Abstract

Carmine is a dye used mainly for coloring food products and galenicals but also in inks. As food irradiation is becoming a regular treatment for food preservation, it is desirable to have a proper knowledge about the radiation sensitivity of dyes that can be included in the food formula. The aim of this work was to establish the radiation stability of carmine against Co-60 gamma radiation. Samples of 50% pure carmine powder as well as 50%, 10% and 5% aqueous solutions were irradiated in a Gammacell 220, dose rate of about 5.2 kGy/h, with doses of 0, 1, 2, 4, 8, 16 and 32 kGy. Spectrophotometric readings at 494 nm show a slight decrease of the absorbance as a function of dose. Samples irradiated with 4 and 32 kGy retained 95% and 90% of absorbance of the unirradiated samples respectively. These results indicate a rather good stability of carmine against γ-irradiation.

1. Introduction

Useful colors of plant or animal origin have been known for a long time and are not only still widely used but also the use of natural-type food colors continues to increase. The use of colors in human food, animal feed, pharmacy, cosmetics, textile and the household sector is strictly regulated, particularly concerning colors of chemical origin. Many consumers believe, even without valid proof, that natural colors are less harmful and therefore more acceptable than synthetic dyes. So, there is a strong tendency in those sectors to return to the use of colors and pigments of natural origin [1, 2].

Cochineal extract (Natural Red 4, EEC No E 120 or CI (1956) 75470) is the common name of the colorant obtained when the dried bodies of the female Coccus cacti (Dactylopius Coccus Costa) insect, a variety of shield louse, are first extracted with aqueous alcohol then the alcohol is removed. The colouring principle of the extract is carminic acid, a hydroxyanthraquinone linked to a glucose unit, comprising 10% of the cochineal and 2–4% of its extract. Carmine is the aluminum hydroxide substrate linked to a glucose unit, comprising 10% of the cochineal and 2–4% of its extract. Carmine is used mainly for coloring food products and galenicals but also in inks, for luxury textiles or artists' paints. Typical applications are at a dosage levels ranging from 0.1 to 0.5% [4].

Carmine acid is very soluble in water and its colors change according to pH. An orange color is obtained in an acidic medium and a transformation from violet to red occurs with increasing pH number from 5 to 7. Carmine acid extracts display good stability to heat, light and oxygen. Treatment of carminic acid with an aluminum salt produces carmine, the soluble aluminum lake. Carmine exhibits good resistance to heat, light and oxygen and provides a blue color in alkaline solution. Reduction of the pH reduces the blue color and below pH 3, carmine is insoluble [4].

Carmine acid and particularly carmine aluminum lake are permitted and widely used in the food industries in North and South America and Western Europe. In Japan, carminic acid rather carmine is employed by the food industry.

There are reports in the literature on the study of bleaching of dye solutions subjected to gamma irradiation with the aim of use for chemistry dosimetry. Several polymer films containing different dyes were also tested. Some remained unaffected by radiation up to doses of about 120 kGy, but others had sensitivities that might allow their use as dosimeters in the kGy range [5].

2. Material and methods

2.1. Carmine

Cochineal carmine, soluble aluminum lake with minimum of 42% of carminic acid was used. The samples were acquired from traditional suppliers and their main characteristics, declared in their analytical description, were: 3% cochineal carmine or 3% dye of cochineal aluminum hydroxide solution, free of additive, pH between 10.2 and 10.8, totally soluble in water, free of coliforms in 1 g, validity of 6 months, maintained in a cold and dark place. Different dilutions (100%, 50%, 10% and 5%) of the original samples were prepared.

2.2. Irradiation

Irradiations were performed in a Co-60 Gammacell 220 (AECL), dose rate 5.2 kGy/h with doses of 0, 1, 2, 4, 8, 16 and 32 kGy, dose uniformity factor: 1.13.

2.3. Spectrophotometry

A 300 mg sample of carmine was added to 10 mL of HCl 2 N and was irradiated in a Gammacell 220, dose rate of about 5.2 kGy/h, with doses of 0, 1, 2, 4, 8, 16 and 32 kGy. Spectrophotometric readings at 494 nm show a slight decrease of the absorbance as a function of dose. Samples irradiated with 4 and 32 kGy retained 95% and 90% of absorbance of the unirradiated samples respectively. These results indicate a rather good stability of carmine against γ-irradiation.

3. Results and discussion

The results of the present experiments are presented in Figures 1 to 4 for original carmine solution and 5%, 10% and 50% aqueous solution respectively.

Although the variation of absorbance as a function of dose for all of the cases was adjusted as a straight line, other adjustments also look possible. Nevertheless, for all the assayed samples, a very slight decrease in the absorbance perceived as the dose
increased. The absorption spectra of unirradiated and irradiated with 32 kGy carmine solution samples show a high similarity (Fig. 5).

There are no significant changes in the hydroxyanthraquinone absorption spectrum due to radiation effect. Samples irradiated with 4 and 32 kGy retained 95% and 90% of absorbance of the unirradiated samples respectively. These results indicate a rather good stability of carmine against γ-irradiation. As food irradiation is becoming a regular treatment for food preservation [6, 7], it is desirable to have a proper knowledge about the radiation sensitivity of additives that can be included in the food formula. Although carmine is considered stable against heat, light and oxygen, the present work is the first report about the behavior of carmine when increasing radiation doses in the range of food irradiation, were applied.

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References