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Extraction of Dyes from *Carthamus tinctorius*(Safflower) and *Jatropha curcas* (Physic nut) from Southern Shan State, Taunggyi (Myanmar)

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Abstract: In this study, a natural dye extraction was carried out to isolate dyestuff extract. The safflower flowers (*Carthamus tinctorius*) that are usable to extract dye was collected from Pin Phyit model village, Yawk Sauk township, Southern Shan State and the bark of *Jatrophacurcas* (Physic nut) was collected from Taunggyi. The dyes were extracted by using the solvents such as distilled water and 10% Na_2CO_3 solution. The water soluble yellowish dye was extracted from yellow colored safflower flower florets. The water soluble dark yellow colored dye was extracted from complex colored safflower flower florets. The alkali soluble dark red dye was extracted from complex colored safflower flower florets by using 10% Na_2CO_3 solution. The yield percents of yellow, dark yellow and dark red dyes were 26%, 26.5% and 2.2%. R_f values of the yellow dye, dark yellow and dark red dye were 0.78, 0.78 and 0.8 respectively. Extracted dyes were compared with the dyes used in curried rice by paper chromatography method. According to chromatograms, R_f values of safflower dyes were the same with that of the food dyes. According to the literature, yellow dye may be *carthamidin* and reddish brown dye may be *carthamin*, but it can not be confirmed due to the lack of authentic. The dyes of safflower flowers can be used as food dyes. The bark of *Jatropha curcas* extracted by using ethanol in both wet and dry basis. The yield percents of dyes with wax extracted from *Jatropha curcas* were 15% and 15.2 %.
Keywords: Safflower, extracted dye, *carthamin*, *Jatropha*.

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Introduction

Safflower; (*Carthamus tinctorius* L.) is a thistle-like herb belonging to the family Asteraceae or Compositae. It is one of humanity's oldest crops cultivated in India mainly for oil from the seeds and a reddish dye from the flowers. Though, safflower flowers have been used in preparations of ayurvedic medicines in India and also merit mention in European and Japanese pharmacopoeias, the interest in this crop has been rekindled in the last few years as the medicinal use of these flowers in China has become more widely known [1].

China has a significant area under safflower plantation , but it is grown almost exclusively for its flowers, which are harvested for use in traditional medicines, and the production is not included in international crop estimate reports. Safflower flowers are used in China for the treatment of many illnesses as well as in 'tonic tea' [4]. The safflower seed is mainly used for wild birds. It also caters to racing pigeons, parrots, other pet birds, gerbils, hamsters and to commercial small animals such as chinchillas [6]. Normally the birdseed market commands a premium over the oil market. Most Canadian produced safflower is for the birdseed market. Seed must meet stringent standards to qualify as birdseed [9].

A health-conscious population in developed countries has created the most significant market for safflower oil as salad oil, margarine and cooking oil. The oilseed market demands seed with over 38% oil. The Japanese market prefers levels over 40% and has generally purchased safflower from California where oil levels tend to be high. The actual oil content of the de-hulled safflower seed is relatively constant at 59 to 64%. These may contain 75 to 80% oleic acid. The full-fat oilseed safflower (at 16-18% protein) or the meal left after oil extraction (at 24% protein) may be used as a livestock feed. Safflower meal is a high protein by-product remaining after extraction of the oil from safflower seeds. Until this century, when cheaper aniline dyes became available, safflower was mainly grown for dye. The water-soluble yellow dye, carthamidin, and a water-insoluble red dye, carthamin, which is readily soluble in alkali, can be obtained from safflower florets. Dye manufacture has virtually ceased in Asia, but dye is still prepared on a small-scale for traditional and religious occasions [10]. In order to get a better colouring effect from carthamin, the yellow colour first has to be separated from it. For extracting the dye, fully-grown flower heads are collected every second or third day before they fade. They are then dried in the shade. Florets can be collected, after the crop ripens, so that dye and oilseed can be obtained from the same crop [7].

Colouring 1kg of cotton yarn crimson requires 1 kg of dye, rose pink requires 500g and light pink 250g. The main active ingredient in safflower medicines is safflower yellow, which is water-soluble, but alcohol extracts are used in some preparations. Many clinical and laboratory studies support the use of safflower medicines for menstrual problems, cardiovascular disease and pain and swelling associated with trauma. Safflower yellow is present in the dried florets to the extent of 26-36 percent [7]. To commercialize safflower flowers in India, efforts have been initiated to popularize them as an herbal health tea for curing several chronic diseases. Regular users of this tea have reported its usefulness in alleviating diseases like hypertension, spondylosis, angina, arthritis, constipation, menstrual disorders and hypercholesterolemia [7].

