Food Texture and Its Perception, Acceptance and Evaluation

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The objective of this study was to understand the term food texture and its perception, acceptance along with methodologies used for their evaluation. Texture is governed by surface response of touch in mouth, deep response of masseter muscles and potentially by auditory means. Texture assessment of food occurs inside the mouth. Texture assessment is based on individual perception of human subject which varying among them. It is well explained by various physical and sensory parameters were used for texture evaluation. Instrumental texture profile analysis continuously used measurable method can be used as a low cost, but it not mimics the inside environment of the mouth and the psychological aspects of texture. The sensory TPA which includes the dynamics of food rheology during mastication may also contain biasness. Thus it was concluded from this study that Electromyography testing were one of the reliable methods used for examine food texture.

Keywords: Mastication, perception, receptors, texture.

Texture and its perception

Texture of food is based on multi parameters; some parameters were governed when food placed inside the mouth while most of them perceived when food gets deformed during mastication and detected through several senses. There is no single and specific receptor which governs the evaluation of texture of food instead there are many receptors and tissues come in to action1.

Texture perception is dynamic and complex process where the food gets manipulated under the forces to get fractured2. Textural perception of food can be estimated with the help of mastication based on physiological techniques3,4.

Texture evaluation depends on subject’s capability to analyze and explain their perceptions. Human perception of food texture is depending on three parameters visual, tactile and auditory. Visual parameter depends on previous experiences with same foods, tactile parameters depends on oral (mouth feel) and hand tactile texture perception and auditory parameter depend on food sounds. Acoustic signals related to food texture like low pitch sound correlated with crunchiness while high pitch sound correlated with crispiness 5. Mechanical parameters which are not perceptible by human sense organs are not play an important role in texture perception 6.
Texture of food generates a psychological response which governs the quality and acceptability of the food. Texture perception depends on the physical properties of food i.e. its nature, composition and also on the rate of food deformation in mouth. Four major senses play an important role in perception of texture like discriminative touch for recognize different shape, size and texture of food, the sense of static position or movement of jaw, the sense of pain and the sensation of cold and warmth. Texture perception is also explained on the basis of neurological manner in which sensory and motor components of peripheral nervous system interacts with the central nervous system. The coordination between motor components is highly required so that all muscle action can be controlled as single unit. The term “Gestalt” defined as perception regard texture of food as a whole developed by the integration of different stimulus generated by various sense organs. The presence of one stimulus may affect the perception of another stimulus. The sensory perception and its nature may be varied from the physical properties of food and integration of all perception is subconscious. The internal characteristics of food are correlated with sensory perceptions. During the perception of sensory analysis, it is to be assumed that different information regard texture may be gathered due to differences in the manner in which interaction of food occurred. Sensory mechanoreceptors which perceive texture and mouth feel are grouped under three categories. First in the superficial structures of mouth, second in the periodontal membrane surrounding teeth roots and third in the tendon and muscles which are involved in mastication. Earlier the sensory perception of texture of food was governed by their rheological characteristics, by the force of mastication measured using miniature load cells placed inside mouth during chewing of food.

Eating situation also influence the texture acceptance and preference. Texture tolerance is defined as how far textural behavior of a food deviates from its expectation. It is depending on the category of food, on the particular food and on dominant characteristics of food. Some food has more texture tolerance then other foods. During breakfast less texture tolerance was found as food which serve during breakfast is the one which get easily lubricated with saliva, manipulate easily inside mouth and make a bolus for its easy swallowing and digestion. During dinner food is enjoyed and appreciated. So that most of the experiment with new texture are performed while serving dinner. During dinner more texture tolerance was found as dinner consist of many food items and there is no fear of going hungry if any particular food item is disliked. Dessert in the dinner explained the fun behavioral of textural characteristics.

Texture and Its Relation to Consumer Behaviour and Acceptance

There are various factors like social, cultural, physiological and psychological which governed the attitudes to texture. Lower socio economic classes are very conscious about their look while eating food and thus bring with negative attitude. Unsatisfied past experience also bring about rejection of texture of food. Learning of textured of food is a continuous process. Texture parameters are associated with liking and disliking characters based on physiological and cultural characters. Various liked and disliked characteristics were used during explanation of food texture like crisp and tough; crunchy and soggy; tender and lumpy; juicy and crumbly; firm and slimy. Textural contrast also plays an important role in the acceptance of food based on the eating experience and excellence of food preparation.

Different countries use different textural characteristics for food like Japan uses crispy, crunchy, hard, soft and sticky food while Americans uses crispiness, crunchiness, tenderness, juiciness and firmness. The image of the food product reflects its food properties. Foods with soothing and relaxing to the human and creamy while food product with energy and aggressiveness should be firm and crispy. The size of serve also affects the textural perception of food. On psychological basis if the appearance of food product is not met with expectation or with the past experience, food is generally rejected. Gummy or slimy food with hard particles or lumps is generally rejected.

The acceptance of food by the consumer is dependent on the rheology and texture of food. Food texture is one of the dominant factors which affect the food choice. Food texture is an important factor for food palatability and thus
affects food eating behavior\textsuperscript{16}. Food texture is defined as the combined sensation derived from various receptors present inside the mouth after taking the food and its relate to the physical properties of food sample like density, viscosity and surface tension etc.\textsuperscript{17}.

