

Detection of Aflatoxin in Food Products using UV Fluorescence Spectroscopy



T.Chandralekha, S.Abinaya, Anshu Rathour, Arthi Mahalakshmi, Chinnerikuppam Heema

Abstract: Aflatoxins are found in food items and are treated as essential to food security issue. Aflatoxins are poisonous toxins which are found in various feed products and are very dangerous for humans and animals as well. These are not the products which cause immediate liver cancer or the liver damage but instead grow slowly in the human body. They are also a type of fungal toxins can only be noticed in costly machines with the use of UV fluorescence spectroscopy. These are mostly found in peanuts, corn, maize and broken rice. Aflatoxins are never found in freshly released products, rather they are formed because of the moisture found in the atmosphere around. Aflatoxin-B1 when present in food products undergoes the process of fluorescent spectroscopy. Here the UV rays are excited to 365 nm for single photon and 730 nm for bi photon. Basically the results for the range of 400 and 550 nm is considered as the most contaminated of the food product. For every wavelength when photons are excited, the inward fluorescent signals are to be noted and observed. Based on the wavelengths of the excitation signal we can distinguish between the hygienic and impure food samples. There would be largest difference of wavelength between single and bi photon fluorescence values. The similarity between the fluorescent signals of the samples of different food products would define the impure samples. Thus UV fluorescence spectroscopy is very essential for measuring the aflatoxin B1 present in various food products.

Keywords : Aflatoxin, Fluorescence Spectroscopy, Radiation, UV rays.

I. INTRODUCTION

The existence of different types of phytotoxins, fungi related toxins, in foodstuff and feed products is a food security problem nowadays. The toxic chemicals which are present in various food products on different types of environments may result to different types of diseases in humans and animals. The FAO tells that 25% of the food products present in the world are mostly affected by phytotoxins which produces fungi. Besides, the agglomeration of phytotoxins in

foodstuff constitute a major problem to animal and human bodies, because they can cause liver damage, cancer and it may even cause immediate death. The major part of phytotoxins which is present in foodstuff is aflatoxin B1. They are produced by fungi toxins and are found in different types of food materials such as peanuts, broken rice, maize, red chillies, spices. There are four types of aflatoxins present which are B1, B2, G1 and G2. Out of the four aflatoxin B1 is the most toxic and dangerous to health. It also affects animal health and may cause liver damage. Animals and humans cannot detect the presence of aflatoxin in food, so the food which contains aflatoxin should not be consumed. The aflatoxins can affect the food products after the harvest and this is initiated by the presence of moisture. It has been observed through, aflatoxin is to be found in various species. As the moisture increases in the climate the aflatoxin keeps increasing in the products.

Therefore the main focus is upon the existence of aflatoxin-contamination, in red chillies, maize, peanuts, broken rice etc. The occurrence of aflatoxins in food related items is monitored in more than 100 countries regularly. It is stated by the European commission that the maximum amount of total aflatoxin concentration in food products should be up to 10 ppb. To fulfil these requirements, the presence of aflatoxins these days recognised by the usage of different chemicals in the products, i.e. "High-performance liquid chromatography (HPLC) or liquid chromatography-tandem mass spectrometry (LC-MS/MS)". These chemical-analysis procedures are usually costly, take a long time and dangerous. Because of the irregularity in the presence of the toxins in food items or the cereals, the samples based testing some times results a restricted perspective about the level of poisoning. The real degree of aflatoxin density may not be confirmed precisely, resulting in difficulties in the removal of aflatoxin-affected foodstuff and crops without wiping out a huge part of products and causing financial losses. An instant, non-degrading, low cost and precise technique to detect the aflatoxins is very much required. Hence the application of "optical spectroscopic detection" methods to pinpoint aflatoxins is proposed. Different spectroscopy based methods have already made their mark in the food related industry for the quality based and efficient evaluation of food products. By using "absorption and fluorescence spectroscopy", it may be feasible to estimate water presences and concentration in the food items. However, toxins contaminating the food items cannot be detected easily, even by optical methods.

