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Plant originated colour pigments used in traditional arts

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Abstract
Keeping in mind as one of the leading arts and paintings and their dependency upon colour for its impact, mood and depth, colour played a very important role. The effect of colour on the viewer visual senses is highly potent and even one tiny dab of brightly coloured pigment in an otherwise monochromatic picture can transform the work. Even the earliest exponents of prehistoric cave painting (30,000-12,000 BC) were experts in the use of primitive pigments, obtained from the plants. Traditional plant originated pigments used by prehistoric cave painters and artists from Ancient Antiquity, as well as colours which appeared in palettes of the Renaissance, Baroque, Rococo and Impressionist periods. Since the late-19th century, the majority of pigments employed by most painters are improved synthetic variants of traditional older colours. Malus (Apple) bark used for yellow colours, while Rubus berries for pink, Areca catechu for deep pink colour and many more plants are used in traditional arts.
But nowadays, most natural colourants are obsolete. Modern artificial colours tend to be more lightfast, more permanent, more intense and considerably cheaper and safer to use. It's amazing how many of the older pigments (both natural and early synthetic variants) were highly toxic compounds containing lead, mercury, chrome and arsenic - even cyanide. The total 35 plant genus belonging to 36 species are listed in the table 1 which are used for obtaining colours from various parts.

Keywords: plant parts, colour pigments, traditional arts, suggested mordant

Introduction
Pigments are the raw materials of painting and art. They are insoluble particles that impart colour and some degree of hiding power over the surface to which they are applied [1]. Pigments, and advances in their technology, have influenced the development and history of Western art since its earliest forms. Pigment creation has been paralleled to some extent by the development of paints and binders into which the pigments could be dispersed. This paper reviews the history of art from the perspective of the pigments used to create that art and the development and influence of science and technology in art.

Primitive Pigments
Primitive man used pigments from his natural environment in painting, thus the pigments found in different areas of the world tend to vary [3]. It is thought that pigments were applied by two methods [2, 4]. The first was to mix pigment with animal fat and apply it as a paint with the fingers or a reed. The second method was to blow pigment powder onto the painting surface using a hollow tube.
Many early dyes were discovered by the ancient Egyptians, such as blue woad (*Isatis tinctoria*), indigo (*Indigofera* tinctoria) and red madder (*Rubia tinctorum*), which all came from plants, and red carmine, which was produced from the kermes beetle [5, 6]. These dyes were converted into pigments by making lakes, a technology pioneered by the early Egyptians. Laking is the precipitation of a dye onto particles of an insoluble, colourless binder such as chalk or white clay. The Egyptians may have also produced lakes by complexing the dye molecules with metal salts such as aluminum from alum.
Woad and indigo were extracted from the leaves of their respective plants with hot water, and the laked pigments were made by scraping off the foam that formed on top of the extraction and purple were extracted from the root of the plant by an aqueous filtration process. The dried ground roots were mixed with water and treated in a series of stages with alkali, then filtered through meshes to extract the colouring matter. The red dye was converted into a lake pigment by precipitation onto a binder, although it is not clear whether the Egyptians actually used madder lake as a pigment.
Carmine, a red colorant mentioned in the Old Testament and by Pliny [7-9], was probably first used as a lake pigment as early as Egyptian times. It was obtained from the kermes beetle, which is native to Europe and Asia, and found on various types of oak trees [9]. The female insect attached itself to the oak tree to lay eggs, and then both were collected just before hatching and killed with vinegar. The colour was extracted by pouring boiling water onto the dried insects to release the water soluble kermesic acid, which was then precipitated with iron-free alum to give an insoluble lake pigment [10].
Two yellow pigments of note were introduced to Europe from the East around 1600 [11]. European links with the Near and Far East were just beginning to expand [12], and in England many new items were imported by the East India Company [13]. The first of these pigments was gamboge5, an organic pigment made from the gum of the *Garcinia* evergreen tree.

The trees were tapped by making incisions in the bark to let the gum drip out; the gum was then heated and run into hollow bamboo tubes where it was left to set. The hardened gum was removed for sale as hard sticks in Europe. Gamboge was used as a water colour pigment and was something of a novelty, being both a pigment and a binder combined into one [1, 14].

The second yellow pigment imported from the East was called Indian yellow [18], and was made in only one small region of India near Monghyr [15]. The pigment was made by feeding cows solely on a diet of mango leaves, which caused their urine to become bright yellow. The urine was collected and heated in order to precipitate the yellow colorant, which was then separated and formed into lumps ready for sale. Indian yellow was used mainly in water colours and was a bright, very light fast pigment. Its use only declined when the Indian government later banned its manufacture on the grounds of animal cruelty [16].