Texture is one of the important parameter of sensory evaluation. Texture cannot be treated as absence of defect while it should be treated as attribute of freshness, excellence of food preparation and enjoyment of eating\textsuperscript{1}. Texture governs the palatability, quality and safety of food\textsuperscript{18}. Texture of food also used as an indicator for quality parameter. For example, freshness of food is governed by its texture.

Food texture and mouthful are the two important characteristics for consumer food preference and acceptance\textsuperscript{2}. To maintain the quality of food and consumer acceptance food industries must examine textural characteristics of their food products\textsuperscript{19}. Texture of food is generally taken for granted and consumer does not comment on it unless they were asked with specific questions regard texture of food. The acceptance of food on the basis of its textured depends not only on the consumer but also on the food properties and eating behavior. Consumer does not pay so much attention on the food for its sensory and nutritional returns until the food yield pleasant flavor\textsuperscript{20}.

On the basis of consumer texture profile, ideal textural characteristics of food are determined. The deviation of the test food from the target food is calculated for determining the ideal texture. The difference among them explains the area of improvement. Closer to the ideal point explain increase the degree of liking of food. Thus textural parameters correlate with bad and good identify compare to the ideal; make negative and positive impact on acceptance of food.

**Parameters used during food Texture Evaluation**

Texture is used for solid and semisolid food while mouthfeel is used for describing the feeling properties of food inside the mouth. Food texture is governed by mechanical, geometrical and others surface properties which are perceive by means of various receptors\textsuperscript{21}. Mechanical characteristics were explained in terms of physical and sensory manner as shown in Table 1 and Table 2.

Geometrical characteristics are further classified on the basis of particle size (gritty, grainy, coarse) and shape (fibrous, cellular, crystalline) while other characteristics are further classified in to primary parameters i.e. moisture (dry, moist, wet and watery), fat content and secondary parameters like oiliness and greasiness\textsuperscript{1}.

| S.no | Parameter | Definition |
|------|-----------|------------|
| 1    | Hardness  | As the force required for breaking of food sample into many small pieces by molar teeth during first bite which can vary from soft, firm to hard. |
| 2    | Adhesiveness | As the force which is required to reduce the adherence between the food material and the surface with which it is in contact. On the basis of adhesiveness food can be sticky or tacky gooey. |
| 3    | Cohesiveness | As the limit to which a given food sample deformed before it breaks. |
| 4    | Springiness | As the rate at which the deformed food material gets back in to its original condition when the applied force is removed from them. On this basis food can be divided in to two categories i.e. plastic and elastic. |
| 5    | Gumminess | As the amount of energy which is required for the disintegration a food sample which is semi solid in nature for its swallowing. Its value classified as short, mealy and pasty gummy. |
| 6    | Brittleness | As the force which is required by the food material for its fracture. It is also called brittleness, which can be varied from crumbly, crunchy to brittle. |
| 7    | Chewiness  | As the amount of energy which is required for the chewing of solid food for its swallowing. On the basis of chewiness food can be classified in to Tender, chewy and tough. |
Mouthfeel textural parameters like astringency and juiciness play a significant role in textural characterization of liquid beverages. Astringency is the tactile sensation associated with ability of certain chemical to bind and precipitate salivary mucus proteins that lubricate the mouth. During mastication the amount of juice which is released from food is described as juiciness.

**Texture Evaluation**

**Texture Profile Analysis**

For qualitative and quantitative analysis of food, texture should be studied in depth using the application of imaging and simulation techniques. The role of computer makes a significant advance in this research area. Texture Profile Analysis (TPA) is one of the instrumental methods which are basic and simple thus used for the evaluation of food texture based on the mechanical attributes of the food product. Texture profile method test the food sample twice under the compression and then record the force deformation curves. Textural profile method classified the textural attributes into initial, masticatory and residual part. Texture analyzer test these attributes by applying controlled forces to the food products and record their

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Table 2. Various parameter of texture based on sensory manner (Szczesniak, 2002)

| S. no | Parameter | Definition |
|-------|-----------|------------|
| 1     | Hardness  | As the force between tongue and palate for compression of a food sample, |
| 2     | Viscosity | As the force which is required to draw liquid from a spoon over the tongue. On the nature of food, it can be varying from thin to viscous. |
| 3     | Adhesiveness | As the force required for removing the adhesive food material adhere to the mouth. |
| 4     | Cohesiveness | As the extent up to which food sample compressed between the teeth before it ruptures. |
| 5     | Springiness | As a level up to which food get back in to its original shape, |
| 6     | Gumminess | As denseness of the food product which remains exist throughout the process of chewing. |
| 7     | Brittleness | As the force with which food get cracks. |
| 8     | Chewiness | As the time required for the chewing of food under the effect of constant force. |

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Fig. 1. Concept of Food Texture
responses in the terms of force, deformation and time.