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The established procedures only allow the detection of the said toxin in specific beverages, like beer, wine etc. even more, these fluorescent toxic products could be detected if none or very few light absorbing elements are detected. Many of the foodstuff contain various fluorescence based proteins which pose problems for the aflatoxin detection. even so, as the aflatoxin is one of the luminous medium, “fluorescence spectroscopy” is the better and reliable method.

In addition to the process, the existence of phytotoxins namely aflatoxin B1 inside various foodstuff, the position of crops and red chillies will obtain the data related to fluorescence. The difference between healthy and impure samples results in the wavelength measurements. The food products when comes into a dark place, by analyzing the product, the photons present may excite to different wavelengths. The aflatoxin present in food products may differ by their colour, size, shape. This process is generally more useful in industrial setup, whereas in industrial setup it may cost to higher level, but the realtime detection of impure samples may costs around 30k. The main aim of the project is to analyze UV fluorescence spectroscopy and this is also known as a non-destructive optical detection and it is used to identify the samples of foodstuff. The optical detection present in the industrial setup is super-fast, optical based scanning mechanism and this scanning is done just after the harvesting of food products. The analysis of every grain of foodstuff is done and remove the particular grains. The product when analyzed and then the photon get excited to different wavelengths such as 360 nm, 410 nm, 720 nm, 780 nm, and 810 nm.

II. LITERATURE SURVEY

Emergence of side effects of aflatoxin-contaminated foods in the recent years has been identified as a dangerous problem in the present times. Many studies have been conducted in the field of mycotoxins so as to study their effects on the metabolism of the living beings. These studies have demonstrated that they cause many adverse side effects in human beings such as cardiovascular diseases, tumors etc. Out of these, aflatoxin seems to be the most dangerous carcinogen, causing many deaths worldwide. Hence many organisations have been monitoring the amount of these toxins in the food products, both in national and international commerce [2][8]. The process requires high level of data and image processing, which makes it very costly and slow. This produces huge amount of data which may not be processed easily or quickly enough. therefore a non-destructive and simpler method or system of sorting data and images is required for a process such as this [1][4]. Therefore a local and discriminant study based algorithm was created so as to easily detect features of the food product in question.

Aflatoxin is a toxin that is both secondary and vital, produced by some varieties of common fungi usually present in many primary food products such as peanuts or maize. It poses a huge pressure on the food industry due to the contamination produced and the ensuing damage. The consumption of the above mentioned toxin can cause stunting or cancer etc (IARC 2002). Although it is used for many farm related purposes or cattle rearing, it is considered highly unfit for human use. In the past several chromatographic or immunochemical methods have been used to detect the said

toxin in food products with little success [1][3]. These methods of detection could not satisfactorily segregate the contaminated kernels from the fresh ones, which resulted in financial losses for food traders. The other forms of standard methods such as LC-MS. the incompetency of these methods led to the need for a better and faster method. many studies and researches have been conducted for the same purpose and in which, many procedures and systems have been proposed based on the range of the light rays such as UV, Infrared rays etc [1][2]. The position of the kernels and how they are placed also affect the the results of the process. All these methods have usually produced results with limited scope as they used only some parts or portions of the spectral rays [2]. The currently widespread methods of detecting aflatoxins in food products are mostly based on chemical testing, which take a lot of time to be executed and require huge investments. also a lot of skilled professionals are required to perform this process and hence this makes it more complex and time consuming [2][9].

Aflatoxin is a fast spreading and very threatening toxin that causes many adverse effects in the human body once consumed regularly. The toxin acts as a carcinogen in the human body and may result in the formation of dangerous tissue or tumors in the body. Hence it has become a necessitous to detect and segregate the contaminated food immediately—as both a safety measure and to reduce losses for the food industry [8]. The above reviewed context suggests that a fool-proof, clear and simple method of detecting the aflatoxin in the food products is needed in real time. The use of chemical induced techniques have yielded results but not as required to food safety standards and are hardly reliable or affordable by everyone [8][2]. To better segregate the contaminated food products, more structured systems with larger scales of implementation should be performed.

