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Unit 5- TEXTURE

By

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1. Introduction

Food is enjoyed for its good texture and it plays an important role in overall acceptance of a product. Pleasure is derived from taste, smell, temperature and vision of food and also perceptional texture and sensation that is the most relevant consideration of food structures. The awareness of food texture was found at the subconscious level and is usually pushed to the background in flavourful foods. The concept becomes clear and effect accentuated when deviation from the expected texture of foods are noticed and is more important in bland and crisp/ crunchy foods.

Following aspects would be dealt to understand texture under sensory analysis in this chapter

- Definition and importance of texture
- Phases of oral processing
- Texture perception & receptors involved
- Rheology of foods
- Classification of Texture
- Texture measurement

- **Definition and importance of texture**

The attribute texture is clearly a sensory attribute. It is a resultant of a combination of physical properties perceived by the senses of tough, sight and hearing. In its broadest scope, the texture was defined by Jowwitt as “The attribute of a substance resulting from a combination of physical properties and perceived by the senses of touch (including kinaesthesisa and mouthfeel),sight

and hearing. Physical properties may include size, shape number and conformation of constituent structural elements" and so isdescribed to engulf consistency and rheology as illustrated by the work of Szczesniak and coworkers and Jowitt. Further it may be defined as sensory manifestation of structure or inner makeup of products in terms of their reactions to stress measured as mechanical properties, tactile feel properties measured as geometrical properties and other mouthfeel properties.

Food texture has been an area of brisk and vigorous research over the years.The interest and time spent on it could be seen by work on meat and fruits on one hand and other spreads on the other. An exclusive journal, Journal of Texture Studies has been devoted to the area since 1969. It has been recognized that quantitative changes in the intensity of attributes need to be measured and then, finally relate them to the measures of overall quality for meaningful investigations. But it remains for the researchers to develop product specific methods because a term has a different meaning for different foods, e.g. Firmness as applied to butter and carrots, and Tenderness as applied to meat and beans. A precise definition may not always be possible but a reference can be defined in units more stable and universal than these terms.

2. Phases of oral processing

Processes leading to perception of texture as follows,**fig 1**

Information about the textural characteristics of foods may be obtained prior to mastication. The visual appearance of the sample may provide some clues, e.g, the color of fruit may indicate its taste of ripeness and hence its firmness. The limp appearance of a leafy vegetable would suggest a lack of crispness. When a sample of a solid food is manipulated in hand by squeezing, impressing or bending or is cut with a knife or penetrated with fork, clues as to its firmness, toughness or crispness or fibrousness may be revealed.

Initial perception in the mouth is at a relatively low shear rate.Two categories of sensation have been identified. Those due to touch,which occur regardless of any shearing and those that require a small amount of shearing, and those that require small amount of deformation. With no shear at all we gather impression about the foods homogeneity- such as the presence of size and shape of particles or air cells. At slightly higher shear rate caused by movement of the tongue, the food is deformed and flows under these conditions, characteristics such as elasticity, stickiness to the palate and viscous behavior are perceived.During the first few chews, much of the structure is broken.

3. Texture perception &receptors involved:

Often sensory assessments of texture are made on the basis of the sensations perceived where the food is manipulated in the mouth i.e. where it is introduced, bitten, masticated and swallowed. During such manipulation, there is a reciprocal interaction between the texture of the food and the buccal work acting to change the structure to state suitable for swallowing.

Apart from the use of sensory techniques there are three other general approaches to the study of textural properties of foods. The most common involves the use of instruments to evaluate the physical properties of the samples. Another is to examine the structure of the foods and third is to determine their chemical composition, in particular that of their structural components.

