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Utility of UV-Visible and Fluorescence Spectra in Detection of Food Adulteration

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ABSTRACT

Food adulteration means intentional addition of non-nutritious substances to food, generally in small quantity, to improve its appearance, flavor, texture, or storage properties. The main reasons for food adulteration include lack of effective coordination, lack of food laws lack of Government initiative and common people are not conscious enough. Even though there are many food laws in force in India, food adulteration is common now a day. One of the authors (Prof SR) purchased a food item "Finger Chips", (made of potato) from a sweet stall, located at Scheme Road in Dindigul, Tamilnadu, India. Usually it is brown in colour. But the purchased "Finger Chips" were green in colour. Curiously he asked the owner of the stall, why it was green in colour. The reply was that coriander paste has been coated on the potato chips to make them attractive. The author suspected that malachite green would have been added. Hence the present work was under taken to know if the green colour is due to coriander leaves or malachite green. UV-Visible absorption spectroscopy and fluorescence spectroscopy were used to unravel the mystery. The present study leads to the following conclusion: (1) The green coloured coated on the green colour potato chips is due to coriander leaves and not malachite green. (2) Hence people need not hesitate to take these green colour finger chips sold at "Anjali Sweet Stall" Scheme Road, Dindigul, Tamil Nadu, India.

Keywords: Food adulteration, Coriander leaves paste, Malachite green, "Finger Chips" (made of potato), UV-Visible absorption spectroscopy, Fluorescence spectroscopy

INTRODUCTION

Food adulterant means "non-nutritious substances which are added intentionally to food, generally in small quantity, to improve its appearance, flavor, texture, or storage properties". The Federal Food, Drug, and Cosmetic (FD & C) Act 1938 provides that food is "adulterated" if it meets any one of the following criteria: (1) it bears or contains any "poisonous or deleterious substance" which may render it injurious to health; (2) it bears or contains any added poisonous or added deleterious substance (other than a pesticide residue, food additive, color additive, or new animal drug, which are covered by separate provisions) that is unsafe; (3) its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health; or (4) it bears or contains a pesticide chemical residue that is unsafe. (It is to be noted that the Environmental Protection Agency (EPA) establishes tolerances for pesticide residues in foods, which are enforced by the FDA. Food also meets the definition of adulteration if: (5) it is, or it bears or contains, an unsafe food additive; (6) it is, or it bears or contains, an unsafe new animal drug; (7) it is, or it bears or contains, an unsafe color additive [1].

Following adulterants are used, in food and beverages

- Water, for diluting milk and alcoholic beverages
- Roasted chicory roots used as an adulterant for coffee
- Diethylene glycol, used dangerously by some winemakers in sweet wines
- Apple jellies (jams), as substitutes for more expensive fruit jellies, with added colorant and sometimes even specks of wood that simulate raspberry or strawberry seeds
- Urea, melamine and other non-protein nitrogen sources, added to protein products to inflate crude protein content measurements [2]
- High fructose corn syrup or cane sugar, used to adulterate honey
- Water or brine injected into chicken, pork, or other meats to increase their weight [3]

There have been many incidents of adulteration in history. Some of them are mentioned here. In 1981, denaturized colza oil was added to olive oil in Spain and 600 people were killed (Toxic oil syndrome). In 1987, Beech-Nut was fined for violating the US Federal Food, Drug and Cosmetic Act by selling flavored sugar water as apple juice [4]. In 1997, Conagra foods illegally sprayed water on stored grain to increase its

weight [5]. In 2007, samples of wheat gluten mixed with melamine, presumably to produce inflated results from tests for protein content, were discovered in the USA. They were found to have come from China. The main reasons for food adulteration include lack of effective coordination, lack of food laws lack of Government initiative and common people are not conscious enough. There are many food laws in force in India. They include: The Prevention of Food Adulteration Act, 1954 (37 of 1954); The Meat Food Products order, 1973; The Milk and Milk Products Order, 1992 etc., Even then, food adulteration in common now a day.

Origin of the present investigation

One of the authors (Prof SR) purchased a food item "Finger Chips", (made of potato) (Figure 1), from a sweet stall, located at Scheme Road in Dindigul, Tamil Nadu, India. Usually it is brown in colour. But the purchased "Finger Chips" were green in colour. Curiously he asked the owner of the stall, why it was green in colour. The reply was that coriander paste has been coated on the potato chips to make them attractive. The author suspected that malachite green would have been added. Hence the present work was under taken to know if the green colour is due to coriander leaves or malachite green. UV-Visible absorption spectroscopy and fluorescence spectroscopy were used to unravel the mystery.