Both of these yellow pigments were widely used by artists before they were replaced in this century by synthetic colorants that were more reliable. Besides the various uses of plant originated natural pigments in paintings and arts, their permanency as well as shining can also be imorovec by using chemical mordant as suggested in table 1 agaisnt each colour.

Observations and Results

The scientific names of plants along with the common English names listed in Table 1 arranged in alphabetical orders, a selection of plants that have stood the test of time, and are used widely and traditionally. Natural colour pigments fall into the following categories:

- Leaves and stems
- Twigs
- Petals and flower heads
- Kernel skins and nuts
- Unripe fruits
- Barks
- Rhizomes and roots
- Outer skins, Scales of wood
- Whole plants
- Berries and immature fruits
- Lichens

Table 1: Plants are arranged according to the alphabetical orders of scientific names along with popular English names, parts used and colour obtained with their suggested mordant

S. No.	Scientific Names	English/Common Names	Plant Parts Used	Colours obtained	Mordant Suggwsted
1.	*Acer saccharum*	Maple	Bark	Tan	Copper Sulphate
2.	Allium cepa	Onion	Skin (scaly leaves)	Yellow Orange	Alum
3.	*Anchusa tinctoria*	Alkanet	Roots	Grey	Alum cream of tartar
4.	*Arachis hypogea*	Groundnut	Kernel skins	Purple, brown, pink deep pink	Copper sulphate
5.	*Areca catechu*	Areca nut	Nuts	Deep pink	Alum
6.	*Butea monosperma*	Forest fire/palas	Flower	Orange	Alum
7.	*Calendula officinalis*	Scotch marigold	Flower heads	Yellow	Alum
8.	*Camelia sinensis*	Tea	Leaves	Beige	Tea
9.	*Carthamus tinctoria*	safflower	Flower heads/Petals	Yellow, red	Alum
10.	*Chlorophoria tinctoria*	Dyer's mulberry	Wood scales	Yellow	Fustic
11.	*Curcuma longa*	Turmeric	Rhizome	Yellow	Alum
12.	*Dahlia pinnata cav.*	Dahlia	Petals	Dark yellow	Alum
13.	*Diospyros peregrina*	Gaub tree/pale moon ebony	Unripe fruits and leaves	Blank and grey	Alim
14.	*Eucalyptis citriodora*	Eucalyptus	Leaves	Dark grey And gold	Copper Sulphate
15.	*Genista tinctoria*	Dyer's green weed	Flowering twigs	Dark yellow	Alum
16.	*Hypogymnia psychodes*	Linchen	Whole linchen	Brown	Alum
17.	*Irohgofera tinctoria*	Indigo	Leaves and immature pods	Blue	Not required
18.	*Isatis tinctoria*	Woad	Whole plant	Blue	Lime
19.	*Jacaranda mimosifolia*	Jacrand	Petals	Purple & blue	Alum
20.	*Lawsonia inerrnis*	Hinna	Leaves	Orange yellow & gold	Not required
21.	*Ligustrum vulgare*	Common Privet	Leaves and berries	Yellow, green, red & purple	Alum, Tin
22.	*Malus pumila*	Apple	Bark	Yellow	Alum
23.	*Mercurialis perenis*	Dog's markary	Whole plant	Yellow	Alum
24.	*Nyctanthus arbortristis*	Night flowering Jasmine	Corolla tube	Orange yellow	Copper, Alum
25.	*Ochrolechina parella*	Lichen	Asa whole	Orange & red	Alum
26.	*Prunus avium*	Cherry	Bark	Yellow, brown	Alum
27.	*Prunus spinosa*	Blue berris	Berries, bark	Brown, Red	Alum
28.	*Quercus* species	Oak	Inner bark	Gold, brown	Alum
29.	*Rhamnus cathartica*	Buckthorn	Bark, berries	Brown, yellow	Iron, tin, cream of tarter
30.	*Rubia tinctoria*	Madder	Whole plant	Red, orange	Alum, tin
31.	*Rubus lociniatus*	Black berry	Berries	Purple	Alum, tin
32.	*Salix nigra*	Black willow	Bark	Brown, Red	Iron
33.	*Sambucus nigra*	Elder	Berries, bark, leaves	Grey, yellow	Iron, alum
34.	*Sanguinaria canadensis*	Blood roots	Roots	Red	Alum, tin
35.	*Senecio vulgaris*	Stinking willie	Ragwart flowers	Deep yellow	Alum
36.	*Urtica dioica*	Nettles	Leaves	Green, yellow	Alum, copper

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