The latex of *Jatropha* contains the alkaloids such as 'jatrophine', 'jatropham' 'Jatrophone' and 'curcain' which are believed to have anti-cancerous properties. Leaves contain apigenin, vitexin and isovitexin. The-amyrin, stigmosterol and stigmastenes along with two new flavonoid glycosides found in leaves and twigs. The seed fat is rich in palmitic, oleic and linoleic acids. The toxicity of the seeds is because of 'curcin' alkaloids. It is used to dress sores and ulcers and inflamed tongues. The alkaloids of latex such as Jatrophine and Jatropham are found to have anticancerous properties. The latex is applied topically against honey bees and wasp stings. It is also used as an external application for skin diseases, burns ring worms, haemorrhoids and ulcer. The tender twigs are used for cleaning teeth. *Jatropha* grows readily from plant cuttings or seeds up to the height of 3-5 m. *Jatropha* is not considered good forage material. The plant is highly pest and disease resistant. Various parts of the plant are of medicinal value, its bark contains tannin, the flowers attract bees and thus the plant is honey production potential.

Jatropha removes carbon from the atmosphere, stores it in the woody tissues and assists in the buildup of soil carbon. The research on indigo, a major requirement of dyeing industry is a milestone in the field of biological dye extraction [12].

A package of simplified technology has been developed first in the world for transfer to villages so as to benefit women and traditional farmers. Special tanks which could serve for both soaking the harvested indigo plants for fermentation and then for oxidation of the fermented liquid have been designed and erected. Use of special nets to hold the plants during the soaking and fermentation processes prevents plant debris from contaminating the dye preparation. The innovations minimize the time for the extraction process and augment the quantity and quality of the dye [2]. The extraction methods, characterisation and application of dyes from other sources like *Cassia augustifolia*, *Peltaphorum ferrugeneum*, *Bixa orellana*, *Jatropha curcas* as well as certain bacteria, fungi, algae and lichens are also being investigated [11]. Extraction of some coloured compounds from a few microbes in the laboratory has already been achieved. Studies on the properties of dyes from the microbes and the higher plants under investigation as well as on the use of natural dyes in paper and textile industries are being pursued now [8]. The whole plants, flowers, seeds, and oil have a wide range of medicinal uses in different countries. A 'tea' from safflower foliage is used to prevent abortion and infertility by women in India and Afghanistan. Flowers are used as tonics for a multitude of conditions in China, such as dilation of arteries, reduction of hypertension, increase of blood flow, thus oxygenation of tissues. Seed decoctions are used with sugar as laxative in Pakistan, for flushing out urinary tracts in Kashmir, and ground up and mixed with mustard oil, to reduce rheumatic pains in Bangladesh. The oil is used in Iran to treat liver and heart ailments and in charred state in India to treat sores and rheumatism [2, 3].

Materials and Methods

Sample collection

During March 2019, complex colored safflower flowers were collected from Pin Phyit model village in Yawk Sauk Township, Southern Shan State (Myanmar). Then, they were dried in the shade and safflower florets were obtained. Safflower florets were separated as yellow colored and complex colored petals. The water-soluble yellow dye, *carthamidin,* and a water-insoluble dark red dye, *carthamidin*, which is readily soluble in alkali, can be obtained from safflower petals. The bark of *Jatropha curcas* were collected from Taunggyi, Southern Shan State (Myanmar) extracted by using ethanol in both wet and dry basis.

Chemicals

All chemicals used in this work were from British Drug House Chemical Ltd., Poole, England. All standard solutions and other diluted solutions throughout the experimental runs were prepared by using distilled water. In all the investigations the recommended methods and standard procedures involving both conventional and modern techniques were employed [4]. All other chemicals and reagents used were of analytical grade.

Extraction of Dyes from Safflower flowers

Extraction of Yellow Dyes with water

In a beaker, about 10 g of the yellow colored safflower petals were mixed with 300 cm^3 of hot distilled water and soaked for one night. Yellow dye was extracted and the process was repeated until the no color was observed in the extract. Then, the extract was placed in a porcelain basin and heated by using water-bath. The basin was cooled in a desiccator and weighed. Heating, cooling and weighing was repeated until constant weight was obtained.

