* Abstract
  + From the present review, it was shown that fluorescence spectroscopy is able to determine several properties (functional, composition, nutri- tional) without the use of chemical reagents. This is due to the use of chemometric tools (descriptive and predictive methods). Our study focuses on the use of fluorescence spectroscopy for the determination of the quality of animal (i.e., dairy, meat, fish, and egg) and vegetable (oils, cereal, sugar, fruit, and vegetable) products as well as the identification of bacteria of agroalimentary interest.
* Introduction

Public interest in food quality and production has increased in recent decades, probably related to changes in eating habits, consumer behavior, and the development and increased industrialization of the food supplying chains (Christensen et al. 2006). The demand for high quality and safety in food production obviously calls for high standards for quality and process control, which in turn requires appropriate analytical tools to investigate food. Fluores- cence spectroscopy is an analytical technique whose theory and methodology have been extensively exploited for studies of molecular structure and function in the discipline of chemistry and biochemistry (Strasburg and Ludescher 1995). Even though fluorescence is one of the oldest analytical methods used (Valeur and Bochon 2001), it has just, recently, become quite popular as a tool in biological science related to food technology.

An indication for this popularity is the increasing number of research publications about fluorescence as well as the introduction of new commercially available instruments for fluorescence analysis, particularly, front-face fluorescence spectroscopy (FFFS).

Traditional right angle fluorescence spectroscopic technique cannot be applied to thick substances due to large absorbance and scattering of light. Indeed, when the absorbance of the sample exceeds 0.1, emission and excitation spectra are both decreased and excitation spectra are distorted (Karoui et al. 2003). To avoid these problems, a dilution of samples (when it is possible) was performed so that their total absorbance would be less than 0.1.

However, the results obtained on diluted solution of food samples cannot be extrapolated to native concentrated samples since the organization of the food matrix is lost. To reply with this request, FFFS could be utilized. The use of only excitation and emission wavelengths could limit the ability of fluorescence spectroscopy to determine the quality of food systems.

To comply with this requirement, the variation in the excitation and emission wavelengths allows simultaneous determination of compounds in several food- stuffs. Therefore, it would be interesting to use for each food product different excitation wavelengths simultaneously.

This could be realized by using synchronous fluorescence spectroscopy (SFS) which presents two inter- esting advantages from our point of view:

it (1) allows the consideration of the whole fluorescence landscape, i.e., spectra recorded at different offsets and

(2) retains information related to several fluorophores compared to a classical emission spectrum, which is mainly specific to a sole fluorophore.

Synchronous fluorescence spectra are obtained by simultaneously scanning both the excitation and emission monochromators keeping a fixed wavelength interval, named offset between them. It gives a narrower and simpler spectrum. For the SFS technique, the selection of a wavelength interval is one of the most important experimental parameter and the parameter should be optimized, which is carried out by measuring the spectra at various offsets.

This review will provide the reader with the basic principles of fluorescence including the use of this technique, especially the use of the most common FFFS and synchronous fluorescence for the assessment of the quality of several food systems that will be discussed in detail (Table 1).

