JUDGING OF DAIRY PRODUCTS

Module. 2 Requirement of sensory evaluation and physiology of human senses

Lesson 7

PHYSIOLOGY OF SENSORY ORGAN EAR AND EYE

7.1 Sense of Audition

Sound is important in sensory evaluation of products. Crunching of nuts - an important quality attribute. However, it distracts attention from flavor – taste and smell thereby increases threshold. E.g. potato chips – crunchiness used for the advertisement. Sounds, are associated with food preparation e.g. popping of cream, perking of coffee, simmering, frying, cracking etc.

7.2 Anatomy of Ear

Fig. 7.1 Semi diagrammatic Drawing of ear

- The outer ear : The outer ear is comprising of flap of tissue, on the side of head, is a sound gathering trumpet. From it a 3 cm long canal runs obliquely to the eardrum, twisting to protect delicate inner components and warming air to keep things cozy. In this canal, a profusion of hairs and 4000 wax glands against infection, particularly when we swim in dirty water. The eardrum is tough tightly stretched membrane of less than 2 cm actross From there, intricate business of hearing starts. To it sound bearing airwaves strike like a stick – beating drum.

- The middle ear: There are 3 tiny bones called the anvil, hammer and stir up in middle air. These 3 bones step up the tiny movement of eardrum, amplify them 22 times and pass them to inner ear via oval window attached to the last bone.

- The inner ear: It is the real organ of hearing It resides in a fortress like the one caxern hollowed out of the body's hardest bone filled with watery fluid. Its Major hearing component is snail shaped cochlea, whose twisting interior is joined / covered studded with thousands of microscopic hair like nerve cells, each one is tuned to a particular vibration. When the middle ear's stirrup "knocks" on the oval window leading to the inner ear, this fluid is set vibrating, and produces a current in nerve cells. The waving produces a wisp of electricity that feeds in to auditory nerve, which in turn leads to the brain.

7.3 Sense of Vision

The first impression of food is usually visual, and a major part of our willingness to accept a food depends on its appearance. Appearance is a compound of all the information of the size, shape and color and characteristics such as transparency, opaqueness, turbidity, dullness and gloss etc. mediated by the organ of sight / vision. Color prejudices do exist and often have a real basis :

- Green colored fruits are usually unripe, while yellow or red is associated with ripeness.
- The proper color is often one of the most important or only quality factor which consumers recognize.
- In some cases, color changes are accompanied by undesirable changes in texture, taste or odor.

7.3.1 Anatomy of Eye

Eye is just like a miniature television camera, and is much more sensitive than the biggest, costliest TV camera. **Fig. 7.2** Anatomy of eye.

7.3.2 Parts of Eye

- Cornea : clear, dime-size front window, which bends light rays into orderly patterns.
- Lens : A little envelope of fluid, the size & shape of an oval vitamin pill. A ring of tiny, strong, hard working muscle surrounds lens. These muscles when tense- lens flattens for near vision, when relax – it flattens for distant vision. There are two fluid-filed chambers in both the fluids must be clear to permit passage of light.
- Pupil : An adjustable gateway for light. In bright sun it is nearly closed, on a dark night it is wide open.
- Retina : A kind of onion skin wallpaper, which covers the rear 2/3 of my interior, Light passes through lens and brings it into correct focus on the retina covering less than 3 sq. cm, retina contains 137 million light sensitive receptor cells (130 million rod shaped for black and white vision and, 7 million cone shape for color vision)

Rods are scattered all over the retina. They contain a purplish-red pigment-rhodopsin. The faint light bleaches ‘ rhodopsin’, and generates a tiny wisp of electricity, which is fed to straw size optic nerve and is transmitted to brain. Brain intercepts the signals flooding in and hand down its verdict. All this intricate electrochemical activity has been completed in about 0.002sec.

Cones are concentrated in the fovea-a pinhead size, yellowish depression at the rear chamber. This is the center for acute vision for reading, close work and for colors. Cones also have bleachable pigments one each for red, green and blue. Brain blends these colors to make scores of other hues. Anything goes wrong with an intricate electrochemical process the person would be color blind. In dim-light activity of cones diminishes, color sense vanishes, rods takes over and the thing appear gray.

- The lacrimal glands produce a steady stream of moisture-tears-to flush away dust and other foreign material.
- Eyelid acts as windshield wipers, which blinks 3-6 times per minute and keep cornea moist and clean. Tears also contain a potent microbe killer called lysozyme to guard from infective bacteria.