The group of perceptions generally described as the sense of touch can be divided into "somesthesis"(tactile sense, skinfeel) and "kinesthesis"(deep pressure sense or proprioception), both of which sense variations in physical pressure. Several types of nerve endings in the skin surface are epidermis, dermis, and subcutaneous tissue. These surface nerve ends are responsible for the somesthetic sensations we call touch, pressure, heat, cold, itching, and tickling. Deep pressure, kinesthesis, is felt through nerve fibers in muscles, tendons, and joints whose main purpose is to sense the tension and relaxation of muscles.the nerve fibers are buried within a tendon. Kinesthesis perceptions corresponding to the mechanical movement of muscles (heaviness, hardness, stickiness, etc) result from stress exerted by muscles of the hand, jaw or tongue and the sensation of the resulting strain (compression, shear, rupture) within the sample being handled, mastication, etc. The surface sensitivity of the lips, tongue, face and hands is much greater than that of other areas of the body, resulting in ease of detection of small force differences, particle size differences, and thermal and chemical differences from hand and oral manipulation of products.

4.Rheology of foods

Flow properties of foods are defined as Rheology of food. The complex nature of foods variability, and their diverse behavior are some of the reasons for grouping separately the flow behavior of specific foods. The rheological properties of solid foods play a vital role in the manufacture, quality control and product development of foods. The knowledge of fundamental properties is important as well as that of empirical and imitative properties. The effect of temperature on apparent viscosity has been described by Arrhenius relationship. Many rheological equations have been used to describe the flow properties of fluid foods, but the power law and Casson flow models have been found the most extensive use. Viscosity function of n can be used to classify the flow behavior of several foods.The viscosity of Newtonian foods is influenced only by temperature and composition; it is independent of the shear rate and previous shear history. Foods known to be Newtonian are milk, filtered orange / apple juices etc.

Fluids that do not follow Newtonian behavior are called non-Newtonian fluids. The flow properties of non-Newtonian fluids are influenced by the shear rate. Apparent viscosity is defined as ratio of the shear stress to shear rate.

Non Newtonian foods can be divided into two categories: *time-independent and time-dependent.* At a constant temperature, apparent viscosity for the former depends only on the shear rate. A large number of non-newtonian fluid foods exhibit pseudoplastic behavior, and these foods are melted chocolate wheat flour suspension concentrated fruit juices, fruit and

vegetable puries and gum solution. Several instruments are used to measure flow properties-rheometers are used to get information on rheological parameters such as those related to viscoelastic behavior. (Fig.2)

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5.Classification of Texture

Szczesniak in as early as 1963 published a classification of textural terms, which are still in widely use in their original or modified forms. The three major classifications are:

- Mechanical Characteristics relating to the reaction of food to stress.
  Primary – Hardness : force to attain a given deformation. Hard boiled candies,

  Cohesiveness: degree to which sample deforms. –toffees

  Secondary – Adhesiveness: force required to remove sample from a given place. Chewiness, Brittleness

- Geometrical Characteristics – relating to size (Smooth, Powdery, Mealy), shape and orientation of the particles with the food (Flaky, Spongy)
- Other Characteristics – relating to moisture and fat contents of food: e.g : juiciness, creaminess.

The mechanical characteristics have been subdivided into primary parameters of hardness, cohesiveness, viscosity, elasticity and adhesiveness: and secondary parameters of brittleness,chewiness and gumminess. Further Jowitt(1974) proposed a glossary of textural terms arranged into four main categories viz

1.General –structure, texture, consistency

2.Terms relating to the behavior of materials under stress e.g. firm, soft, sticky, crisp, and thick.

3.Terms relating to the structure of the material.

(i)Relating to particle size and shape e.g. smooth, powdery, gritty, and meal

(ii)Relating to shape and arrangement of structural elements e.g.flaky, fibrous, spongy.

4.Terms relating to mouthfeel characteristics e.g.juicy, greasy, and creamy.