This method has certain disadvantages like this method could not be used for texture analysis heterogeneous foods. It does not mimic the in vivo conditions of the mouth i.e. it does not consider the effect of saliva and temperature of the mouth on texture of food. TPA also does not include the psychological, physiological and environmental attributes while determining the texture of foods and moreover this method gives information regarding texture of food before its consumption. Instrumental methods which are used for accessing the texture of food not mimic the rate of deformation (force), dynamic of oral movement, salivary action and thus give low rate of correlation with subjective analysis as each subject used different parameters for governing the texture assessment 27. Instrumental methods not represent the actual state of mastication 20.

The complex mechanism of rate of deformation of food inside mouth cannot be estimated by single mechanical based instrumental method 29. Instrumental analysis of texture also operates at low rate of deformation as compare to force that present in human mouth 30. Instrument use single measurement for examine texture of food while texture should be assessed progressively during chewing 31. Most of the information regard tenderness was governed by first bite but there are evidences which states that more than first bite is required for examine the tenderness of meat 28.

**Sensory Profile Analysis**

During the sensory analysis, texture perception is one of the important factors. Sensory analysis method is used for determining food texture on the basis of some standard scales 32 and also on the selection of panel members 33.

Earlier the sensory perception of texture of food was governed by their rheological characteristics 12, by the force of mastication measured using miniature load cells placed inside mouth during chewing of food 13.

The internal characteristics of food are correlated with sensory perceptions34, 35. During the perception of sensory analysis it is to be assumed that different information regard texture may be gathered due to differences in the manner in which interaction of food occurred 36. Both instrumental as well as sensory method now move from single point analysis to multipoint as many attributes are quantified at a same time 37. Multiple sensory attributes are used for the characterization of mastication 38.

Individual sensory analysis of food is one of the biggest problems in the sensory scientist

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**Table 3. Various definition of Food Texture.**

| S. no | Definitions                                                                 | Authors                  |
|-------|-----------------------------------------------------------------------------|--------------------------|
| 1     | Texture was defined as all of the mechanical, geometrical, surface and body attributes of a product perceptible by means of kinaesthesia and somesthesia receptors and (where appropriate) visual and auditory receptors from the first bite to final swallowing. | ISO, 2008. 52            |
| 2     | Texture was defined as mechanical, geometrical and surface characteristics which are perceive through various sense organs. | Bourne, 2002. 53         |
| 3     | Texture was explained in terms of physiological texture and mouth feel perception. | Guinard & Mazzucchelli, 1996. ² |
| 4     | Texture was defined as a sensory perception of food structure which changes due to the action of applied forces along the presence of senses like vision, hearing and kinaesthesia. | Szczesniak, 1990. ⁹     |
| 5     | Texture was described as changes which were observed in terms of sensory and functional attributes due to mechanical and structural manifestation in food properties. | Szczesniak, 1963. 25     |
| 6     | Food texture is a response which is generated due to interaction of the food with some part of the body. | Bourne, 1975. 54         |
| 7     | Texture was described as combined effect of psychology and physiology. | Brown et al., 1996. 11   |
community. Variation in sensory perception can be due to difference in the genetic makeup of an individual for sensory receptors, sensory experience to discriminate between stimuli, the way used to describe or define different sensory sensation parameters and sensory reporting. This method has certain disadvantages like it is a time consuming procedure, trained panelists are required, the results can be biased, affected by ill health of judge panelist and moreover this method gives information regarding texture after consumption of the food.

To avoid such variation numerous techniques are used like screening of human subjects, training of panelist, use of standardized methodology for examine sensory parameters and testing with specific sensory test. Sensory evaluation and consumer testing is one of the reliable methodology used for examine food texture.

**Electromyography (EMG)**

EMG is a technique which is based on calculation of muscle activity required during chewing of food. EMG measures the action potential of the motor unit of masticatory muscle when they undergo contraction. EMG method uses myoelectric potential from the skin surface of human subjects and relates it with muscle activity. EMG examined for human mastication is combined action of physical and psychological studies. EMG is a non-invasive technique which does not interfere with normal habitual chewing. EMG is a technique which is used for evaluation of texture of food in mouth. EMG is a novel method to investigate the changes in texture during eating of food. EMG studied dynamic changes in food during the process of mastication. Thus it is a complement to texture measurement.

The differences in the signals which were generated during chewing of food were used for the assessment of texture. EMG is a technique which is used to show the differences in the pattern for chewing food which differ in their textural characteristics. This technique is also being used for differentiating the chewing pattern between individuals.

EMG analysis gives better result for texture perception than instrumental method as this method brings information from mastication rhythm which showed differences among different human subjects. EMG is one of the repeatable techniques if homogenized conditions are maintained like by standardization of the applied methodology and analysis.

**DISCUSSION AND CONCLUSION**

Texture perception is a complex process which is based on stimulus of various sense organs. Food texture plays an important role in the acceptance of the food by the consumers. Food industries always expand their knowledge for examine the texture attributes of foods. Thus there is a need of a novel technique for texture evaluation of various foods based on in-vivo conditions i.e. the one which can give information regarding texture of food within the mouth during chewing start from the first bite to final swallowing. Accordingly, the developed technique Electromyography will be in lines with the latest definition of texture as described by International Organization for standardization.

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