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Unit 4- COLOUR

By

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I Introduction

Quality of food is incomplete without the interaction from the user who perceives it through his testing instruments, the five senses. Hence, it is important that product development, marketing should take note of the user's concepts of product.

The first parameter in this direction is how color is perceived followed by appearance and texture. Color and appearance both are caused by visual sense. Vision is regarded .as the process of seeing whereas appearance is the recognition and assessment of the properties, surface texture, opacity, colour etc. Vision has the advantage that a pictorial representation of the object can be recorded including the effect of both the colour of the object and the effect of light in the memory of the observer .Decision making on the acceptance/rejection/purchase of the food depends first on the visual impact it makes. The intrinsic qualities come later. This episode deals with the following aspect of colour:

Importance of colour

Dimensions of colour and attributes of colour

Perception of colour

Measurement of colour

Importance of colour

Among the quality factors of a food material, appearance is an important factor. Appearance may be influenced by several factors of which colour is the most important one. The importance of colour measurement lies in product development and quality control that in turn directly affects the consumer acceptability and marketing. In addition, colour for a number of foods and agricultural commodities is specified by law for quality purposes. These includes Munsell colour meter values for tomato products, Lovibond Tintometer reading for mustard oil, etc.

The classic sensory modalities of vision, smell, touch, taste and hearing have been broadly classified into two classes – physical senses and chemical senses. Physical senses are those that deal with vision, tough and hearing and are dominantly based on the physical properties.

. Visual impact means the entire field of colour and appearance viz. colour, size, shape and visual structure and texture parameters. Thus, the combination of many individual factors make-up for the total perception of appearance of food. This total perception is built from all the visual sensations experienced when a product is viewed on the shelf, A list is being prepared and when it is presented on the plate.

Appraisal of food by its colour is usually helpful and in a vast majority of cases provides a reliable information more quickly than can be obtained by other means . Colour evaluation and control of fresh and processed foods is becoming increasingly important to processor.. The reason is relatively obvious – production of a standard product. The food industry accepts as normal some variability in the colour of raw materials. By judicious blending, especially in juice, it is possible to produce product of fairly uniform colour. Hence evolution of colour of the raw material becomes increasingly important to processor.

II Dimensions of colour and attributes of colour; gloss etc.

Optical Properties comprise of the attributes of colour, translucence, gloss and uniformity. Perception of colour (and of appearance in general) is a phenomenon unique to the individual, standardization of measurements of which involves defined conditions of source of lighting and illumination. Gloss is the next optical property, which also plays an important part. The presence of glossy surface affects the perceived colour by diluting it with the colour of the illuminating light. Thus the perceived colour of the surface changes with angles of illumination and viewing.

Translucence is very common in food products. This quality is usually appreciated in those products, which are almost transparent in their own right, or usually as a thin layer. Light, which is not specularly reflected as occurs in mirror, penetrates into the surface and when light is passed through a translucent object absorption and/or scattering reduce the intensity. These attributes of colour, gloss and translucence are capable of being specified using numbers relative to psychophysical scales..

Mode of presentation consists of product description, package (including shape, design, colour, striking ness of packaging) contrast phenomena of adjacent colours and illumination. All the four aspects apply “on the shelf” while the last two apply on the table. No doubt, price has a profound effect on purchase decisions. Brand name and product description follow the price. But many a times impulsive purchases are made which are able to hold and catch the attention of the buyer for just about a second. Package design and use of colour and colour harmony thereon is not a straightforward subject and it is clear that a new package design should never be used without prior texting. Colour never stands alone but are always in combination with other colours and surfaces around them as well as the direction of light which lines upon them. Colour contrast and strength can make or mar the product on shelf. Ingenuity in choice of coloured lights and crockery will enhance the colour and appearance of foods.

Gloss

The appearance of a surface, whether it is glossy or dull, is an important physical aspect of food quality detected by human vision. In general, a shinny appearance is preferred, although this varies with the product. Typical products where a shiny surface is valued are apples, cucumbers, cherries and rice. On the other hand, oranges, mushrooms, green beans are expected to have a dull surface. The four types of light distribution from objects have the following general relationship to surface appearance: (1) diffuse reflection – shinny (2) specular reflection – glossy, mirror-like (3) diffuse transmission – cloudy, opaque and (4) specular transmission – translucent. Since gloss is a psychological attribute of surfaces associated with specular reflection and since they vary from surface to surface, no well-developed methods exist for quantifying this property though its importance is understood.