The eye records our impression of the physical world, color, size, shape, gloss, glitter etc. However, eye is not a very good quantitative instrument, but very fine qualitatively. The visible spectrum of the eye lies in the wavelength range of 400nm (violet)-700nm(red.) The eye is most sensitive to differences in color is the green (520nm) to yellow (580nm) region.

7.3.3 Color

Colour is the general name for all sensations arising from activity of the retina of the human eye and its associated nervous mechanism when light reaches the retina. We must determine colours' intensity, dominant wavelength & colorimetric purity. Roughly, intensity is to amount of color the dominant wavelength is the predominant color (red, yellow etc.) and colorimetric purity is the relative amount of gray present.

When eye views an illuminated object, the color perceived is related to 3 factors :

- Special composition of the light source.
- The chemical and physical characteristic of the object.
- The spectral sensitivity properties of the eye.

Color nomenclature is somewhat difficult to comprehend. Various systems are available and color maps are used to provide reference points.

7.3.4 Color classification systems

7.3.4.1 C.I.E. system

Commision International De E'clairag – Interantional Commision on Illumination.It is the most important/commonly used for food color description. The C.I.E. system, a tri chromatic system, is based on the fact that a suitable mixture of three primary colors can match any color. The three primaries are red, green and blue. Any possible color can be presented as a point in a triangle. The relative amounts of 3 primaries required to match a given color are called the tri stimulus values of the color. The C.I.E primaries are imaginary, because there are no real primaries, which can be combined to match the highly saturated hues of the spectrum.

The amounts of x, y, z primaries require to produce a given color are calculated from :

I = spectral energy distribution of illumination

R = spectral reflectance of sample

Dh = small wavelength interval

x, y, z = red and green and blue factors.

The ratios of the primaries can be expressed as :

X = x/x+y+z, y = y/x+y+z and z = z/x+y+z

The quantities x and y are called the chromaticity co-ordinates. A plot of x v/s y results in CIE chromaticity diagram.

Achromatic colors are white, black and gray. Black and gray only differ from white in their relative reflection of incident light. The purples are non spectral chromatic colors. All other colors are chromatic. e.g. brown is a yellow of low lightness and low saturation. It has a dominant wavelength in the yellow or orange.

A color can be specified in terms of the tri stimulus value Y and the chromaticity co-ordinates x and y, value is a measure of luminous reflectance/ transmittance and is expressed in % simply as Y/100

Another method of expressing color is in terms of luminance, dominant wavelength and excitation purity, i.e. lightness, hue and saturation.

Lightness – relative luminous flux (reflected / transmitted)

Hue – senses of redness, yellowness etc.

Saturation – strength of hue/relative admixture with white.

One of the problems with this system is that the X, Y, and Z values have no relationship to color as perceived, even through a color is completely defined.

7.3.4.2 Munsell system

In color classification of this system, all colors are described by the three attributes of hue, value and chroma. It can be envisaged as a three dimensional system. The hue scale is based on ten hues, which are distributed on the circumference of the hue circle. There are five hues; red, yellow, green, blue and purple; written as R,Y,G,B,P and five intermediate hues; YR, GY,BG,PB and RP. Each of these ten hues is at the midpoint of a scale ranging from 1 to 10. The value scale is lightness scale ranging form 0(black) to 10(white.) This scale is distributed on a line perpendicular to the plane of the hue circle and going through its center.
Fig. 7.3 The Munsell system.

Chroma is a measure of the difference of a color from a gray of the same lightness. It is a measure of purity. The chroma scale is of irregular length, and begins with zero for the central gray. The scale extends outward in step up to the limit of purity obtainable by available pigments.

The description of a color in the Moonless system is given as HIV/c, e.g. A color indicated as 5R 2.8/3.7 means a color with a red hue of 5r, a value of 2.8 and chroma of 3.7. All colors which a can be made available pigments are laid down as color chips in the Munsell book of color.

