

A collection of various colored fabric swatches, including red, orange, yellow, green, blue, and purple, arranged in a grid-like pattern.

***Eco- Friendly Dye from
Industrial Waste***

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INTRODUCTION

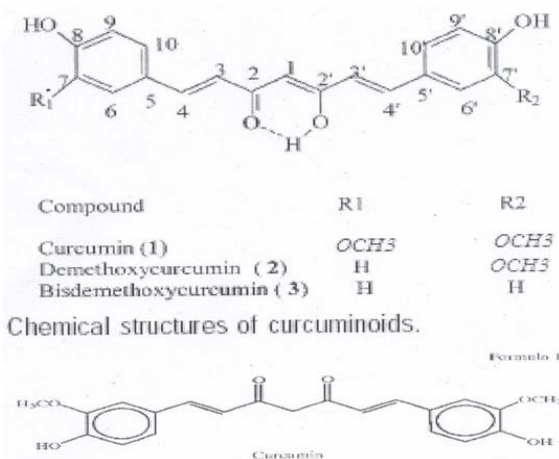
Environmental issues are becoming more crucial all over the world. Natural dyes due to their eco-friendly nature create superior value to the textile substrate. With the advent of synthetic dyes-stuff in abundance and a wide range of colours of remarkable fastness properties made its way making natural dyes a past. Dye is a molecule of the organic compounds which are responsible for coloring & printing of textile material. The dyes extracted from natural sources like plant, animal and minerals are called Natural dyes. Pharmaceutical, food and fruit industry wastes are one of the main sources of colourants which can be employed for textile coloration. Curcumin (*Curcuma longa*), a member of the family Zingiberaceae, is used in food recipes. Curcuminoid pigments are responsible for the yellow colour of turmeric.

CURCUMIN

Curcumin is orange-yellow crystalline substance chemically extracted from rhizome of Turmeric (*Curcuma Longalinn*) plant (figure-1). It consists of mixture of three curcuminoids, namely, curcumin, demethoxycurcumin, and Bisdemethoxycurcumin which are antioxidants. The active constituent of turmeric, curcumin, has been shown to have a wide range of therapeutic effects.



Fig-1 Turmeric plant



Fig(2) Chemical structure of curcumin

Table-1 Chemical Constituents of Turmeric

COMPONENTS	PERCENTAGE
Protein	6.3%
Fat	5.1%
Carbohydrates	60.4%
Moisture essential oil	13.1%
Minerals	3.5%
Essential oil	5.8%
Curcumin	5-6%

Curcumin is the only natural pigment belonging to diarylmethane group. It is a yellow crystalline, odourless powder, having melting point between 184°C -186°C, poorly soluble in water, petroleum ether and benzene; soluble in alcohols and glacial acetic acid and highly soluble in acetone and ethyl ether. Its molecular weight is 368.9 and empirical formula is $C_{21}H_{20}O_6$. It is always present along with its derivatives demethoxy curcumin and bisdemethoxy curcumin. All the three are collectively referred as curcuminoids. Curcuminoids gives turmeric most of medicinal and colouring properties.

Applications of Curcumin in Pharmaceuticals

Curcumin has got a wide uses and applications in the field of pharmaceuticals especially in the field of herbal medicine. Some its uses which make it so important are given below:-