III. Perception of colour

Physically, colour is a characteristics of light measurable in terms of intensity and wavelength. It arises from the presence of light in greater intensities and at some wavelength than others. Physiologically, it is father limited to than band of spectrum from 376 to788 nm and for all practical purpose the range from 400th0700 nm is used. Colour is sensation experienced by an individual when energy in the form of radiation within the visible spectrum falls upon the retina of the eye. Without light colour does not exist. the colour perceived when the eye views an illuminated object depends upon spectral compositions of the light sources and chemical and physical characteristics of the object or colorant and spectral sensitivity characteristics of viewer's eye.

The human eye is a very sensitive organ. It can detect up to 10 million different colors. The determination of colour as seen by the human eye depends on a physical stimulus in the eye followed by an interpretation by the brain. The interpretation of the signals from the retina by the brain is a complex phenomenon and is influenced by many psychological aspects. Visual apparatus consists of the eye that is a light detector wavelength analyzer and neural pathway to the brain in which the visual cortex provides kind of interpretation map of the retinal image. The detection and translation of the

external stimuli into the colored sensation begin in the 200 million cells in the retina. Eye is spherical with diameter of approximately 2 cm. Exterior eye ball has three membranes consist of sclera continues with the sheet of optic nerve posteriorly and anteriorly with cornea. The middle or choroid contains blood capillary network. The iris which controls amount of light entering the eye, ciliary body suspends the lens. Inner membrane is light detecting retina lies inside the posterior of the eye. Light entering the lens of the eye on the retina where rods and cones convert it into neural impulses which travel to the brain via the optic nerve. **(Fig.1)**

Color constancy and chromatic adaptation, contrast phenomena, color memory, color harmony and color vision deficiency are the factors that have an effect on perception of color. Appearance consists of a large proportion of color and the visual attributes of structure.

Product range is thus built by three parts – on the shelf, preparation and on the plate images. The purchase decisions are mostly dependent on the correlations of colour and appearance to intrinsic quality in the eyes of the consumer. The assessment of the images its unfolding should be carried out with carefully built sensory methods coupled with the data generated by the available most sensitive colour measuring systems.

IV. Measurement of colour: Munsell colour system, CIE colour system, Hunter colour system etc.

Colors that fall between existing standards are difficult to communicate to another individual. These are the reasons instrumental methods of colour measurement have been more useful. Measurement of colour depends on several factors including the input light (illuminant), object (the food itself) and the instrument employed for measuring colour (human eye or a colour measuring instrument). The illuminants used in the present time are simulating the average day light (Illuminant C or D_{65}) which can supply continuous spectra of light without variation; illuminants A & B were used in earlier days. These illuminants are defined by their respective colour temperatures. The sunlight varies widely during the day time and due to weather condition and hence, not suitable for colour measurement as a standard illuminant. The food material is the

object that is mostly opaque and therefore is able to provide repeatable results of colour due to reflection. It is also necessary to have a standard white for colour measurement. Standard white may be barium sulphate, magnesium carbonate, glazed white tiles, etc. It is worth mentioning here that user defined illuminants are now finding wide use from the point of product development and quality control.

Among the quality factors of a food material, appearinance is an important factor. Appearance may be influenced by several factors of which colour are the most important one. The importance of colour measurement lies in product development and quality control that in turn directly affects the consumer acceptability and marketing. In addition, colour for a number of foods and agricultural commodities is specified by law for quality purposes. These include Munsell colour meter values for tomato products, Lovibond Tintometer reading for mustard oil, etc.

Principle of Colour Measurement The measurement of colour is usually done by human eye, and thus it is a subjective measurement. Colour measurement varies from person to person. Standard colour charts are available but they possess two limitations; these are fading of colour with time, and comparison of colour which is again a subjective measurement. So a number of colour measuring instruments have been developed to measure instrumental or objective colour of samples. The principles behind those developments lie on several facts. These are--- that the colour can be added or subtracted to have an another colour. Further, human eye can recognize three kind of stimuli and thus colour measurement is known as tristimulus colourmetry. These three stimulus are dominant wavelength or hue, purity or saturation (samples own colour) and brightness (ratio of the reflected light to incident light).Instrumental methods for colour measurement based on transmission, or transreflection, spectrophotometry.The physiologists discussed the response of the human eye in terms of the visible spectrum. It was done in a manner easily reproducible in a laboratory today.

A number of colourmeters are available. Among them common colormeters are **Lovibond Tintometer, Munsell Colourmeter, Hunter Colourmeter** and colour meters based on **CIE system**.