6. Texture measurement-

a)Basic rheological models**,**

b)Texture measurement and

c) Recent advances in texture evaluation

Rheological models – food materials have viscoelastic properties when they are exposed to various conditions of stress or strain. Researchers have found rheological models to be useful in predicting mechanical response of foods to specific stress-strain conditions. Two of the most useful rheological models are **Static Creep and Stress Relaxation.** In the creep experiment , when the load (force) is applied to the sample the sample is rapidly deformed , giving a strain on the material, which continues to increase at a decreasing rate as a function of time.Stress relaxation, can be described as the ability of a material to alleviate an imposed stress under conditions of constant strain.

The most common principle employed in instrumental texture measurements is to cause a probe to come into contact with the sample is deformed and the extent of deformation / or resistance offered by the sample is noted and used as an index of the texture of the food. Some instruments are designated to measure correctly defined mechanical/ physical properties of food sample such as modulus of elasticity and viscosity.

These instruments measured forces and deformations with better precision and a number of test cells could be used through appropriate adaptors. The emphasis has been on product specific method based on systematic procedure.Dynamic testing methods offer apromising new techniques in the evaluation of physical properties of foods.Resonance methods have been used to measure maturity or texture of fruits and vegetables.

To measure textural properties the food is deformed to apply compression, tension, shear and combination of these operations and the reactions of the sample to the applied forces is measured. Within each class the instruments can be further divided into three types:

1.Fundamental:

Classical material test techniques are used to deform a specimen of defined defined shape in a specific way so that all test parameters are known and the results can be readily analysed by rheological theories. Fundamental tests are the ideal method of texture testing because it is possible to determine one or more physical contents that describe exactly the properties of the food in terms of well defined parameters.

2.Initiative:

Mechanism are design to initiate a specific human operation on the food such as chewing the food or squeezing it by hand. Ex. Strain-gauge dexturometer (proctor et al 1955).the objective is to reproduce the motion and deformation applied during human evaluation and assume that the reaction forces developed by the sample represent human reactions.

3.Empirical:

Foods are subjected to mechanical deformations which applies a sequence or combination of stresses. (e.g.compression tension, shear, flow, extrusion) and the sample reaction is recorded. Example: Warner-Bratzler meat shear test, Kramer shear press.

KrammerShear:It was developed initially for quality evaluation of fresh vegetables. ItShears, compresses and the weight of the food has a power law effect on the maximum force recorded. It is used for measuring maturity and textural properties of fruits and vegetables

Warner-Bratzler Shear: is used for measuring toughness of meat. The test cell consists of a thin stainless steel blade with a hole. Two metal anvils move down on each side of the blade and shear the sample material.

Penetrometer: It was developed to measure semisolid foods such as puddings, gels and jellies. The penetrometer consists of a cone, needle, or sphere attached to a short rod that can be mounted on the crosshead of a universal testing machine.

Collection of descriptors for perceived attributes of texture in a food product to the prospective panelists by presenting them the widest feasible range in eating quality. Selection of impact attributes and resolution of semantic problem through panel participations and literature consultation. Identification of levels clearly distinguishable, through providing descriptors for each attribute and definition of optimum level for each attribute. Selection and standardization of an instrumental method and calculation of relevant parameters to describe the impact attributes. Establishing relationships between sensory and instrumental measures for predictive purposes and their validation.

Other Equipment used in the recent years are

- Texture Analyser (SMS),
- Texture Measuring Systems (Instron, Lloyds)
- TPA Curve- deformation-extent of deformation-resistance offered

Different blades are used for measuring different textural parameters of different foods For example:

Compressionis used for measuring dough consistency.,

Penetration for– Fruits, Vegetables tenderness

Shear- Tenderness of meat

Extrusion – Jam, Jellies

Breaking strength – Biscuits

Krammer shear–Samosa , fruits and vegetables

A Typical Texture Profile curve can be seen as given below.**Fig 4**

The five measured and two calculated parameters are as follows:

Fractionability is defined as the force at the first significant break in the first positive bite area(A1).

Hardness is defined as the peak force during the first compression cycle (Ht. of 1st Peak (A1)

Cohesiveness is defined as the ratio of the positive force area during the second compression cycle to the positive force area during the first compression cycle (A_2/A_1).