Malachite green

Malachite Green (MG), is a triarylmethane dye (Figure 2). MG is widely used in food, health, textile and other industries for one or the other purposes. The dye has generated much concern regarding its use, due to its reported toxic effects. The toxicity of this dye increases with exposure time, temperature and concentration. It has been reported to cause carcinogenesis, mutagenesis, chromosomal fractures, teratogenicity and respiratory toxicity [6].

Figure 1: Finger chips

Figure 2: Malachite green dye

Coriander (*Coriandrum sativum* L.) leaves [7]

Coriander (*C. sativum* L.) leaves (Figure 3) are commonly present at each home on Indian family. They use coriander for garnishing, making chutneys (Figure 4) or in parathas. Health benefits of coriander are numerous. Its dark green color makes it more attractive and appealing to eat. Coriander has its unique taste. When we talk about coriander leaves we usually use it for making green chutney as an accompaniment for enhancing the taste of the food. Coriander leaves have many medicinal properties. It is used on large scale in herbal preparations.

Figure 3: Coriander leaves

Figure 4: Green chutney of coriander leaves

Health benefits of coriander are numerous

Health benefits of coriander

- It helps in lowering blood glucose levels in diabetics.
- It helps in digestion; helps settle an upset stomach and prevent flatulence....
- Coriander fights against the Salmonella bacteria.
- It acts as an anti-inflammatory food....
- Coriander protects urinary tract infection.

EXPERIMENTAL SECTION

Extract of green coloured potato chips

Green coloured potato chips were purchased from "Anjali Sweet Stall", located at Scheme Road, Dindigul 624 003, Tamil Nadu, India. About 2 g of the chips were immersed in 100 ml of water in a beaker for 30 min. Green coloured solution was obtained. It was filtered and used in the present study.

Preparation of malachite green solution

MG solution was prepared by dissolving 0.1 g of mg in 100 ml of water.

Coriander leaves extract

About 5 g of green coriander leaves, dried in shade was squashed with water and made upto 100 ml in a beaker. The solution was filtered and used in the present study.

UV-Visible absorption spectra

UV visible absorption spectra of the solutions were recorded in an Analytic Jena Specord S-100, UV-Visible spectrophotometer.

Luminescence spectra

Luminescence spectra of aqueous solutions were recorded in a JascoF-6300 Spectro fluorometry.

RESULTS AND DISCUSSION

The UV-Visible absorption spectra of various test solutions are shown in Figure 5a-c. The UV-Visible absorption spectrum of green colour chips solution (test solution) is shown in Figure 5c. A peak appears at 380 nm. The corresponding fluorescence spectrum (λ_{ex}=380 nm) is shown in Figure 6. A peak appears at 385 nm. The UV-Visible absorption spectrum of an aqueous extract of coriander leaves is shown in Figure 5a. A peak appears at 384 nm. This spectrum closely resembles that of the test solution (Figure 5c). Hence it is concluded that the green coloured coated on the finger chips is due the paste of coriander leaves. The fluorescence spectrum (λ_{ex}=384 nm) of coriander leaves extract is shown in Figure 7. A peak appears at 386 nm. This emission peak also is very similar to that of the test solution.

The UV-Visible absorption spectrum of MG solution is shown in Figure 5b Peaks appear at 388 nm (aromatic peak) and 620 nm (chromophore). These peaks are different from those of the peaks seen in Figure 5a and 5b. The corresponding emission spectra of malachite green solution are shown Figures 8a, 8b and 9.

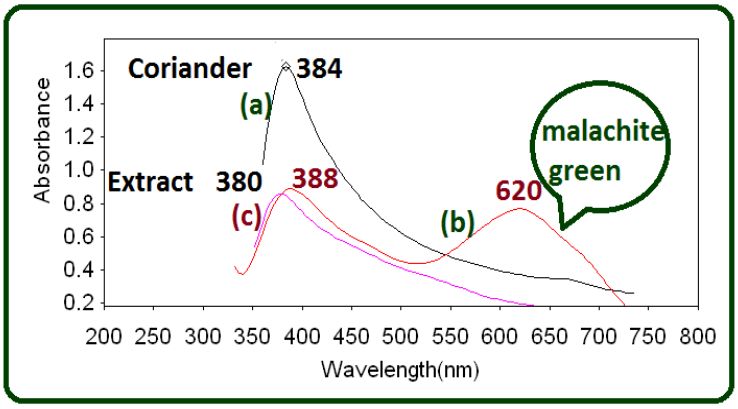

Figure 5: UV-Visible abosorption specta of various solutions: (a) Coriander leaves extract, (b) Malachite green, (c) Extract of the green material coated on the potato chips