Extraction of Dark Red Dyes with alkali

About 10 g of the safflower petals after extracted with water were mixed with 100 cm^3 of warm 10% Na_2CO_3 solution and gently heated for about one hour .Then it was poured into a wet filter paper and washed with cold water. The filtrate was acidified with acetic acid; a reddish brown dye was precipitated. The dye was filtered, dried in an oven and weighed. Drying and weighing were repeated until constant weight was obtained.

Preparation of Paper Chromatography

The solvent system was prepared by mixing NaOH, distilled water and ethanol (1:1:1V/V) and shaking into a clear solution. It was prepared just before use. Whatman paper number-43 was used in this procedure. The used paper size was 5 cm x 20 cm. The dye sample solution was applied to the starting line of the paper 1.5 cm from the bottom edge for convenient immersing in the solvent when the paper was placed in the developing tank. The sample was applied using a fine glass capillary tube to minimize the spotting area. After the spot had been allowed to dry, the paper was placed almost vertically in the developing tank containing the solvent system. The paper was taken out to dry (air drying).

Extraction of Dye from *Jatropha curcas*

About 30 g of the bark was mixed with 400 cm^3 of ethanol and gently heated for about one hour. A dark green dye with wax was produced on wet basis. The dye was filtered, dried in an oven and weighed.

Dyeing with safflower dye powder

Dye powders extracted from Safflower flowers were dissolved in water and boiled. Then pieces of white cotton and pink colored linen were placed and soaked overnight. The next morning, the cotton pieces became ruddy brown and yellow as shown in figure.

Dyeing with *Jatropha* dye powder

Dyes with wax extracted from *Jatropha curcas* were dissolved in ethanol and boiled. Then, pieces of white cotton were placed and soaked overnight. The next morning, the cotton pieces became beige as shown in figure.

Figure 1. Plant of *Carthamus tinctorius* (Sufflower flower)

Figure 2. Plant of *Jatropha curcas* (Physic nut)

Figure 3. Flowers of Safflower

Figure 4. Extracts of dyes from Safflower Flowers

Figure 5. Extracts of dyes from Safflower Flowers

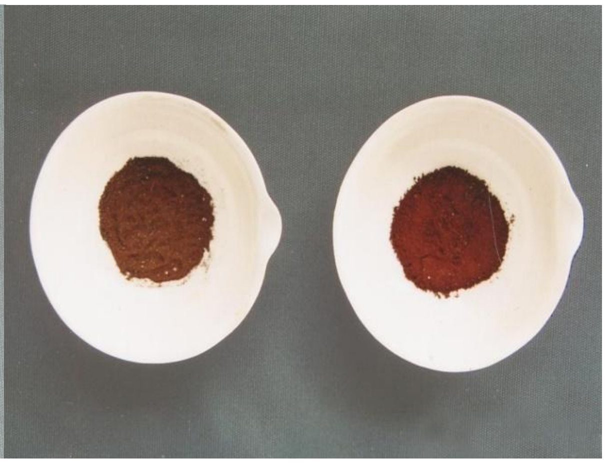

Figure 6 Extracted dyes from Safflower Flowers

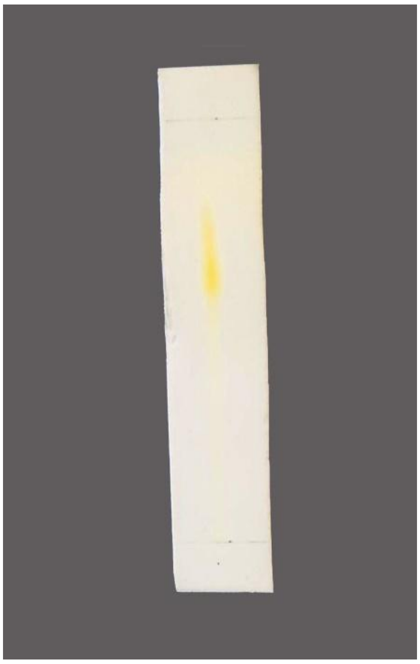

Figure 7. Chromatogram for Safflower dye

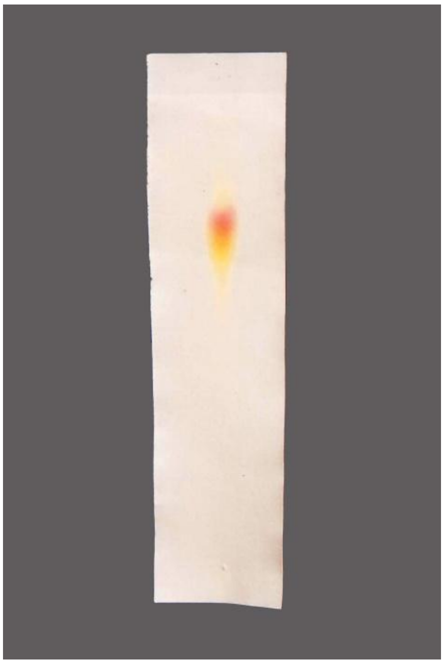

Figure 8. Chromatogram for the mixture of sample dyes and food dyes

Table 1. % Value of Dyes Extracted from Safflower flower (*Carthamus tinctorius*)

