

Synthesis of Natural Dye Nano particles and its Analysis

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Abstract

Synthetic pigments are becoming noticeable due to its teratogenic and carcinogenic effects. Natural dyes have several excellent properties including less side effects, high safety factor, biodegradable, green environmental protective. Natural dyes are obtained from natural resources - fruits and vegetables. Capsicum annum imparted red color is due to presence of specific chromophore group used in food coloring and cosmetic industries. Present manuscript focused on the extraction of capsicum annum dye and its nanoparticles. The dye and nanoparticles was characterized by TLC, UV and FTIR. The developed green nanoparticles of dyes may generate interest of researchers toward ecofriendly biosynthesis of nanoparticles for industrial and socio-economical purpose.

KEYWORDS- Extraction; Stability; Chromophores; Spectroscopy ; Reduction methods

Introduction

Capsicum (Solanaceae) comprises more than 200 varieties. *Capsicum annum*, *Capsicum baccatum*, *Capsicum chinense*, *Capsicum frutescens* and *Capsicum pubescens* are the key varieties frequently used in culinary and pharmaceutical applications (Day A.J. 2006; Rodrigues et. al., 2015). *Capsicum annum* fruits vary widely in size, shape, flavor and sensory heat depending upon the geographical areas. It exhibited hypocholesterolemic (Srinivasan, 2005; Aizawa and Inakuma, 2009) antioxidant and anti-inflammatory (Zimmera, et. al., 2012), antimicrobial, antiviral (Gong et. al., 2008; Debasish Kar et. al., 2016), antihyperlipidemic properties. Viktorija Maksimova (2016) also reported that Capsicum fruit extracts prevent the cytotoxic effects of capsaicin.

Libby, (2002); Arroyo and Iruela-Arispe, (2010) reported that oxidative stresses are closely linked to the pathogenesis of atherosclerosis and consequently to the increased risk of cardiovascular diseases. Inbuilt pharmaceutical ingredient in capsicum annum plays vital role in diversified therapeutic applications. The natural dyes gradients intensity and its properties depend on stress that exhibit better biodegradability, compatibility and fastening with the environment than synthetic dyes. It is the only genus having the potential to produce capsaicinoids, with capsaicin and dihydrocapsaicin accounting for up to 90% of the total pungency of pepper fruits (Anupam Das, et. al., 2015). Capsaicin contents are employed to treat asthma, coughs and sore throats, to relieve toothaches, counter-irritant

balm for external application (Effionora et. al., 2014). Capsicum is not only a rich and varied source of nutrients, medicinal properties and dyestuff, but also the possibility of becoming an income source due to its innovative environmental friendly application. Its chemical compositions is capsaicinoids, nonvolatile alkaloids, are acid amides of C₉-C₁₁ branched-chain fatty acids and vanillylamine, which are responsible for the pungency of the Capsicum species (Diaz J., Pomar et. al., 2004). The potential of a high biological activity and their pharmacological, neurological and dietetic activities have been reported by Thangaraj Shankar et. al., (2017).

The capsaicin (C₁₈H₂₇NO₃) a phenyl propanoid compound (trans-8-methyl-Nvanillyl-6-nonenamide) is a crystalline, lipophilic alkaloid extracted from various capsicum fruits was described by numerous methods like maceration, Soxhlet extraction, supercritical fluid extraction (CO₂), Gas chromatography chromatography (LC) with ultraviolet (UV), and high performance thin layer chromatography (TLC) etc. Capsaicin-loaded poly-L-lactide-co-glycolide (PLGA), nanoparticles enhance the drug-loading efficiency for the treatment of discogenic back pain due to its effect on pain control neuronal degeneration and also site-specific drug delivery system (Kim S et al., 2011 ; Baskaran et. al., 2017).

Metal nanoparticles have a high specific surface area and a high fraction of surface atoms. Hence, researchers extensively focused on it due to its unique physicochemical characteristics (Antariksh Saxena et. al., 2010; Devendra Jaina et. al., 2009). Present research attempted on synthesis of Capsicum fruits dye and fabrication of its nanoparticles using Ag⁺⁺ and

Cr⁺⁺⁺metal. Silver nanoparticles are well-known for its antimicrobial activity, antitumor activities. Different types of nanomaterial like copper, zinc, titanium, magnesium, gold, and silver have been used by the researchers. For the fabrication of AgNP, AgNO₃ required which is expensive compared to chromium. Therefore study focused on the preparation of CrNP using the red dye obtained from red capsicum and compared with AgNP.

Materials and Methods

Capsicum annum/Bell pepper, Red variety was purchased from local markets of Thane (MS) India in the month of July 2016 to February 2017. Washed, dried, powdered and packed in sealed container and stored at 4⁰C to get rid of contamination.

All experiments were repeated thrice. Reagents used were of analytical pure grade and glass distilled water was used throughout the study.

Extraction of the Dye

Capsicum (10 gm) mixed with 100ml of ethanol and stirred at 60-90° C for 8 hours. Change in colour was observed throughout the extraction process at different temperature and time. The obtained dye was monitored with help of TLC using n-hexane: acetone (1:1) as solvent system. Characterization of obtained dye was carried out by spectroscopy.

FTIR was performed by using KBr pellets - Nicolet iS5 and UV was carried out on UV 1800 - Shimadzu Spectrophotometer.

The extraction procedure was repeated using aqua condition instead of ethanol. Analysis was carried out with TLC and spectroscopy.