7.3.4.3 Hunter system

To overcome the problem encountered in C.I.E. system, the Hunter system color classification, widely used for food colorimetry, have been suggested. The so – called uniform – color, opponent colors, color scales are based on the opponent-colors theory of color vision. In this theory, it is assumed that there is an intermediate signal switching stage between light receptors in the retina and the optic nerve which transmits color signals to the brain. In this switching mechanism red responses are compared with green and result in a red-to-green color dimension. The green response is compared with blue to give a yellow to blue color dimension. These two color dimensions are associated with the symbols a and b. The third color dimension is lightness, L, and is non-linear and usually indicated as the square or cube root of Y. This system can be represented by the color space shown in **Fig. 7.4.** The Hunter System.

The L, a, b, color solid is similar to the Munsell color space. The lightness scale is common to both. The chromatic spacing is different. In the Munsell system, there are the polar hue and chroma coordinates, whereas in the L, a, b, color space chromaticity is defined by rectangular a and b coordinates. CIE value can be converted directly by the use of equations as shown in Fig.7.5 into L, a, b, values and vice versa. This is not the case with Munsell values. There are obtained from visual comparison with color chips (called Munsell notations) or from instrumental measurements (called Munsell renotations), and conversion is difficult and tedious.

The L a b color solid is similar to the Munsell color space. The lightness scale is common to both. The chromatic spacing is different. In Munsell system there are the polar hue and chroma coordinates, whereas in the L, a, b color space chromaticity is defined by rectangular a and b coordinates.

7.4 After Images

After images are known to occur (motion pictures depends upon them). These may be positive, with the same qualitative characteristics, or negative, i.e. with an antagonistic or complementary quality.

7.5 Color Contrasts

Color contrast is another phenomena. If a gray square is placed on a color surface the gray appears to be tinged with an antagonistic or complementary to the background color.

7.6 Gloss

In addition to the color, there is another important aspect of appearance, namely GLOSS. Gloss can be defined as ‘’ the characteristic, which is related to the reflecting properties of the material’’. Reflection of light can be diffused or undiffused (specular). In specular reflection, the surface of the object act as a mirror and the light is reflected in a highly directional manner.

Surfaces can, therefore, be classed on a scale going from a perfect mirror completely specular reflection to a surface reflecting in a completely diffuse manner. In the latter, the light from an incident beam to scatterness in all direction the surface is called matty.

The eye has the same physiological properties and limitations as the other sense organs. The most important are:

[a] absolute threshold

[b] differential threshold

[c] duality of reception

[d] adaptation

[e] hue and saturation

The effective light energy at the threshold is a few hundred billionth of an erg or 5-11 quantum.

At low light intensities, we can distinguish very small changes in light. – 30 jnd

7.7 Adaptation

It is a phenomenon of all the sense. It is a decrease in response after exposure, If we remain in dark room for 30 min., the retina will become sensitive to 1/100000 the intensity needed to stimulate it before entering the dark room. In the light, sensitivity gradually decreases. Presumably the visual pigment rhodopsin in the eye is broken down in the light and has to be synthesized in the dark, lack of vitamin A has been shown to increase thresholds markedly.

Hue discrimination is dependent on the wavelength and on intensity bag if the intensity of a red light [660 nm] us sharply reduced, it is necessary to decrease the wavelength to maintain the hue. Saturation in purity discrimination is also important. Purity is the relative absence of grayness in colors.

7.7 Food Pigments

The colors of foods are the result of the presence of natural pigments or of added dyes. The pigments are a group of natural colorants found in animal and vegetable products. The artificial colorants are additives used to improve the appearance of foods, which would otherwise be unattractive. Both the groups of colorants are organic in nature. The naturally occurring group of pigments is generally considered to embrace the pigments already formed on heating storage or processing. These pigments can be divided into four groups :

1. Tetrapyrrole Compounds : chlorophyll, hemes and billins.
2. Isoprenoid Derivatives : carotenoids
3. Benzopyran Derivatives : anthocyanins and flavonoids
4. Artefacts : melanoid, caramels

The chlorophyll are characteristics of green vegetables and leaves. The Heme pigments are found in meat and fish. The carotenoids are a large group of compound widely distributed in animal and vegetable products. They are found in fish, vegetables, fruits, eggs and dairy products. Cereals. Anthocyanins and flavonoids are found in root vegetable and fruits e.g. berry, grapes. Caramels and melanoidins are found in syrups and cereal products, especially, which are subjected to heat treatments.

Instrument used to measure color in foods are:

1. Additive Colorimeters
2. Subtractive Colorimeters
3. Comparators
4. Spectrophotometers
5. Tristimulus Filter Colorimeters

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