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Concentration dependent dosimetric evaluation of Coriandrum Sativum dye solution under gamma irradiation

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ABSTRACT

In the present study chemical dosimeters having aqueous solutions of Coriander leaves dye were irradiated by Cs-137 gamma source in the range (0-100)KGy. The standard aqueous solutions were scanned by UV/VIS spectrophotometer for the determination of maximum wave length (λ_{max}) and the absorbance (A). The plot between concentration C and A gave approximate linear relationship and hence verified Beer's Law. Out of all the dye concentrations it was found that c1 =35g L^{-1} gave ideal dosimetric behavior which proved that these dye solutions are strongly dependent on dye concentration. Useful dose range for this dye to be used as a chemical dosimeter was found to be 60kGy to 100kGY.

Keywords: Aqueous solutions, Coriander leaves dye, chemical dosimetry, gamma irradiation, Optical density (OD).

INTRODUCTION

Radiation (may be electromagnetic, light photons or ionizing radiations comprised of γ-photons, α or β-particles) is emission and propagation of energy from one point to another from a source to sink. The ionizing radiations can cause biological, chemical as well as physical changes in the exposed matter. So Cs-137-radiation source caused chemical changes in the aqueous solutions of coriander leaves dye in the form of increase in the acidity of the sample solutions (a definite clue of gamma interaction with water). The present study dealt to find a new dye dosimeter of its type. Radiation doses are generally measurable with linear response, over absorbed dose ranges between 1 and 10^4Gy, depending on the initial dye concentration, the pH and the presence of additives as alcohols, buffers and inorganic salts [1-14].

The aim of the present work was to explore that the natural dyes can be used as a dosimeter. It is known that dyes either natural or synthetic contain pigmentations (colouring substances) which are used to impart colour to the fibers. However, synthetic dyes also have other uses like as chemical dosimeters for high gamma radiation doses [15]. The overall objective of this work was to check for this natural dye to respond to Gamma radiation like as a dosimeter. Furthermore, the other parameters studied were the effect of dye concentration on the gamma response and the verification of Beer's law in order to find the suitability of this dye to be used for dosimetric studies in 0-100kGy dose range.

MATERIALS AND METHODS

The Coriander leaves were dried and then grinded to make fine powder form. 14 gm of Coriander powder was weighed and boiled in 400ml of water at 80°C for 20 minutes to make a solution of concentration 35g L^{-1}. The ready solution color was red and pH 6.5. Solution was filtered and different concentrations of the solution were prepared such as NDc1=35g L^{-1}, NDc2=17.5g L^{-1}, NDc3 =8.75g L^{-1} at different pH values as pH_4 and pOH_8 by using 1 molar solution of sodium hydroxide (NaOH) and hydrochloric acid (HCl). In dosimetric studies, those dye dosimeters are considered to be satisfactory which show a linear relationship between the concentrations (C) of the dye in the solutions and absorbance (A) measured at the primary absorption peak maxima that is actually verification of Beer's Law [1-14]. For irradiation, the dye solutions were placed in 5 ml glass ampoules having internal diameter 1.03 cm and thickness 0.18 cm with fit in ground stoppers. Cs-137 gamma radiation source (Mark IV Irradiator) available at Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad and having dose rate of 12Gy h^{-1} was used to irradiate the samples. All the samples were irradiated at room temperature by placing them inside the irradiation chamber at fixed positions in the gamma flux with the help of a fixed stand. The samples were irradiated according to pre-selected doses, i.e. 60KGy, 70KGy, 80KGy, 90KGy, 100KGy. The samples were scanned for optical wavelength (λ_{max}) and the absorbance (A) measured by T80 UV/VIS spectrophotometer having band pass setting of 1mm.Beer's Law was verified by plotting the absorbance (A)versus concentration (C).

RESULTS AND DISCUSSION

The irradiated dye was found to be changed in color which is an evidence of its structural changes. To check the effect of different values of pH on the stability of response of dosimeter during the post irradiation storage, five sets of the solution were irradiated to a known dose levels. The color of the controlled samples remained stable and its exposure to visible light did not cause any impact on the color of the dye .The optical wavelength (λ_{max}) and the optical density (OD) of the samples were measured with a single beam spectrophotometer using a band pass setting of 1mm. Figure 1. Shows graph between absorbance, absorbed dose and mean of different concentrations. It is clear from the graph that c1 = 35g L^{-1} exhibited ideal dosimetric response i.e. exponential behavior of absorbance versus absorbed dose as compared to dye solutions of other concentrations.

