CHAPTER III

THEORETICAL CONSIDERATION

3.1 ELECTRICAL RESISTIVITY :

Ohmic heating is based on the passage of electrical current through a food product that serves as an electrical resistance[27,28].

The electrical resistance (R) to electrical current offered by a solid sample of length 'l' and cross-sectional area s depends on its dimension and is given by

$$R = \rho\, l/s$$

where ρ is a constant at constant temperature and pressure and is known as resistivity of the sample. Its unit is ohm – m. The reciprocal of this resistivity is known as the conductivity (σ) of the sample i.e

$$\sigma = 1/\rho$$

and its S.I unit is mho – m^{-1} or Siemens per metre (S m^{-1}).

During ohmic heating, phase change, dehydration and starch gelatinization may affect the electrical conductivity.. Starch gelatinization during heating alters the electrical conductivity of the system. Effects of starch on electrical conductivity are enlarged as the heating temperature increases. On the other hand heat generation depends on electrical conductivity and on the other hand electrical conductivity is influenced by temperature, particle size, concentration of the food system and location of the particles [2].

Electrical conductivity depends on ions (charged atoms or molecules) in solution. Ions found in plant tissue include potassium (K^+), proteins and organic acids, such as ascorbic acid and citric acid. Sugars and starch are uncharged molecules so do not conduct electricity.

3.2 X-RAY FLUORESCENCE

X-RAY FLUORESCENCE analysis is a reliable multi-elemental and non – destructive analytical method widely used in research and industrial applications.

When an analytical sample is irradiated with X – rays emitted from an X-ray tube or radioactive source, fluorescent X-rays are generated in the sample and can be measured for quantitative analyses of its constituent elements. X-ray fluorescence analysis is rapid, precise and non-destructive [29].

An electron can be ejected from its atomic orbital by the absorption of a light wave (photon) of sufficient energy. The energy of the photon (hv) must be greater than the energy with which the electron is bound to the nucleus of the atom. When an inner orbital electron is ejected from an atom, an electron from a higher energy level orbital is transferred to the lower energy orbital level. During this transition a photon maybe emitted from the atom. This fluorescent light is called characteristic X-ray of the element. The energy of the emitted photon is equal to the difference in energies between the two orbital occupied by the electron making the transition. Because the energy difference between two specific orbital shells, in a given element, is always the same (i.e. characteristic of a particular element), the photon emitted when an electron moves between these two levels, will always have the same energy. Therefore, by determining the energy (wavelength) of the X-ray light (photon) emitted by a particular element, it is possible to determine the identity of that element.

For a particular energy (wavelength) of fluorescent light emitted by an element, the number of photons per unit time (generally referred to as peak intensity or count rate) is related to the amount of that analyte in the sample. The counting rates for all detectable elements within a sample are usually calculated by counting, for a set of time,the number of photons that are detected for the various analytes' characteristic X-ray energy lines. These fluorescrnt lines are actually observed as peaks with a semi-Gaussian distribution because of the imperfect resolution of modern dectector technology. Therefore, by determining the energy of the X-ray peaks in a sample's spectrum, and by calculating the count rate of the various elemental peaks, it is possible to qualitatively establish the elemental composition of the samples and to quantitatively measure the concentration of these elements.

3.3 CHARACTERISTIC RADIATION

Each element has electronic orbitals of characteristic energy. Following removal of an inner electron by an energetic photon provided by a primary radiation source, an electron from an outer shell drops into its place. There are a limited number of ways in which this can happen. The main transitions are given names: L→K transition is called Kα, M →K transition is called Kβ, an M→L transition is called Lα, and so on. Each of these transitions yields a fluorescent photon with a characteristic energy equal to the difference in energy of the initial and final orbital.

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