Plants Used As Natural Dye Sources In Turkey. Economic Botany,2003:57(4):442-453.
15. Le VSQ & Pham THP. Review of dye plants for fabric/yarn of Vietnam, 2020, 1-56. https://docs.google.com/do
16. cument/u/3/d/e/2PACX1vS3ht1eUmi_qOTFDvu0lIf3simf2htoe0UNizIyWBj32nC7gwPMkSVOr_yMcVbXrQ/pub?fbclid=IwAR07cVtI_z_fS2SxzhB-gY1_FL3ALhf17DJolXjFaObSi_IruHKIqCRbljs
17. Avinc, Ozan, *et al*. Natural dye extraction from waste barks of Turkish red pine (*Pinus brutia* Ten.) timber and eco-friendly natural dyeing of various textile fibers. Fibers and Polymers,2013:14(5):866-873.
18. Truong NK. Study the change of critical environmental factors according to the altitude belts in the Hoang Lien Son range (in Lao Cai province) for biodiversity conservation (vascular plants) and tourism development Ecological. Thesis of PhD in Biology. University of Natural Sciences, Vietnam National University, Hanoi, 2015.
19. Yan XF, Yan QZ, Ai ZL, Alan H, Chuan FW, Liang QLi *et al*. Indigenous knowledge of dye-yielding plants among Bai communities in Dali, Northwest Yunnan, China. Journal of Ethnobiology and Ethnomedicine,2018:14:74. doi.org/10.1186/s13002-018-0274-z
20. Phung VP. Study on flora in Mau Son natural forest, Lang Son province. Journal of Forestry Science and Technology,2019:1:71-78.
21. Lam VT. Study on morphological and ecological characteristics of plants used for food colouring in Binh Gia district, Lang Son province. University graduation thesis. Nong Lam University, Thai Nguyen University, 2014.
22. Dau BT. Study on vascular plant diversity in Pu Luong Nature Reserve, Thanh Hoa. Thesis of PhD in Biology. Vinh University, Nghe An, 2013.
23. Richardson D and Sue. Asian Textile Studies. Internet: Http://Www.Asiantextilestudies.Com/, 2020
24. Huu N (editor), Vu VC. Dictionary of Vietnamese Traditional Culture. World Press, 1992: 511.
25. Sy DT, Le NC, Daophone PP. Study the diversity of vascular plants in phoenix protection forest, Dai Tu district, Thai Nguyen province. National Scientific Conference on Ecology and Biological Resources, 6th, 2015, 922-927.

26. Nguyen TH. Study on morphological and ecological characteristics of food colouring plants in Bac Quang District - Ha Giang Province. University graduation thesis. The University of Agriculture and Forestry-Thai Nguyen University, 2014.
27. https://www.jardineriaon.com/vi/nh%C3%A0-m%C3%A1y-nhu%E1%BB%99m.html
28. Ly TT. Study indigenous knowledge on using plants as food colourants in Thai Nguyen province. University graduation thesis. University of agroforestry. Thai Nguyen University, 2015.
29. Luu DC, Nguyen QB, Yoshinori S. Traditional dyeing plant of the Black Thai people in Thuan Chau district, Son La province. National Scientific Conference on Ecology and Biological Resources, 5th, 2013, 917-922.
30. Dang MQ. Study on plant diversity according to forest ecosystems of Phu Quoc National Park. Thesis of PhD in Biology University of Science, Vietnam National University, Hanoi, 2015.
31. Kusumawati N, Santoso AB, Sianita MM, Muslim S. Extraction, Characterization and Application of Natural Dyes from the Fresh Mangosteen (Garcinia mangostana L.) Peel. International Journal on Advanced Science, Engineering and Information Technology, 2017: 7(3): 878. doi:10.18517/ijaseit.7.3.1014.
32. Shigeyuki B, Hung TC, Sanit A. Useful products of mangroves and coastal plants. Phan Van Hoang (translated). International Association of Mangrove Ecosystems International Tropical Timber Organization, 2011.