Dyes	% value	R_f value	Curried rice R_f value
Yellow	26.00%	0.78	0.78
Dark Yellow	26.60%	0.78	0.78
Dark red	2.20%	0.80	0.81

Table 2. % Value of Dyes Extracted from *Jatropha curcas* (Physic nut)

Dyes	% value
Wet dyes	15.00%
Dry dyes	15.20%

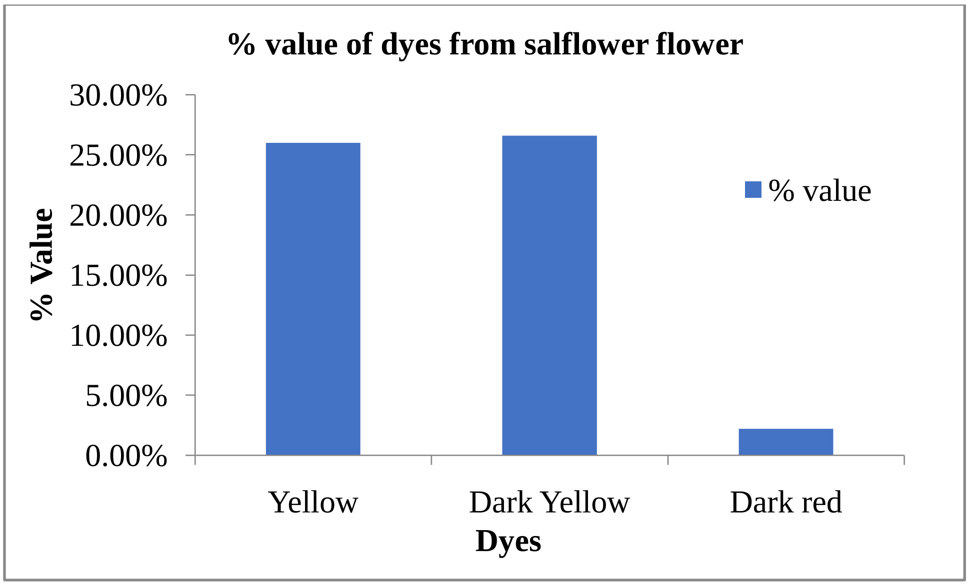

Figure 9. % Value of dyes from salflower flower (*Carthamus tinctorius*)

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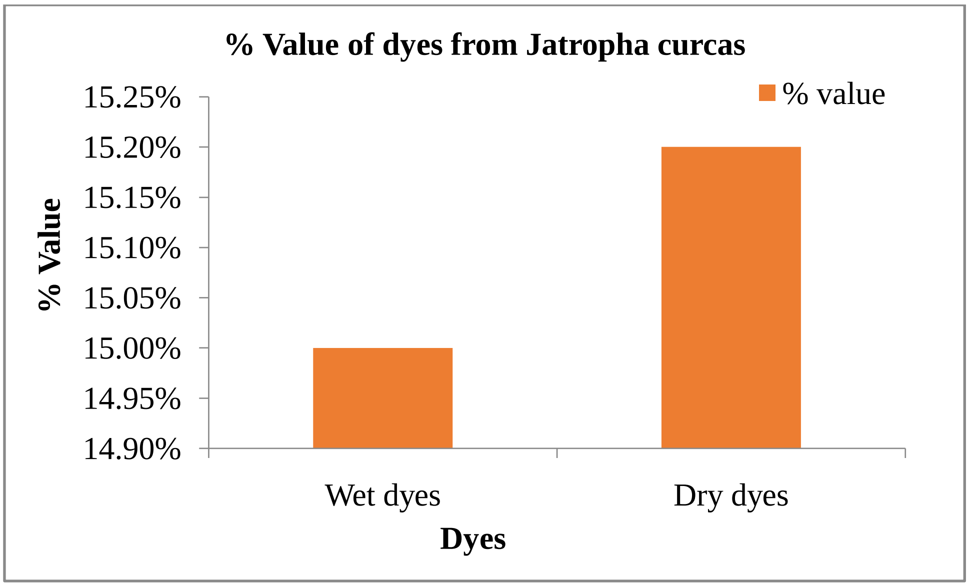