Munsell colour meter is developed for USDA for colour grading of processed tomato product such as juice , tomato puree, tomato pest , tomato ketchup and sauce, in munseell system the three attributes of colour are designated as hue (H), value (V) and chroma (C) and are always given in the same sequence. The hue scale is based on ten hues which may be distributed on the circumference of a “hue circle”. The letters used to designated hues are R (Red) , Y(Yellow), G (Green), B(Blue) , and P(Purple), and their intermediaries YR,GY,BG,PB and RP. Each hue is at the midpoint of a scale from 1 to10. The vale scale is perpendicular to the plane of the hue circle and passes through its center .it ranges from 0(black0 to 10 (white). In practice, the working scale is normally set from 1 to9. The chroma (intensity of hue) scale – the third attribute of colour –starts from the center of the hue circle (zero chroma) and extends radially in a series of steps and is of irregular length to limit permitted by available pigment.

Hunter colour system is based on the colour space **(Fig 2)** and expresses colour in terms of **L, a** and **b.** The parameter **L** represents lightness (or brightness), **a** indicates redness when positive and greenness when negative, and **b** indicates yellowness when positive and blueness when negative**.** But these colorimeter can not express the color of samples completely.

The basic color attributes as defined by hunter (1991) are:

- **Brightness:** the attribute of a visual sensation according to which an area appears to exhibit more or less light
- **Hue:** The attribute of a visual sensation according to which an area appears to be similar to one, or proportions of two, of the perceived color red, yellow, green and blue.
- **Colorfulness:** The attribute of a visual sensatiom according to which an area appears to exhibit more or less of its hue.
- **Lightness:** The brightness of an area judged in proportion to the brightness of a similarly illuminated area that appear to be white or highly transmitting(strong and weak)

- **Chroma:** the colorfulness on area judged in proportion to its brightness of a similarly illuminated area that appear to be white or highly transmitting (strong and weak)
- **Saturation:** The colorfulness of an area judged in proportion to its brightness.

These six attributes will be quite useful in describing and quantifying the color of any product with regard to the environment.

The Commission Internationale d'Eclairage (CIE) system is a complete but complex colour measuring system because it is an imaginary system. It can give values for all three parameters of colour measurements such as hue, chroma and brightness. It initially calculates the tristimulas (X, Y, Z) followed by estimation of chromaticity coordinates (x, y). It then uses the standard colour space graph (**Fig. 2)** to obtain the all three colour characteristics such as hue, chroma and brightness. It is thus desirable to use this system to obtain a clear picture about the colour of the food system and to finally relate them with the colour measurements obtained by sensory assessments. CIE approved three standard illuminants. Illuminant A with a colour temperature of 2854 K, represents light from an incandescent lamp. Illuminant B, with a colour temperature of 4800 K represents direct sunlight. Illuminant C,with a colour temperature of 6500 K represents average daylight The CIE fourth series is D illuminants usually known by the first two digits of the Kelvin colour temperature scale D_{65}.D_{75} etc.

It can be concluded that colour measurement in scientific manner is highly important for quality control and for product development though detailed measurement of the colour is a complex process**.** The measurement of colour depends on the light energy in the visual spectrum emitted when a light beam interacts with an object. The signal , which can be either reflection or transmission, impinges on the retina of the eye, which in turn sends a signal to the brain. Mathematical data for interpreting the visual signals are rigid for ideal situations namely complete reflectance or transmittance, but most foods are in between the two extremes. This gives some empiricism into the instrumental interpretation of colour.

v. Colour abnormalities

Some aspects of color perception which must be considered in sensory testing are:

- Subjects often give consistent responses about an object color even when filters are used to mask differences.
- Subjects are influenced by adjoining or background color and relative sizes of area of contrasting color, blotchy appearance.
- The gloss and texture of a surface also affect perception of colour.
- Color vision differs among subjects: degrees of color blindness.eg. inability to distinguish red and orange or blue or green.

Pigments are perceived as colours because receptor on the retina of the eye receive physical stimuli. Colour is also associated with taste for example.

Yellowish green- acidic

Moss green- saltish

Pink- sweetish

Dark brown- bitterness

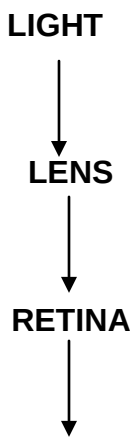
The surface characteristics or appearance factors are related to the quality of the product and they could be the most important factors evaluated. Appearance provides the first clue for the consumer of the product's quality. Factors such as the length, thickness, width, particle size and the apparent wetness, dryness, softness, hardness or crispness of surfaces are used by consumers for making purchasing decisions. Colour is also equality important – a darker than anticipated colour might lead the consumer to assume that the product is overdone and of low quality, which might result in rejection of the product. Is the colour the expected one, or it too light or too dark? In baked

products, too dark or too light a colour might indicate or connote under or over-baking. Appearance factors are divided into those related to (a) colour and the wavelength distribution of light and (b) the special distribution of light. The geometric attributes include glossiness, clarity, haze, turbidity or opacity; distribution of pieces; and surface texture. Is the length, thickness, width or particle size what is expected? Does the surface appear wet, dry, soft, hard or crispy? Because these questions are used by consumers for making purchasing decisions, appearance factors need to be evaluated.