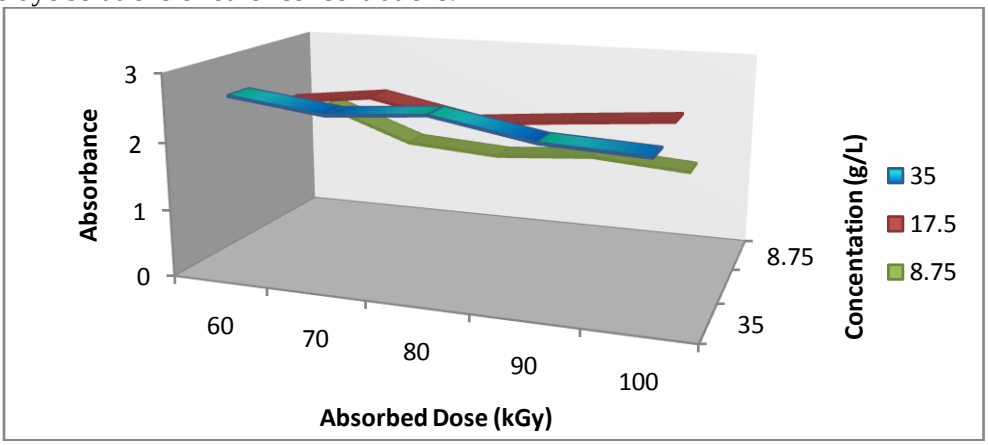

Figure 1. Graph between absorbed dose, absorbance and concentration

Fig.2. Dose versus absorbance showed the decrease in absorbance, at the primary peak as a function of absorbed dose D, in water the radiation induced loss in dye concentration with dose as a non function of absorbed dose D, in water the radiation induced loss in dye concentration with dose as a non linear curve

on a semi-logarithmic plot. Therefore following Beer's law it is possible to express the radiation response as follows D = -K logA

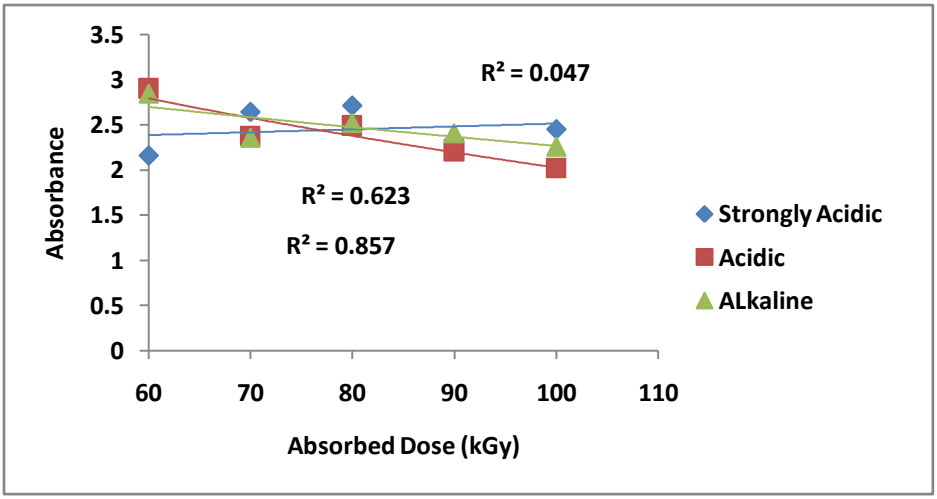

Figure 2. Graph between Absorbed dose and Absorbance of Coriander dye NDc1 samples

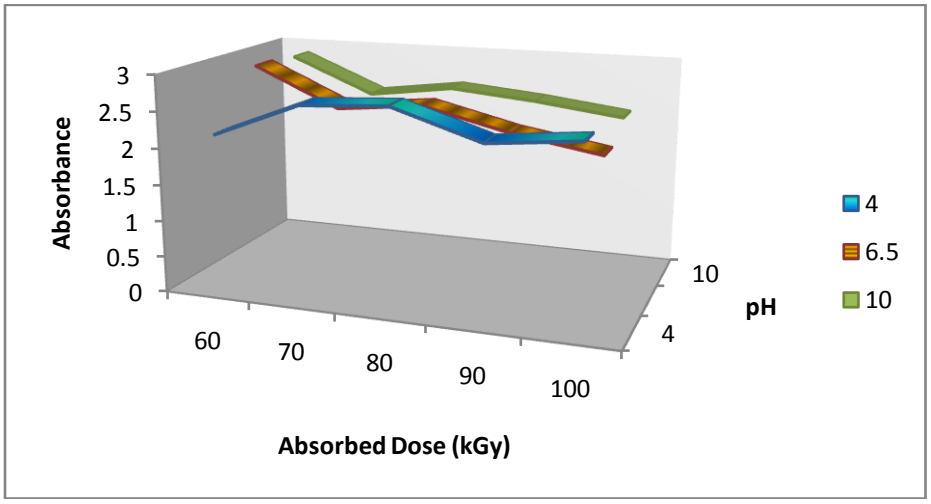

Figure 3. Graph between PH, Absorbance and absorbed dose of Coriander dye NDc1 samples

Fig. 3 is pH versus absorbance and absorbed dose clearly showed that the absorbance of acidic samples decreased exponentially with absorbed dose , making solutions more acidic. Gamma interaction disturbed the internal structure of the dyes i.e. molecular dissociation had been taken place which is the evidence that this dye having moderate acidic nature can be used for the chemical dosimetry. But in comparison with the artificial dyes, these dyes show the poor response as indicated by the non linear behavior in our experimental findings.