III. METHODS AND IMPLEMENTATION

Some food products have been investigated as to whether they are contaminated or not and some challenges were tackled accordingly. This type of technique is a very fast and simple process to get the impure samples from among the healthy samples. It can be processed in large amount of products as UV light is passed through which has a wavelength of 200nm to 400 nm. The energy of UV radiation which is soaked up is almost identical to the variation in the energy levels of the ground level and upper level electronic states. As the aflatoxin products are produced by flavus and parasiticus of aflatoxin which are present in weedy molds. UV spectroscopy is a technique which corresponds to UV-Vis absorption. When the food products are kept in a closed container and UV light is passed in through the food products, then the final particles of wavelength are excited when any photon of lower energy is found in food products. There are many types of levels in excitation phase such as ground state, first excited electronic state and these levels are based on “HOMO (Highest energy occupied molecular orbital) and LOMO (lowest unoccupied molecular orbital)” respectively.

The electrons inside the molecules are distributed into the ground state. By using an analysing instrument namely monochromator the fluorescence excitation is obtained by fixing the emission wavelength. Without the presence of any chemicals in the process, the process is done in a very less time. In addition to the electronic levels, there is a small amount of energy present which is known as vibrating sublevels. These are the sublevels which are present between the excited levels. When food particle absorbs UV light then it excited from HOMO to LOMO.

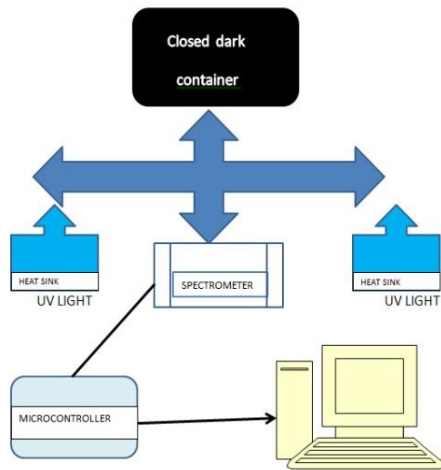


Fig 1. Basic architecture

The peak values which are found in wavelength are present due to the sensitivity of fluorescence. The excitation spectrum mainly has two problems namely the light intensity where it varies everytime along with the wavelength and the intensity. The shorter wavelength values mostly results the presence of aflatoxin in food stuff. Lower wavelength of the UV light which is absorbed is emitted in one direction and higher wavelength is emitted in many directions. There are two more types of instruments which exist such as filters to isolate the UV light and spectroflurometers to isolate all types of light. The most of the molecules which are present in food products are of s orbital where s orbital consists of sigma bonds and p level orbitals are found in very higher levels where it consists of combination of both pi and sigma bonds in wavelength. The electrons go through different types of transitions such as pi to pi, nonbonding to sigma, sigma to sigma, pi to sigma, sigma to pi. Generally UV florescence spectroscopy applies beer-lambert law where the ray of UV light is iterated through food products and it also states that the "decrease in intensity of radiation is proportional to the incident radiation and also the concentration of solution" if it is used to measure the fluorescence. The larger the molecules which absorbs UV light, the greater the extent of light absorption. The unknown substances can also be detected with the help of UV spectroscopy and every substance is compared with the reference sample and identifies the unknown sample. The unknown substances are to be recognized and are not tested. UV Spectroscopy is a mechanism which determine both liquids and solids.

I. Instrumentation in UV spectroscopy

A. Light source

With the use of spectrometer, the UV light of wavelength which ranges from 190nm to 800nm is used and radiated. The

source of radiation is tungsten filament which ranges from 300nm to 2500nm which are continuous over UV region.

B. Radiation source

The wavelength range varies from the radiation source and electrical simulation of hydrogen or deuterium particles in an environment with minimal pressure results in the production of contiguos UV spectral light. The above mentioned technique comprises the creation of stimulated molecules that eventually separated into more than one substances at the atomic level.