Conclusion

Color and appearance both are caused by visual sense. Vision is regarded .as the process of seeing whereas, appearance is the recognition and assessment of the properties, surface texture, opacity, colour etc. Appraisal of food by its colour is usually helpful and in a vast majority of cases provides a reliable information more quickly than can be obtained by any other means. Color contrast and strength can make or mar the product on shelf. The determination of color as seen by the human eye depends on a physical stimulus in the eye followed by an interpretation by the brain. The interpretation of the signals from the retina by the brain is a complex phenomenon and is influenced by many psychological aspects. The food material is the object that is mostly opaque and therefore repeatable results on colour can be produced due to reflection.

Colour perception by the human eye as follows



RODS and CONES

↓

NEURAL IMPULSE

↓

OPTIC NERVE

↓

BRAIN

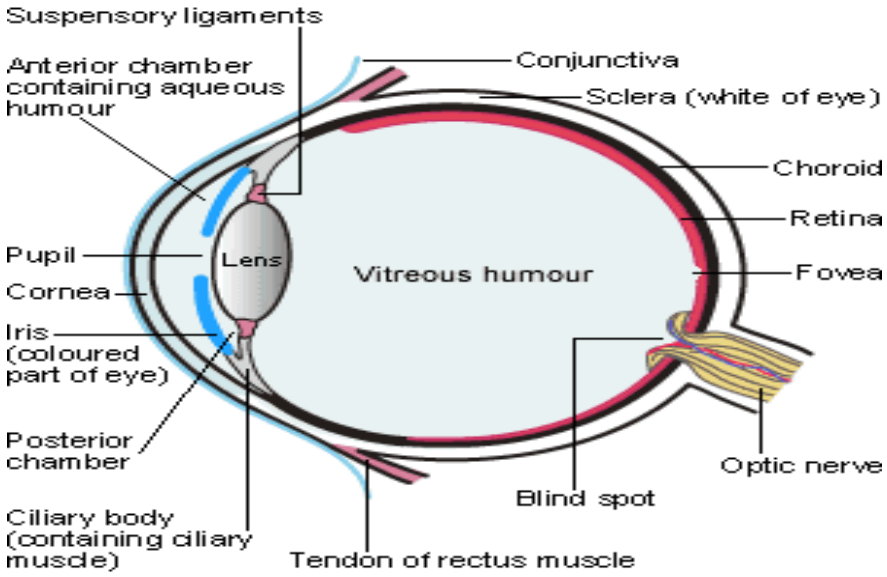


Fig.1 Cross section of Eye

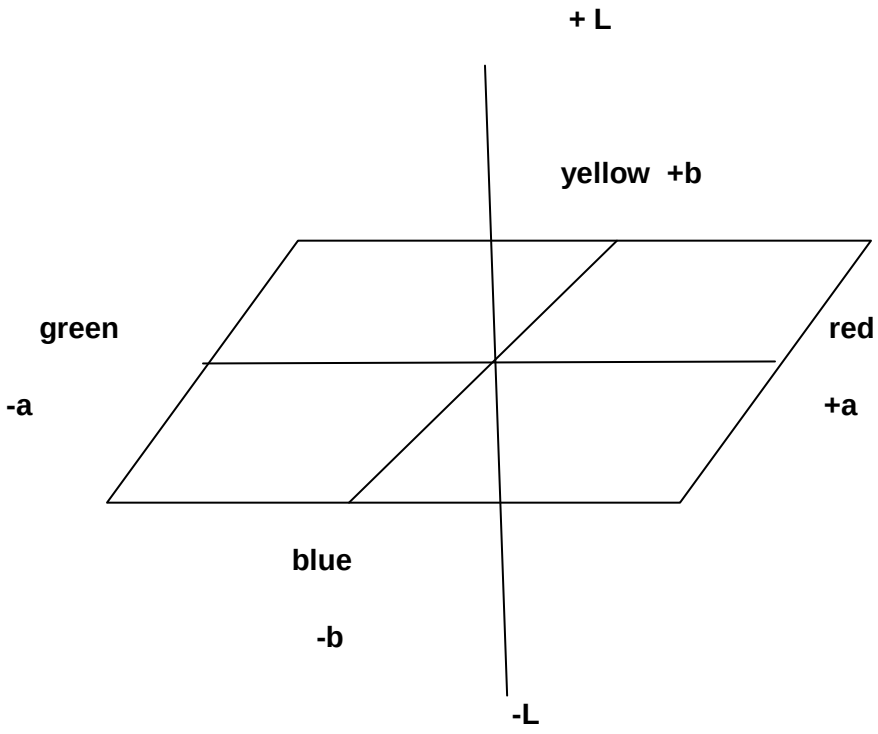


Fig.2 Hunter Colour Space

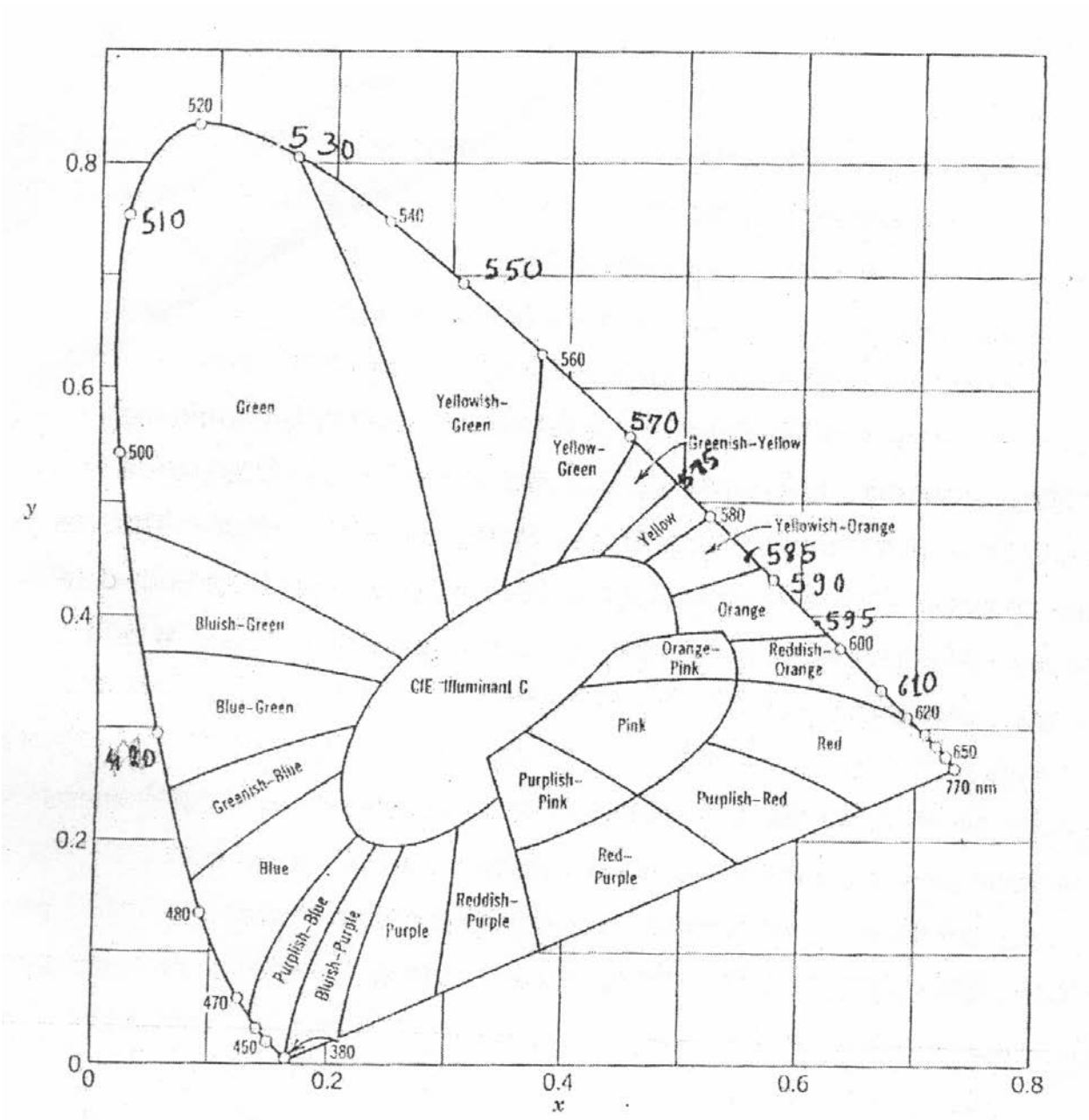


Fig. 3 Chromaticity Chart in CIE colour measuring System