APPLICATIONS

This method is useful as chemical dosimeters for high gamma radiation doses.

CONCLUSIONS

The decolouration and degradation of Coriander leaves dye in aqueous solution by gamma radiation has been demonstrated. The linear relationship found between absorbance and concentration verified Beer's Law which confirmed that Coriander leaves dye can be used as a dosimeter over a small range of gamma dose ranging from 60KGy–100kGy. The pH of sample solutions being a great factor to affect the response of the solutions should also be carefully handled. However, additional studies are still required to increase the radiation doses beyond 100kGy, to evaluate the dose rate and energy dependency.

FUTURE PROSPECTS

Dye dosimetry is an active area of research now a day, if it should be checked that the whole process of extraction and dying must be not only ecologically safe but also extremely less damaging for human health. No doubt there is a lot of scope of dye dosimetry for obtaining multi colour shades as per requirement of the textile and painting industry, using different doses and eco-friendly textile industrial procedures with proper dose delivery check up, enhancement of shelf life, sterilization and pasteurization, waste management without opening boxes, drums and sacs using colour change technique. The above said future objectives will only be achieved by getting proper knowledge of radiation protection and safety, documentation and dose assessment techniques.

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REFERENCES

[1] B. Nasef, El Assy, C.Yun-Dong, M.L.Walker, M.A. Sheikhly, W. L. Mclaughlin WL, *Radiat Phys Chem.* **1995**, 46, 1189-97. http://dx.doi.org/10.1016/0969-806X(95)00353-Y
[2] C. Baker, A.D. Sharifeh, M. Kudrimoti, B.A. Shahid, S.M. Ali, *J Appl Clin Med Phys*. **2007**, 8(2). 37-46.
[3] M.F. Barakat, K.E. Salamawy, M.E. Banna, M. Abdel-Hamid, A.T. Abdel-Rehim, *Radiat Phys Chem.* **2001**, 61, 129-36.
[4] A.E. Buenfil, C. Ruiz-Trejo, I. Gamboa-deBuen et al, *Nuc Instrum Meth Phys Res* B. **2002**, 197, 317-22. http://dx.doi.org/10.1016/S0168-583X(02)01488-X
[5] K. Farah, F. Kuntz, O. Kadri, L. Ghedira, *Radiat Phys Chem*. **2004**, 71, 337-41. http://dx.doi.org/10.1016/j.radphyschem.2004.05.041
[6] S. Ebraheem, W.B. Beshir, S. Eid, R. Sobhy, A.A. Kov, *Radiat Phys. Chem* **2003**, 67, 569-73. http://dx.doi.org/10.1016/S0969-806X(03)00107-5
[7] M.Y. Hussain, N.A. Shad, N.Akhtar, S. Ali, T. Hussain, Inam-ul-Haq. *Pak J Agri Sci* **2009**, 46(1), 78-81.
[8] M.Y. Hussain, Islam-ud-Din, T. Hussain, N. Akhtar, S. Ali, Inam-ul-Haq. *Pak J Agri Sci* **2009**, 46(3), 224-27.
[9] T. Hussain, M. Sc. Thesis, Dept. Phys Uni Agri Faisalabad Pakistan **2008**.
[10] M.A. Rauf, S.S. Ashraf, *J Hazard Matter* **2008**, HAZMAT-9131, 1-11.
[11] A.M.S. Galante, B.M. Rzyski, L.L. Campos, A.L. Villavicencio, *Radiat Phys Chem* **2002**, 63(3), 719-72. http://dx.doi.org/10.1016/S0969-806X(01)00605-3
[12] M.K. Hasan, A. Mohammad, S.C. Zahid, *Radiat Phys Chem* **2002**, 63, 713-17. http://dx.doi.org/10.1016/S0969-806X (01)00640-5
[13] M. Kattan, Y. Daher, H. Alkassiri, *Radiat Phys Chem* **2007**, 76(7), 1195-99.

http://dx.doi.org/10.1016/j.radphyschem.2006.12.004
[14] H.M. Khan, M. Anwer, Z.S. Chaudhry, *Radiat Phys Chem* **2002**, 63, 713-17. http://dx.doi.org/10.1016/S0969-806X(01)00640-5
[15] H.H.Mai, N.D.Duong, T.Kojima, **2004**, *Radiat. Phys. Chem*, 69, 439- 444.
[16] A. Baha, Masters thesis, University Putra Malaysia **2005**.
[17] N.B. El-Assy, E.S. El-Wakeel, A.A. Fattah, *Int J Radiat Appl Instrum,* **1991**, 42, 89-96. http://dx.doi.org/10.1016/0883-2889 (91)90129-O
[18] R.G. Emi, K. Andras, J.J. Fletcher, *Radiat Phys Chem* **2007**, 76, 1519-22. http://dx.doi.org/10.1016/j.radphyschem.2007.02.064
[19] D.R. John, S.H. John, W. Waldo, *Radiat Phys Chem* **1995**, 4-6, 1269-72.
[20] A.L. Ahmad, S.W. Pausa. *Chem Eng J* **2007**, 132, 257-65.