Adhesiveness (Stickiness) is defined as the negative force area for the first bite representing the work required to pull the plunger away from the food sample(Area of -ve peak)

Gumminess is defined as the product of hardness and cohesiveness (Hardness X Cohesiveness).

Chewiness is defined as the product of gumminess and springiness (Gumminess X Springiness).

Springiness is defined as the height to which the food recovers during the time that elapses between the end of the first bite and the start of second bite (D_2/D_1).

Texturometer evaluation of mechanical parameters of a food correlated well with scores got by the use of a trained texture profilepanel. This correlation indicates that General Foods texturometer has the capacity to measure certain characteristics with a type and intensity similar to those perceived by the human mouth..Bournne (1978)was the first to apply the texture profile analysis technique. He also said that Instron generated force curves can be calculated intonewtons units.

Sensory properties include whatever we smell, taste, see, hear and feel with our senses and are manifest in the flavour, texture and appearance of products. Fast, reproducible estimates of a bakery product's sensory properties of chemical, physical or instrumental measurements can be developed only when we adequately understand the sensory processes.

7. Texture measurement--Applications in few foods

Processing and Biscuit

Baking is a process by which the raw ingredients are subjected to cooking and drying along with development of texture, colour and flavour so that the final product is made palatable. Many attributes of bakery products, like all food products, can be measured only by sensory techniques, as some chemicals are additive and others are suppressive, the amount of sweetness or bitterness that a person perceives does not relate directly to the amount of sugar, acid or bitter components measured by chemical methods. Crispness, cohesiveness during mastication and

acceptability are only a few of many characteristics that cannot be measured by any physical or chemical test. Understanding the sensory perception process and the inter-relationships of sensory properties to acceptability is fundamental to successful marketing of finished bakery products.

Ingredients and Biscuit texture

The quality of finished bakery products depends on various parameters like processing conditions, formulae, method of preparation, etc. The quality of raw material is the prime and the most critical criteria to produce quality products. Refined wheat flour provides the frame work for baked goods, retains the gas during baking and forms the structure of biscuit. Sugars impart sweet taste top biscuits, create tenderness and firmness of texture, partly by weakening the gluten structure. They contribute to the crust colour of biscuits. Fats and oils tenderize the product and soften the texture, improve the palatability of biscuit and add flavour. Water acts as a dispersing agent for ingredients, helps in the aeration of biscuit and gelatinizes the starch. Leavening agents increase the volume of the products; make it more porous, crisp and palatable.

Texture parameter assessed in few foods:

Dairy products .Emulsifiers improves tenderness, flavour release, increase the volume and improve the texture and spread.

In Cheese: Surface- bumpy, grainy /gritty, wetness, oily/ fatty, loose particles.

First Bite/ first chew - firmness, hardness, denseness, cohesiveness.

Partial compression – springiness.

In Potato Chips: Surface – oiliness, roughness, macro, roughness micro crumbs.

First bite/ first- chew hardness, crispness, denseness, particles after 4-5 chews

In Bread : Surface- crumb texture, roughness, loose particles moistness, crust texture roughness loose particles moistness.

First chew- crumb denseness, crumb cohesiveness, crumb firmness,crust hardness, crust denseness crust cohesiveness.

Conclusion:

The awareness of food texture was found at the subconscious level and is usually pushed to the background in flavourful foods. The concept becomes clear and effect accentuated when deviation from the expected texture of foods are noticed and is more important in bland and crisp/ crunchy foods.Texture was defined by Jowwitt as “The attribute of a substance resulting from a combination of physical properties and perceived by the senses of touch (including