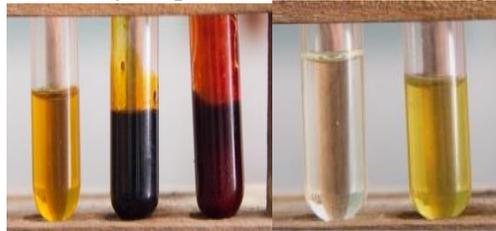
Green Synthesis of Nanoparticles by Reduction Method

The synthesis of nanoparticles using red dye was performed by reduction of Ag^{++} and Cr^{3+} with citrate along with aqueous dye solution respectively. The formation of the nanoparticles was recorded by colour change. TLC and UV of particles along with dye were studied.

Results and Discussion

Yield of the dye

Capsicum annum dry powder (10gm) procured 2.6 gm of dye in ethanol and 3.6 gm in aqua. The color of dye from ethanol is bright red and attractive as compared to aqua dye. The higher yield of aqua dye was due to moisture content hence characterization of the ethanolic dye was studied (Table1). The qualitative and quantitative estimation of these substances was realized by Thin Layer Chromatography (TLC), SEM and FTIR. The change in color of AgNP and CrNP dyes particles shown in Fig 1.



A1 A2 A3 B1 B2

Figure 1: A1- CrNP, A2- Change in color of Dye-CrNP, A3- *Capsicum annum* dyes and B1-AgNP; B2 Change in color AgNP of Red *Capsicum*

TLC, Spectroscopic Analysis of the Dye and Nanoparticles

	Dye	AgNP (Orange)	Change in color	CrNP (Dark Red)	Change in color
Rf Values	0.71, 0.32	0.58, 0.85	Red to Green to colorless for AgNP	0.41, 0.72	Red to Golden Yellow to colorless for CrNP
λ_{max} nm	485	981	1063	798	419, 285

Table 1: Characterization of the dye obtained and its AgNP and CrNP

According to figure 2, There is a sharp absorption band at 3386.85 cm^{-1} , ($-OH$) 2926.90 cm^{-1} , ($-CH$), 1629.97 cm^{-1} , ($-C=C-$), 1059.44 cm^{-1} , ($-C-O$). The stretching vibration appears at 2926.90 cm^{-1} and 2927.74 cm^{-1} position was related to methyl group of methylsulfonyl group ($-CH_3SO_2$) showing symmetry at 1059.44 cm^{-1} position. It may act as excellent hair dye, since it contains $-OH$ group, showing positive effects of phenolic characters. The maximum absorption band or broad peak at 3386.85 that probably embraces the absorption ascribed either to $n \rightarrow \pi$ and or $n \rightarrow \pi^*$ electron transitions. Shifting of absorption band of dyes to its Ag particles was from lower to higher indicate tautomerism.

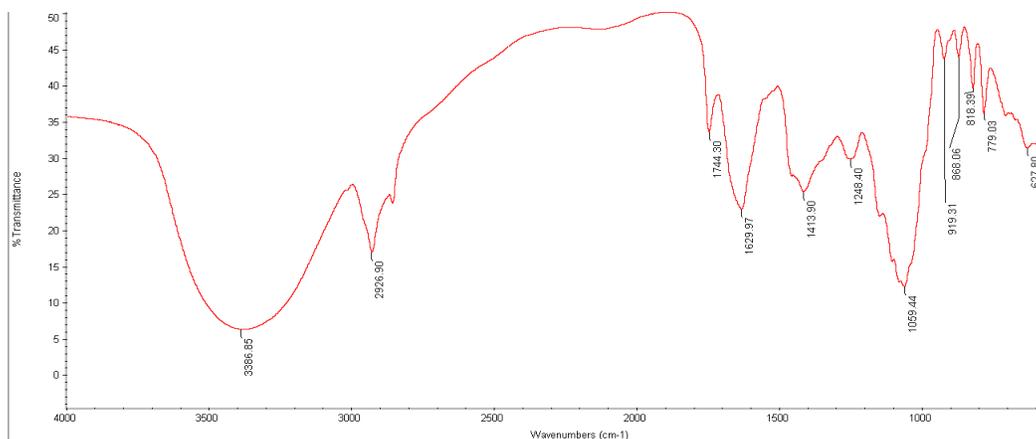


Figure 2. FTIR Spectra of dye obtained from Red capsicum

Hence, orange brown colour may be used in body paintings. Silver nanoparticles of dye appeared green to golden and then changes to yellow while Cr nanoparticles yellow to dark red. It may be due to protein which is having the structure tetrahydroxyflavinol nothing but quercetin, which may act as antioxidant, inhibitor of various diseases. Though King, Janice A, 2017 claimed that the antioxidant property not observed in quercetin and cannot be assigned as a dietary content level. Hence it may be used as coating agents since it does not undergo conjugation with the nanoparticles for medicine delivery and are rapidly excreted from the body. Due to rapid excretion it may aid in fat burning and also help in weight loss.

Conclusion

Capsicum annum fruits contain bioactive compounds like capsiacin which possess effective pharmacological behavior. The extracted dye used in the preparation of silver and chromium nanoparticles by reduction is a cost efficient and convenient method. The biosynthesised chromium nanoparticle using a plant source has provided an affordable alternative to silver nanoparticles which

may have potential applications in nanomedicine and its integration in various other applications.

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