33. Guo-Q, Tian TC. A Dyeing Experiment of Pure Silk Fabric Using Leaf Pigment of Vaccinium Bracteatum As A Natural Dye. Science of Sericulture,2011:5:13
34. Senthilkumar RP, *et al*. Natural Colours From Dyeing Plants For Textiles. International Journal of Biosciences And Nanosciences,2015:2(7):160-174.
35. Tran VH. Study on diversity of vascular flora in Phia Oac-Phia Den National Park, Cao Bang Province. Thesis of PhD in Biology. Academy of Science and Technology. Vietnam Academy of Science and Technology, 2020.
36. Luu DNA, Nguyen QB, Yoshinori S. Traditional colourant plants of Black Thai people In Thuan Chau District, Son La Province. National scientific conference on ecology and biological resources, 5th, 2012, 917-922.
37. Nguyen DH. Study on diversity of vascular flora and propose conservation solutions in Pu Hoat Nature Reserve, Nghe An province. Thesis of PhD in Biology. Academy of Science and Technology. Vietnam Academy of Science and Technology, 2020.
38. Hoang TL. Natural Dyes In Eastern Asia (Vietnam And Neighbouring Countries). Handbook Of Natural Colorants, 2009, 65-72.
39. Chuprayoon S, Sirimungkarat S, Pojun D. Development of Natural Dye Standard For Eri Silk. In: 47. Kasetsart University Annual Conference, Bangkok (Thailand), 2009.
40. Kumar V, Prabha R. Extraction And Analysis Of Natural Dye. Journal of Natural Products and Plant Resources,2018:8(2):32-38
41. https://www.ydhvn.com/news/cay-duoc-lieu-cay-go-mat-go-den-sindora-siamensis-tejsm-ex-miq-var-siamensis-s-cochinchinensis-hbaill
42. Shan L, Anthony BC, Ru YF, Yu HW. Identity blues: the ethnobotany of the indigo dyeing by Landian Yao (Iu Mien) in Yunnan, Southwest China. Journal of Ethnobiology and Ethnomedicine,2019:15:13. doi.org/10.1186/s13002-019-0289-0
43. Vankar PS, Shanker R, Wijayapala S. Dyeing Cotton, Silk and Wool Yarn with Extract Of Garcinia Mangostana Pericarp, Journal Of Textile And Apparel, Technology And Management,2009:6(1):1-10.
44. Boer E and Lemmens RHMJ. *Pterospermum diversifolium* Blume. In: Sosef MSM, Hong LT And Prawirohatmodjo S (Eds) Plant Resources of South-East Asia. Timber Trees: Lesser-Known Timbers. Backhuys Publishers. Leiden, 1998, 5(3).
45. Lemmens RH MJ, Toona C MR. In: Louppe,D, Oteng-Amoako AA & Brink M (Editors). Prota (Plant Resources Of Tropical Africa / Ressources Végétales De L'afrique Tropicale), Wageningen, Netherlands. Accessed, 2020.
46. Kundal JSVS, Singh SV, Purohit MC. Extraction of Natural Dye From Ficus Cunia And Dyeing Of Polyester Cotton And Wool Fabric Using Different Mordants, With Evaluation Of Colour Fastness Properties. Natural Products Chemistry & Research,2016:4(3):1-6
47. Nellis DW. Poisonous Plants and Animals of Florida and the Caribbean. Pineapple Press Inc,1997, 227.
48. Adeel, Shahid, *et al*. Environmentally friendly plant-based natural dyes: Extraction methodology and applications. In: Plant and Human Health, Volume 2. Springer, Cham, 2019, 383-415.
49. Kültür S. An Ethnobotanical Study of Kırklareli (Turkey). Phytologia Balcanica,2008:14(2):279-289.
50. Vu AT. A new record of species *Rubia tinctorum* L. (Rubiaceae) for the flora of Vietnam. Journal of Biology,2012:34(4):452-454.
51. Gokhale SB, *et al*. Natural Dye Yielding Plants, 2004.