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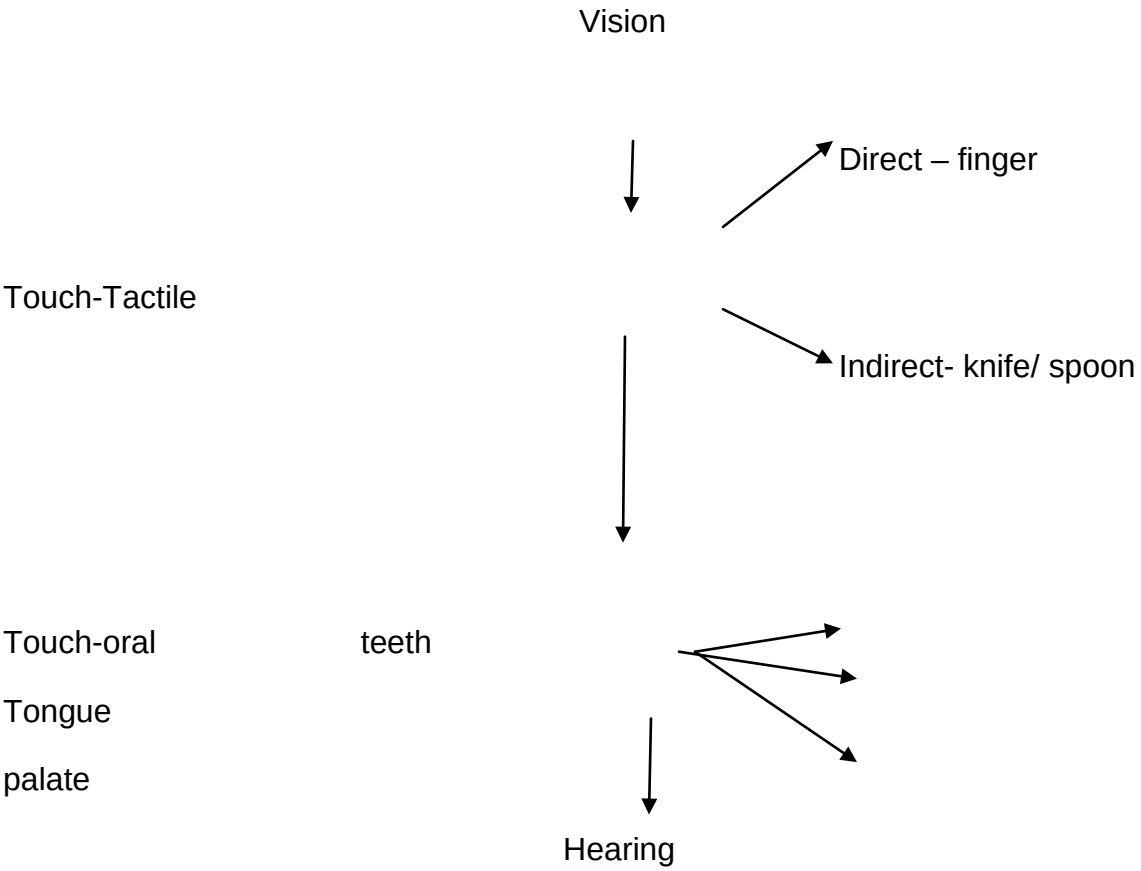