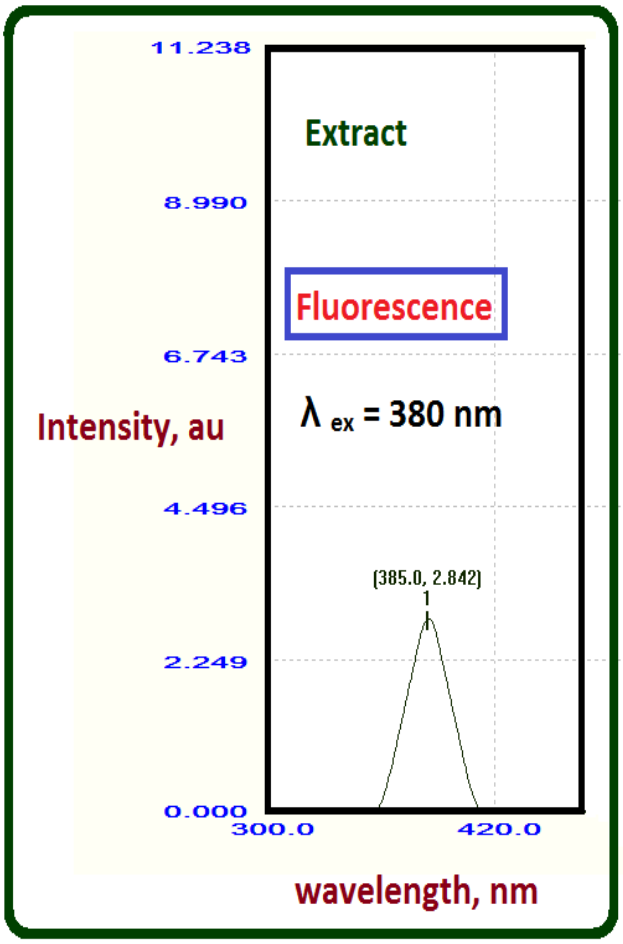

Figure 6: Fluorescence spectrum of green solution extracted from potato chips

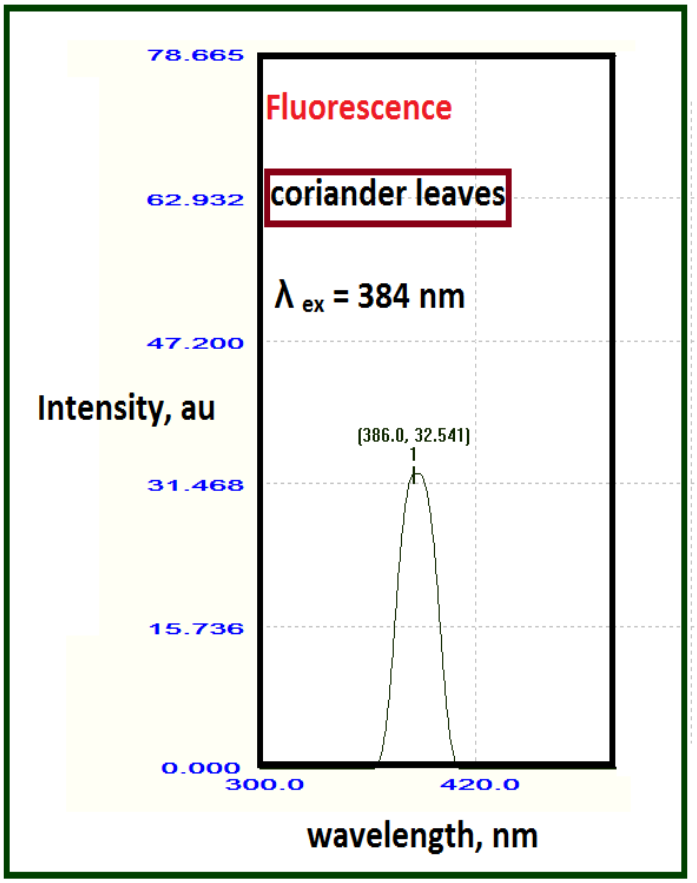

Figure 7: Fluorescence spectrum of the extract of coriander leaves

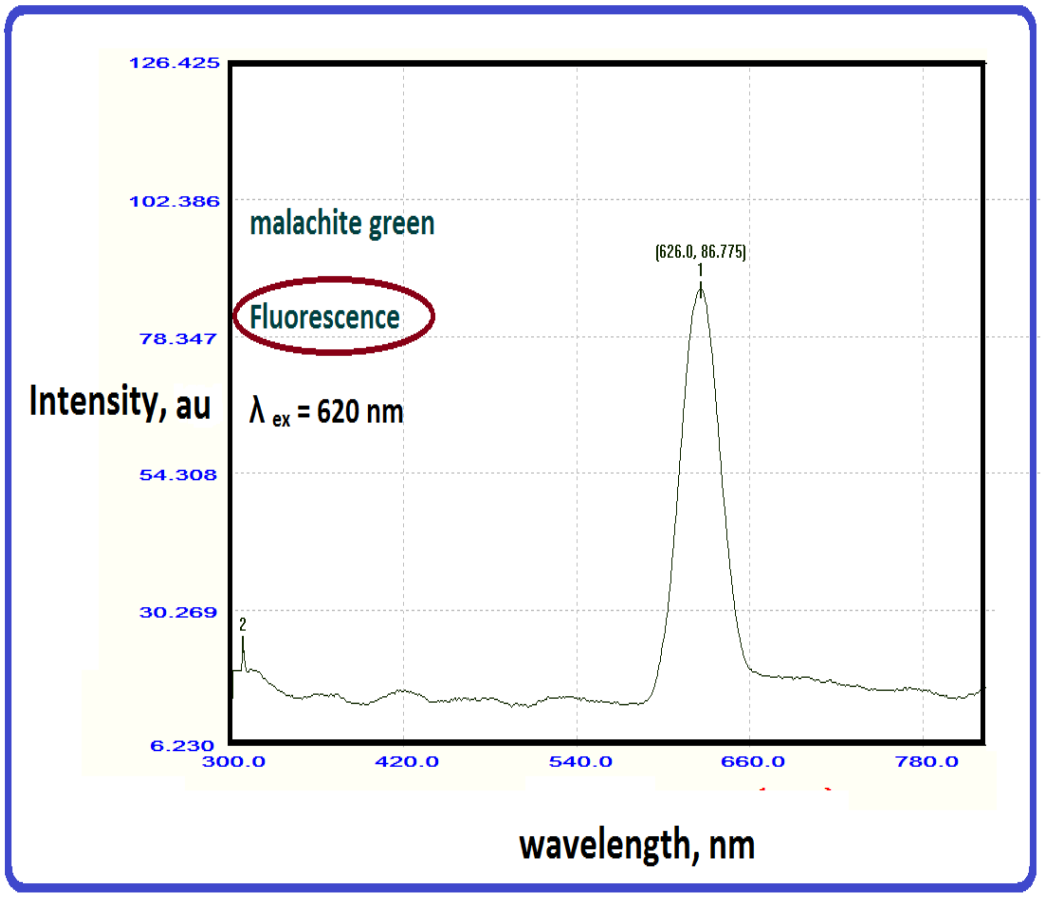

Figure 8a: Fluorescence spectrum of malachite green solution

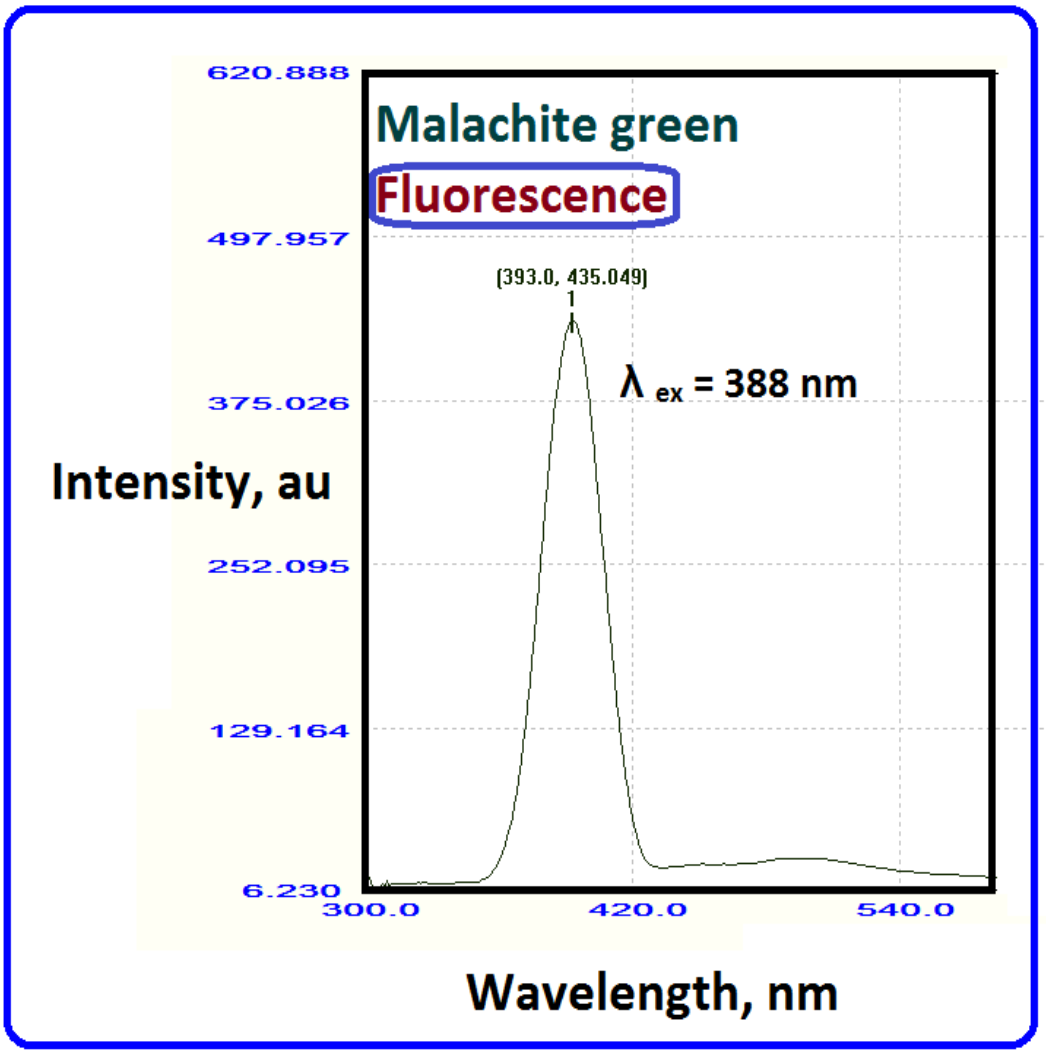

Figure 8b: Fluorescence spectrum of malachite green solution

Application of fluorescence of three solutions

Test solution and coriander leaves extract solution

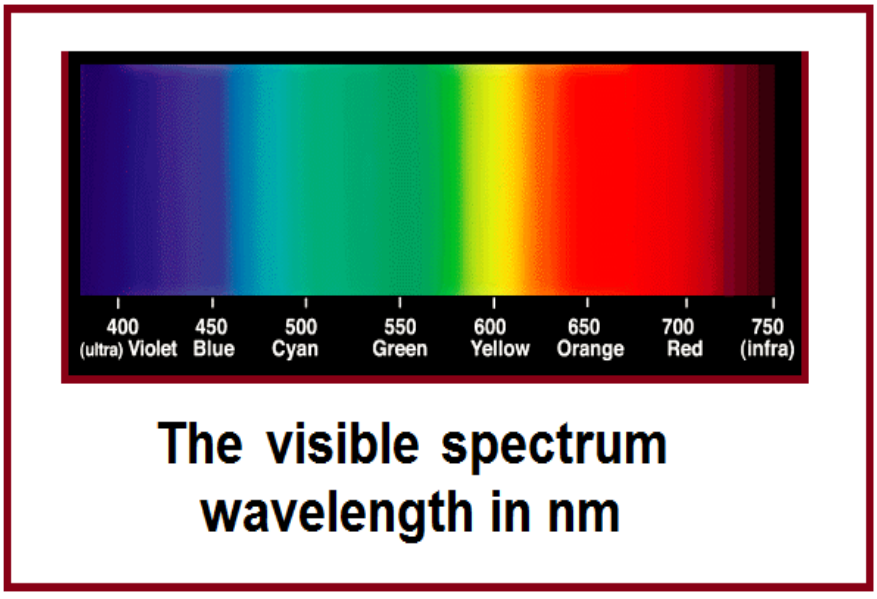

Figure 9: The visible spectrum

The fluorescence spectra of these two solutions are representatives of UV-UV emission. The uses for UV light include a broad range of applications in commercial, industrial and healthcare settings. The type of applications that use UV lamps include the curing or drying of materials such as inks and coatings; disinfection for viruses and bacteria; hygiene and infection control; fluorescent inspection; and tanning.

Malachite green solution

Malachite green solution gives two fluorescence spectra. 388 nm → 393 nm and 620 nm → 626 nm. The 388 nm → 393 nm fluorescence represents UV-UV emission. The 620 nm → 626 nm emission represents yellow – red emission. This emission may find application in light emitting diodes [8].

CONCLUSION

The presence study leads to the following conclusion:

- The green coloured coated on the green colour potato chips is due to coriander leaves and not malachite green.
- Hence people need not hesitate to take these green colour finger chips sold at "Anjali Sweet Stall" Scheme Road, Dindigul.

ACKNOWLEDGEMENT

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