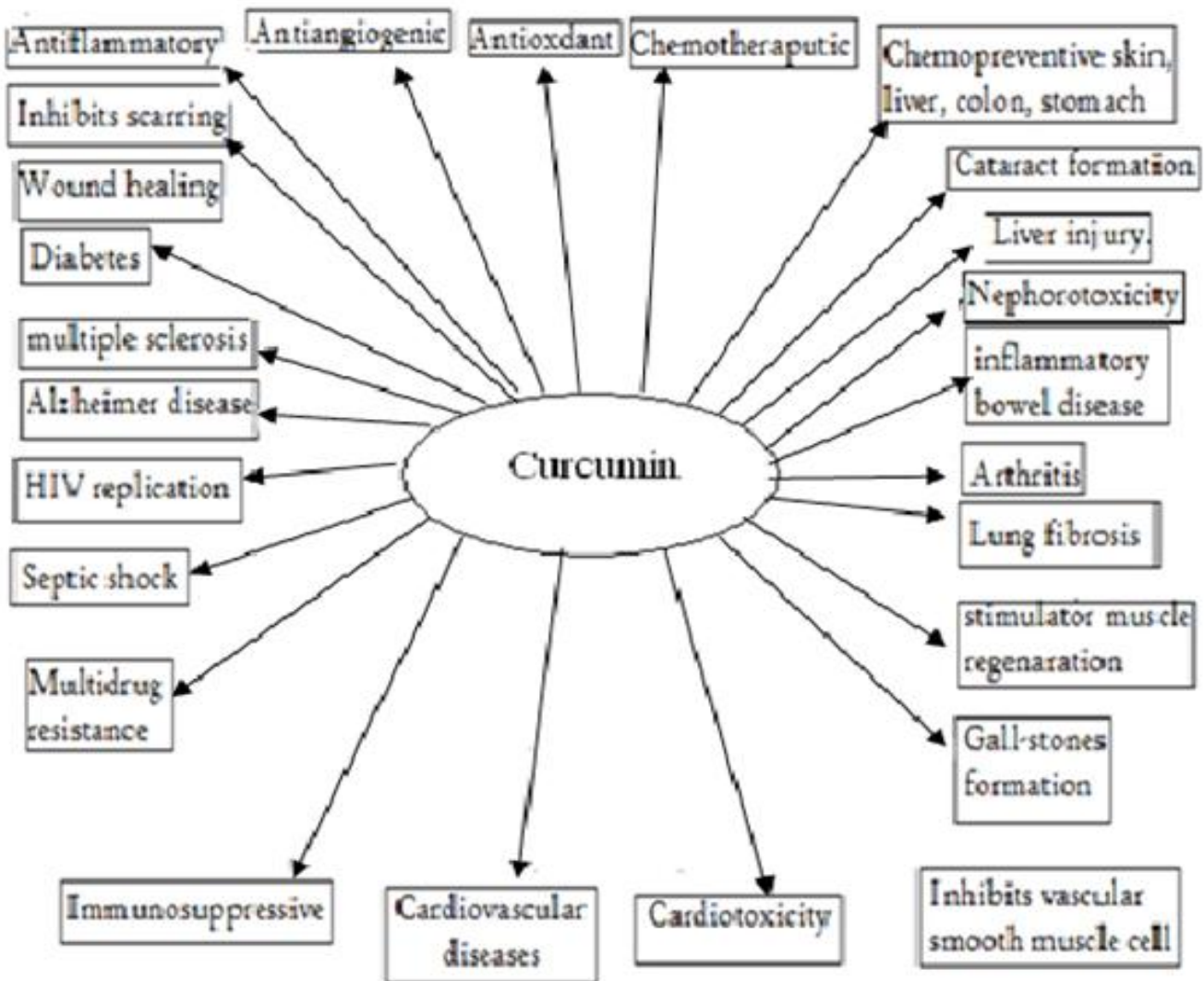


Fig-3 Application of curcumin in medicine

EXPERIMENTAL METHODS

In the present study we have collected waste from herbal pharmaceutical industry. The solid waste management is the problem of the industry. This generated waste is utilized for dyeing and printing of textile goods. This waste is ecofriendly as it is generated from curcumin. Haldi oil utilized for medicinal value was extracted from curcumin by using isopropanol and then isopropanol was recovered by vacuum distillation so the waste is free from any added chemicals.

Characterization of Herbal waste

The waste is crystalline yellowish - orange in colour. It is a polyphenol so insoluble in water but soluble in organic solvents and also in base.

Extraction of dye from waste

The industrial waste is in solid form. This waste is converted into fine powder and screened for removal of unwanted solid materials. The fine powder thus obtained is polyphenolic in nature & therefore it is insoluble in water. To make it soluble the organic solvents like acetone, ethanol, methanol, propanol or a base like sodium hydroxide were used. This solution of waste in proper solvent is called a dye. This dye prepared is ready for dyeing textile substrate.

Pretreatment

The pretreatment is essential for the fabric to be dyed. The fabric under treatment is firstly desized, followed by scouring, bleaching and mercerizing. Mercerized cloth is taken for further processing.

Mordanting

Mordanting can be carried out before dyeing (pre-mordanting), with dyeing (simultaneous mordanting) and after dyeing (post mordanting). After wetting process the fabric is treated with Alum, FeSO_4 (5%) in 1:20 material to liquor ratio as part of mordanting process. The mordanting is done at room temperature for about 30 minutes. The mordanted fabric is dried without washing and now the fabric is ready for dyeing process.

Dyeing Process

The extracted waste according to shade (%) was taken for dyeing. Three different shade 3%, 6% & 9% were used. The dye powder is taken for the three above mentioned % ages of shades and made soluble in 1% of NaOH. Already mordanted fabrics are then dipped in the dye bath & the dyeing carried out at 70°C - 80°C with constant stirring for 30-45min. Subsequently the sample is washed with hot water, soap solution of 1 gpl, non-ionic detergent for 10 mins at 60°C and cold wash is given finally. Thus 3%, 6%, 9% shades were obtained on the cotton fabric samples after drying.