Fig 1: Process of oral processing

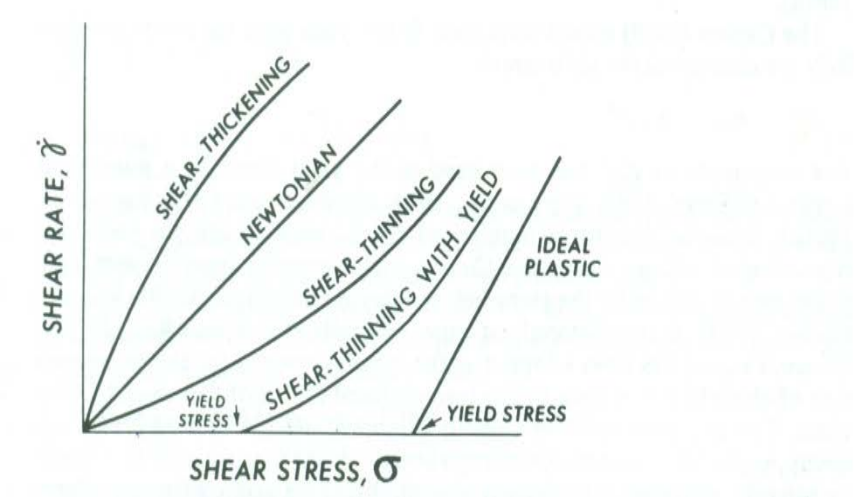

Fig 2 Newtonian and time independent non Newtonian fluids.

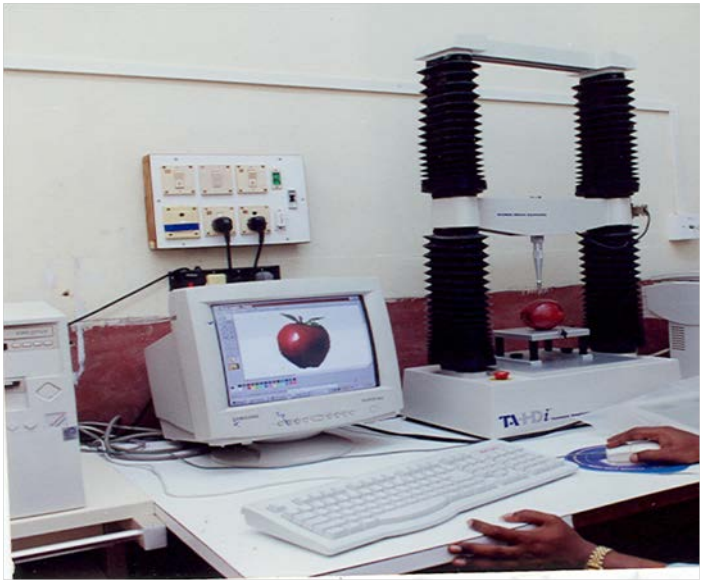

Fig 3:TEXTURE ANALYSER

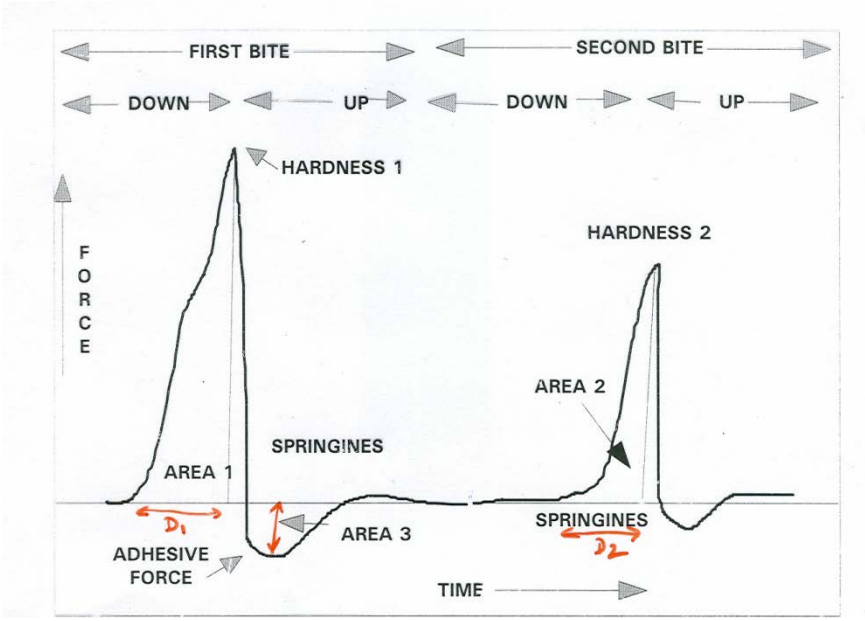

Fig. 4Texture Profile Analysis Curve