Figure 10. % Value of dyes from *Jatropha curcas* (Physic nut)

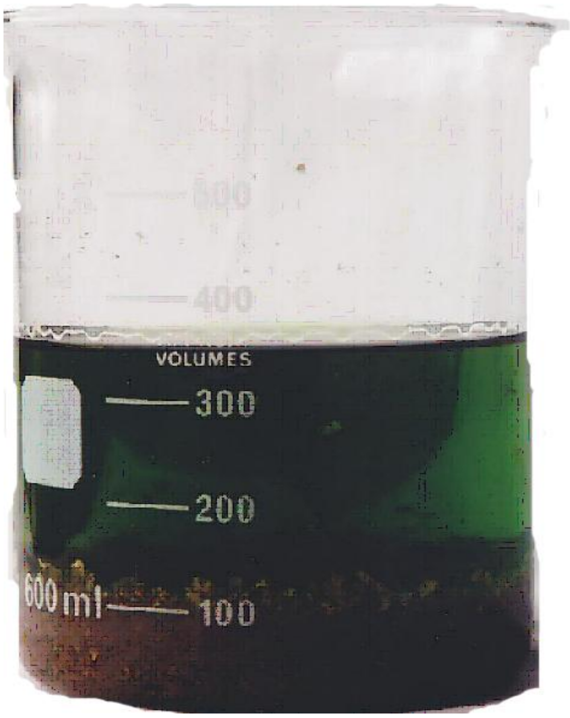

Figure 11. Extract of *Jatropha curcas* (wet basis)

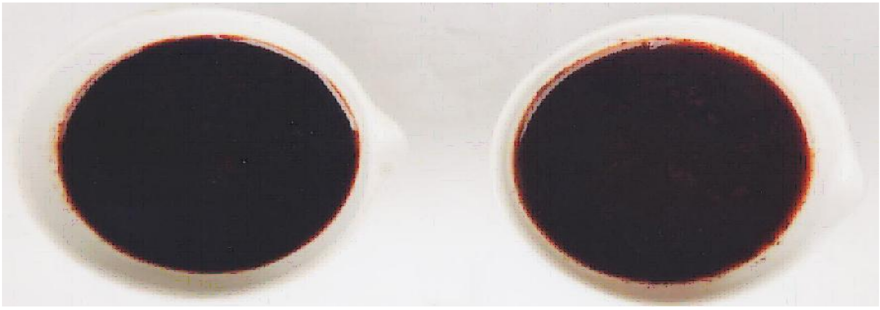

Figure 12. Extract of *Jatropha curcas* (dry basis)