C. Monochromator

The monochromator contains silts and prisms and is mostly of double beam spectrometers. The UV light when passed through the monochromator, is emitted in different directions through the use of rotating prisms. It actually separates the unwanted wavelengths present in the light beam. There might be many lines of light source which is passed through the monochromator and the main purpose is to convert all types of lines into a single source of lines by eliminating all types of light source which is not required.

D. Samples

The samples are the products which contain the aflatoxin and are to determine the impure samples among them. The food products which are been used generally to detect are red chillies, broken rice, maize, corn, millets, peanuts. These products generally when produced newly does not contain any type of chemical or the aflatoxin particle in it. The aflatoxin will be detected only in the products which is exposed to moisture and also due to environmental conditions.

When the UV light is produced on the food products, there would be a large amount of heat present. The presence of aflatoxin is detected in the colour of blue. The sample is always enclosed in a closed container and the entire process of determining samples is only done in a dark area. The entire process does not involve any types of other light, if it involves other types of light the process will get entirely damaged. The UV light when passed through the food products produces a large amount of heat. When the food product produces more amount of light, the wavelength also happens to appear at the highest peak. The wavelength around 350nm is always considered as visible range.

III. RESULTS

Generally, the observations, for the edible food samples (when under UV light) in this process are in between the range of 350 nm to 850 nm. However, the results for the contaminated samples are in then range of 400 to 550 nm. If the wavelength is of higher value or is at one of its higher peaks, then the energy jump is also proportionally higher. Whether the food is contaminated or not, can be determined by its colour when observed under UV light. The food products affected by toxin are distinguished by their blue coloured appearance. The values obtained for the affected food particles may be compared to values obtained for the reference healthy samples and hence the degree of toxic contamination of the food product can be determined.

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this process is easy to execute and does not require much time or effort.it is simple and much more effective than the previously designed systems before.

ABSORBANCE WAVELENGTH	Kernel reading 1	Kernel reading 2	Kernel reading 3	Kernel Reading 4	Kernel reading 5
400	0.556471	0.592743	0.592907	0.643197	0.671206
710	0.336127	0.402373	0.415277	0.48658	0.526479
1244	0.317447	0.366055	0.36973	0.419042	0.432633
1812	0.489956	0.549116	0.542073	0.624059	.660199
2260	0.622029	0.675784	0.672587	0.764576	0.820735

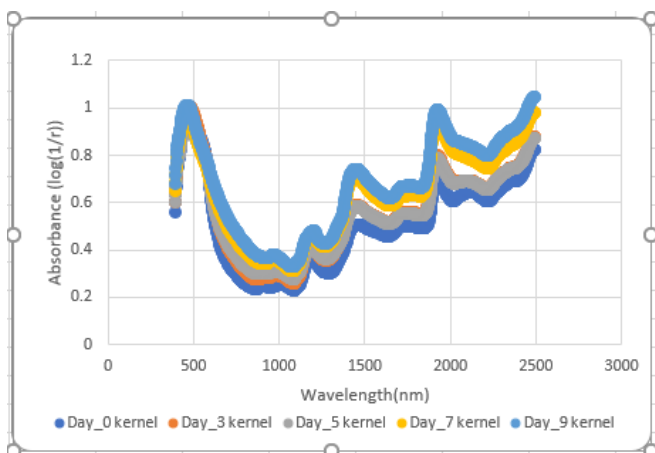


Fig 2. Graphical representation of data collected

IV. CONCLUSION

The system facilitates the easy and fast detection of aflatoxin in many food products that have to be exported in a large scale across many countries.in this process, the wavelength and energy emitted by food particles play a very important role in the final result that can be produced.the process is relatively cheaper and more adaptable to modern standards,which makes it unique and quite reliable. This newly deployed scheme is one of the many systematic and cheaper procedures for instant monitoring and detection of contaminated foods. This newly deployed scheme is one of the many systematic and cheaper procedures for instant monitoring and consultation. It would be helpful to perform live analysis that may eventually make way for an improved and appropriate diagnosis probability and segregation of food products in an extended and further benefiting fashion.

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