Colorimetry and spectrophotometry for food products

Identification

Key words	Colorimetry, spectrophotometry, colour measurement, food, visual identification, non-invasive
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How does it work?

Primary objective	Colorimetry: quantify and evaluate the colour of an object. Spectrophotometry: quantify and evaluate the transmission properties of a material as a function of the wavelength of an object.
Working principle	Colour is one of the important features used by consumers to assess the quality of a food product. It may be defined as the individual's response to the visual signals generated by the light on a product. Thus, it is very important how colour is perceived and measured and what are the ways in which it can be better understood and controlled in food. In current food industries' practice, two principal colour measurement techniques are used [1-3]: **Colorimetry** concerns the quantification and physical description of the human perception of colours. Colorimetry is the technique which quantifies colour by measuring three primary colour components of light which are seen by the human eye, specifically, red, green and blue (also referred to as "RGB"). These colour measurements provide data on how much of these three components are present in the light transmitted or reflected by a sample. The obtained data are mainly characteristic of the sample since light absorption is specific of each sample. The absorption of light in a certain medium is described by the Beer – Lambert law I = I0e-□x Where I0 = incident intensity, I = emergent intensity, □ = absorption coefficient and x = the distance the light travels through the material. The Beer – Lambert law relates the absorption of light to the properties of the material through which the light is traveling via the □ parameter. While in spectrophotometry the light is broken up in a spectrum, colorimetry uses band filters to reduce colour spectra to the physical correlates of colour perception, most often the CIE 1960 XYZ colour space tristimulus values. **Spectrophotometry** is the quantitative measurement of the reflection or transmission properties of a material as a function of wavelength. Thus, spectrophotometers measure the spectral transmittance (or reflectance) of an object across the full spectrum of human visible light wavelengths, from 400 nm to 700 nm, and (190-400 nm) enabling precise specification of any desired colour. The working principle of the spectrophotometer is presented in the figure: The result of the spectrophotometric measurement is the absorption spectrum of the sample representing the absorbed intensity versus the wavelength, I = f(λ).
Images	
Additional effects	Spectrophotometry is also used for instance for measuring (bio) chemical reactions (such as e.g. enzyme activity) that involve changes in the emitted spectrum.
Important process parameters	sample, instrument geometry used for measurement, instrument calibration

Important product parameters	geometry, dimension, colour, consistency, sample presentation [3-7]

What can it be used for?

Products	Colorimetry and spectrophotometry can be used for all type of food products (solids and liquids) since both transmission and reflection measurement techniques are available [8].
Operations	Quality control and monitoring of processes which take place during the manufacturing, packaging, shipping or storing of food products.
Solutions for short comings	Non-invasive method.

What can it NOT be used for?

Products	-
Operations	-
Other limitations	In the case of opaque products, measurements of the reflected light intensity are available. Also in case of floating particles in a liquid sample, it’s better to filter the sample prior to measuring colour.
Risks or hazards	The use of colorimetry and spectrophotometry for food control presents no risks.

Implementation

Maturity	Colorimetry and spectrophotometry are mature control techniques. Equipments are available for both laboratory and industrial use.
Modularity /Implementation	Colorimetric and spectrophotometric techniques can be easily inserted in an existing production line. The operation of the related equipments is simple.
Consumer aspects	No negative aspects expected.
Legal aspects	• ISO 11664-5:2009 specifies the method of calculating the coordinates of the CIE 1976 Luv colour space including correlates of lightness, chroma, saturation and hue • ISO 11664-5:2009 is applicable to tristimulus values calculated using the colour-matching functions of the CIE 1964 standard colorimetric system • ISO 11664-5:2009 may be used for the specification of colour stimuli perceived as belonging to a reflecting or transmitting object, where a three-dimensional space more uniform than tristimulus space is required
Environmental aspects	Colorimetry and spectrophotometry are environmentally friendly techniques.

Facilities that might be interesting for you

Title	Institute/company
Field Flow Fractionation INPT - EI Purpan	INPT - EI Purpan
Fruit & vegetable analysis INRA	INRA - SQPOV
Gas analysis INRA	INRA - SPO
Mastersizer FBR	Wageningen UR - FBR
Microbiological analysis INRA	INRA - SQPOV
Multi-user olfactometer INRA	Ecole des Mines d'Alès
PlantLipPol-Green INRA	UMR IATE

Further Information

Institutes

Companies Konika Minolta, HunterLab, Optronik

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