Figure 13. White strips after direct dyeing of Safflower without mordanting

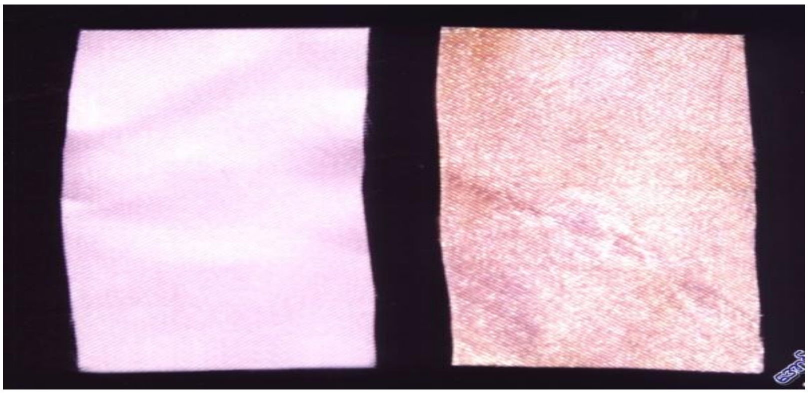

Figure 14. Pink strip after Safflower dyeing

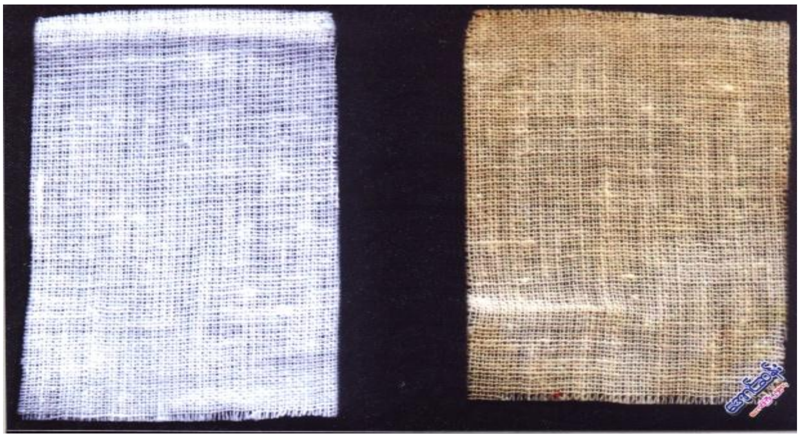

Figure 15. White strip after *jatropha* dyeing

Result and Discussions

The main purpose of this project was not only to extract dyes from Safflower flowers but also to present the utilization of Safflower. Now a day, safflower (*Carthamus tinctorius*) is cultivated only as leaf crop for vegetable consumption in Myanmar. The safflower flowers that are usable to extract dyes were collected from Pin Phyit model village, Yawk Sauk township, Myanmar. The dyes were extracted by using distilled water and 10% Na_2CO_3 solution. The water soluble yellowish dye was extracted from yellow colored safflower flower florets. The water soluble dark yellow colored dye was extracted from complex colored safflower flower florets. The alkali soluble reddish brown dye was extracted by using 10%Na_2CO_3 solution.

The yield percents of yellow, dark yellow and dark red dyes were 26%, 26.5% and 2.2 %. R_f values of the yellow dye, dark yellow and dark red dye were 0.78, 0.78 and 0.8 respectively. The yield percent results are shown in Table 1 and Figure 9. Extracted dyes were compared with the dyes used in curried rice by paper chromatography method. The result are shown in figure 7 and 8. According to chromatograms, R_f values of safflower dyes were the same with that of the food dyes. According to the literature, yellow dye may be carthamidin and dark red dye may be carthamin, but it can not be confirmed due to the lack of authentic. Dyes of Safflower are used as coloring matter in industries of pharmacy, confectionery, cosmetology, foodstuff and textile. Bark of *Jatropha curcas* were collected from Taunggyi (Myanmar) and extracted by using ethanol in both wet and dry basis. The yield percents of dyes with wax extracted from *Jatropha curcas* were 15.0% and 15.2 %.Percentage of dyes extracted are mention in Table 2. Dyeing process of Safflower and *jatropha* are shown in figure 14 and 15.

Conclusion

In dyeing processes, brown and yellow colors were obtained by direct dyeing of safflower on white colored strips and orange color was obtained by direct dyeing on pink colored strips. Dyes of Safflower are used as coloring matter in industries of pharmacy, confectionery, cosmetology, foodstuff and textile. According to Traditional Chinese Medicine, the red color of safflower flowers indicates the presence of iron that is used to activate the blood circulation and menstruation. A medicinal tea of the petals is very warming and to ward off colds. The petals can be made into a poultic and applied to bruises and burns and they are helpful to the heart, fitting their Sun influence. The petals can be added to handmade paper. Safflowers have been prized for their dietetic, medicinal and cosmetic benefits. Its emollient and moisturizing properties mean that is still very useful substance in cosmetology. Carthamin is the only chalkone-type pigment suggested for colouring foods. It finds use in coloring cakes, biscuits, butter, ice cream, rice, soup, sauces, bread and pickles, yellow to bright orange. Both safflower yellow and carthamin can be used as non-toxic food colourants [5]. True saffron (or) Gonegaman (*Crocus Sativus* L.), which is the world's costliest spice, is quite commonly substituted or adulterated with safflower florets due to the similarity in their appearance. Direct dyeing of *jatropha* (dry basis) gives beige color.

Dyeing of *jatropha* (wet basis) requires dewaxing and microbial fermentation. Dyeing processes of Safflower were accomplished without mordanting but dark blue dye from *jatropha* (wet basis) can not be produced due to the absence of mordanting and biological fermentation by microbes. In dyeing process of jean wears, *jatropha* is added to biologically fermented dye bath of indigo. Natural dyes are additionally claimed to be non-toxic to human. Therefore, textiles dyed using natural products are becoming important for the current eco-friendly lifestyle [3]. Apart from these advantages, natural dyestuff usage has some drawbacks leading to a rise in use of synthetic dyestuffs.

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