COLOUR FASTNESS TEST

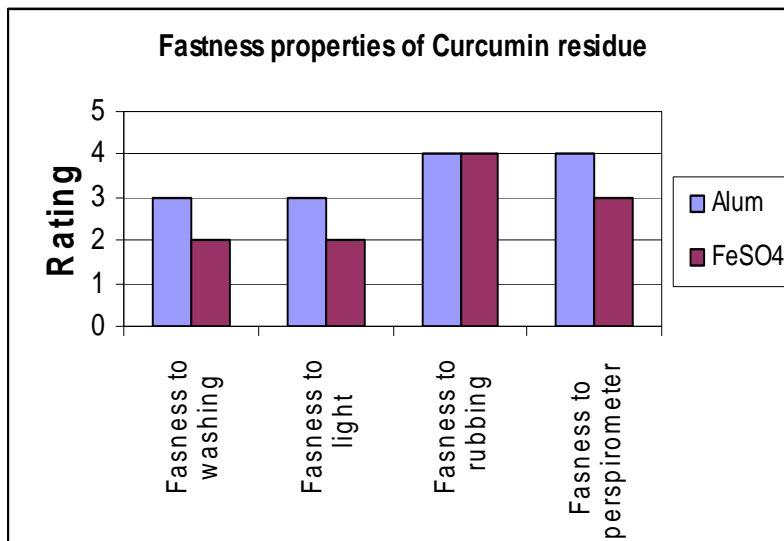
After dyeing the fabric is tested for Washing fastness [BIS No IS – 3361-1979(test-2)], Light fastness [BIS No IS – 2454-1985], Perspiration fastness [BIS No IS – 791-1983], Rubbing fastness [BIS No IS – 766-1988] to verify the performance of the dye.

RESULTS & DISCUSSION

Fastness properties of dye extracted from industrial waste (curcumin residue), are tabulated in the table-2 given below. At the time of dyeing two different mordants was use for dyeing. Optimization of mordants was carried out by keeping the metal ion content within eco mark system.

Table-2 Result of fastness properties of Curcumin residue

Name of the Mordant	Shade %	Fastness to wash		Fastness to light		Fastness to rubbing		Fastness to Perspirometer	
		Rating	Remark	Rating	Remark	Rating	Remark	Rating	Remark
Alum (5%)	3%	3	Fair	3	Fair	4	Good	4	Good
	6%	3	Fair	3	Fair	4	Good	4	Good
	9%	3	Fair	3	Fair	4	Good	4	Good
Ferrous Sulphate(5%)	3%	2	Poor	2	Poor	4	Good	3	Fair
	6%	2	Poor	2	Poor	4	Good	3	Fair
	9%	2	Poor	2	Poor	4	Good	3	Fair



Graph-1 Fastness Rating

From the graph-1, it is clear that rubbing fastness & perspiration fastness is good with alum mordant and with ferrous sulphate mordanted fabric rubbing fastness is good but perspiration fastness is fair. The light fastness and washing fastness is coming fair for alum mordant and poor for ferrous sulphate mordants.. Between the two mordants alum is having more potential for enhancing the fastness properties of dye compare to ferrous sulphate. For poor light fastness properties of natural dyes different mordanting technique, i.e. Pre- mordanting, simultaneous mordanting and post-mordanting treatments were used by

which the fastness property of natural dyes can be increased and it depends upon the stability of various complexes formed between mordants and dye molecules. For changing of hue and obtaining variation on shade, the use of metal salts seemed to be handy as in certain cases, it brightened the shade or, in other cases, caused dullness and deepening of shade. They are also found to be improving fastness properties.

Fabric Samples dyed with above dye with different mordant gave different shades are shown in fig(4) and fig(5).



5% Ferrous sulphate & 6% Dye



5% Alum & 6% Dye

CONCLUSION

The herbal pharmaceutical waste can be used as textile dye. The dye prepared & tested for different fastness properties like washing, rubbing, sunlight & perspiration. The tests were conducted according to BIS. The result shows that the fastness properties are good. Therefore it is decided that the Pharma waste can be utilized as textile dyes for dyeing different textile substrate. Already successful application is done on cotton and trails are going on wool, polyester, silk, bamboo, banana fibres, etc. As well as trails are going to develop dye for paper & earthen pot. As this dye is natural in origin it is eco-friendly dye suitable for green technology. In this way waste can be utilized for getting best.

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