* Fluorescence Spectroscopy
* Fluorescence is the emission of light subsequent to absorption of ultraviolet or visible light of a fluorescent molecule or substructure, called a fluorophore. Thus, the fluorophore absorbs energy in the form of light at a specific wavelength and liberate energy in the form of emission of light at a higher wavelength. The general principles can be illustrated by a Jablonski diagram
* Excitation Spectrum
* The excitation spectrum is defined as the relative efficiency of different wavelengths of exciting radiation in causing fluorescence. The shape of the excitation spectrum should be identical to that of the absorption spectrum of the molecule and independent of the wavelengths at which fluorescence is measured. However, this is seldom the case because the sensitivity and the bandwidth of the spectro- photometer (absorbance spectrum) and the spectrofluorim- eter (excitation spectrum) are different. In addition, for many food samples, scattering properties and energy transfer between neighboring molecules could contribute to this difference. A general rule of thumb is that the strongest (generally the longest) wavelength peak in the excitation spectrum is chosen for excitation of the sample. This minimizes possible decomposition caused by the shorter wavelength, higher energy radiation.
* Emission Spectrum
* The emission spectrum of a compound results from the radiation absorbed by the molecule. The emission spectrum
* is the relative intensity of radiation emitted at various wavelengths. In theory, the quantum efficiency and the shape of the emission spectrum are independent of the wavelength of the excitation radiation. In practice, this is not the case. Indeed, it has been shown that fluorescence of chlorophyll from a green leaf has a lower short wavelength emission maximum when excited with green light than when excited with blue light (Buschmann 2007). Green light penetrates more deeply into the leaf since it is less absorbed than blue light and the green light- excited fluorescence from more inside the leaf is more readily re-absorbed by the chlorophylls on its way to the sample surface. The re-absorption of fluorescence is particularly high in the short wavelength fluorescence where it overlaps with the absorption spectrum of chlorophyll. If the exciting radiation is at wavelength that differs from the wavelength of the absorption peak, less radiant energy will be absorbed and hence less will be emitted.
* Instrumentation
* The basic setup for an instrument for measuring steady- state fluorescence is shown in Fig. 4. The spectrofluorim- eter consists of a light source (generally xenon or mercury lamp); a monochromator and/or filter(s) for selecting the excitation wavelengths; a sample compartment;a mono- chromator and/or filter(s) for selecting the emission wave

lengths; a detector, which converts the emitted light to an electric signal; and a unit for data acquisition and analysis. The sampling geometry can have a substantial effect on the obtained fluorescence signal. If absorbance is less than 0.1, the intensity of the emitted light is proportional to the fluorophore concentration and excitation and emission spectra are accurately recorded by a classical right-angle fluorescence device. In this case, the excitation light travels into the sample from one side, and the detector is positioned at right angles to the center of the sample. When the absorbance of the sample exceeds 0.1, the intensity of emission and excitation spectra decreases and excitation spectra are distorted. To avoid these problems, dilution of samples (when it is possible, i.e., liquid samples) is currently performed so that their total absorbance will be less than 0.1. However, the results obtained on diluted solutions of food samples cannot be extrapolated to native concentrated samples since the organization of the food matrix is lost. In addition, the dilution may change the concentration of other relevant fluorescent species below or close to the detection limit of fluorescence. Moreover, for solid samples, the dilution cannot be realized (e.g., meat, cheese). To avoid these problems, FFFS can be used (Fig. 4). In this manner, it is possible to measure more turbid or opaque samples, since the signal becomes more indepen- dent of the penetration of the light through the sample. However, when front-face sampling is used, the amount of scattered light detected will increase due to the higher level of reflection from the surface topology of the sample and sample holder. To minimize these effects, it is recommended that the sample is not placed with its surface oriented at an angle of 45° to the incident beam, but rather at 30°/60° to the light source and the detector (Lakowicz 1983).

* Data Analysis
* Data analysis of fluorescence spectra has been well established by Smilde et al. (2004). Fluorescence is inherently multidimensional. Indeed, multidimensional fluorescence signals recorded from a sample can conve- niently be presented as a matrix of fluorescence intensities as a function of excitation and/or emission wavelengths. Due to the neighboring wavelengths, highly correlated data present in emission and excitation spectra have been pointed out (Smilde et al. 2004). In this case, principal component analysis (PCA), common component and specific weights analysis (CCSWA), partial least squares
* regression (PLS), factorial discriminant analysis (FDA), parallel factor analysis (PARAFAC), etc. have proven to be powerful methods for the extraction of valuable information (Boubellouta and Dufour 2010; Christensen et al. 2006; Hammami et al. 2010; Kulmyrzaev and Dufour 2010).
* Applications of Fluorescence in Foods and Drinks
* Dairy Products
* Meat and Meat Products
* Conclusions