TEXTURE PROFILE ANALYSIS OF FOOD AND TPA MEASUREMENTS: A REVIEW ARTICLE

Srilakshmi.A[1]

[1]*Scholar, Student of B.E- Food Processing and Preservation Technology of Avinashilingam Institute for Home Science and Higher Education for Women*

---***---

Abstract - *Textural analysis is an important aspect for quality control and the taste of the certain food products, and also determines the chew ability index of the products. Textural properties of the product encourage the consumer to taste the certain product again and again. Basically the consumer preference differs according to their opinion, some may like the chew able food product and some tends to choose the crispy food products. According to age group the food we eat differs for example during our childhood our mom gives as juicy or semisolid food and during adolescent period, we eat more crispy products, and also sometimes it differs according to the taste preference. Textural analysis is mainly done in food and pharmaceuticals industry to determine the digestibility and to identify the sensory characteristics of food, and also to determine the general food texture profile that includes initial, masticate and the residual (undigested food) food in the body. There are many texture profile analysis (TPA) instrument widely available in the market.*

Key Words: Textural analysis, general food texture profile, TPA instruments, Textural properties.

1. INTRODUCTION

According to the stable microsystems, Texture Analysis itself is the study of the deformation and flow of a food when under the influence of stress and includes the assessment of raw materials, intermediate components and finished products. A texture profile is defined as the organoleptic analysis of the texture complex of a food regarding its mechanical, geometrical, fat, and moisture characteristics, the degree of each present, and the order in which they appear from first bite through complete mastication [8]. In simple terms we can say it as how the food reacts from entering the mouth to coming out as faeces through the anus.

During a TPA test samples are compressed twice using a texture analyzer to provide insight into how samples behave when chewed. The TPA test was often called the “two bite test” because the texture analyzer mimics the mouth's biting action [5].

Texture analysis is mainly done to check the pre-quality and post-quality of the product. The Standard tests include compression, tension, and Flexibility are used to measure hardness, crispiness, crunchiness, softness, springiness, tackiness, and other properties of food. Comparing the results from mechanical texture analysis with trained human sensory panels has shown that measurements have a high correlation with various sensory attributes associated with textural quality [9]. Confectionery creates unique texture analysis challenges, as the texture is deliberately designed by food technologists to meet a consumer desire and expectation. Combining different ingredients and altering production methods to achieve the right texture consistency requires a repeatable, accurate, and objective method of texture analysis. The measurement of texture (from butter spread ability to curd firmness) is paramount in modern dairy production. Texture analyzers support food technologists assess engineering performance and sensory quality throughout the manufacturing process [10]. The different products are produced day by day with unique textural properties. This paper gives a brief discussion about the textural properties and texture analyzing parameters as it is an important parameter of the properties of food.

1.1 Textural Properties:

The textural properties of a food is that group of physical characteristics that arise from the structural element of the food, are sensed primarily by the feeling of touch, are related to the deformation, disintegration, and flow of the food under a force, and are measured objectively by the functions of mass, time, and distance [11]. Texture Analyzers are used to measure many properties, such as Hardness, Brittleness, Spread ability, Adhesiveness, Tensile Strength, Extensibility, etc... The instrumental texture analysis include Abrasion, Actuation force, Cohesiveness consistency, Combability, Compressibility, Compactability, crispiness, Crunchiness, Disintegration, Extrudability, Firmness, Hardness, Softness, Ripeness, Flexibility, Bending force, Flowability, Caking, Fracturability, Brittleness, Friction, Gel strength, Reel strength, Seal strength, rupture force, Spredability, Springiness recovery, Stickiness, Adhesiveness, Swelling proving, Syringeability, Tensile strength, Break strength, Extensibility, Toughness, Chewiness, Bite strength, Cutting force, Viscoelasticity, Stringiness, Tailing, etc… are done according to the food product. From the raw material to the consumer mouth the texture is an important characteristic for the better quality of the product.

Food texture is a cognitive property assigned to foods based on how senses interact with the food by vision, touch, and oral processing. This concept involves all the rheological and structural (geometric and surface) attributes of the food products [12].

1.1.1 Hardness:

Hardness is an important parameter in textural properties. If the product is so hard the consumer can't bite the food; it should be in a correct order for the mouth's biting action to take place. The articles all described Hardness as the peak force that occurs during the first compression even though with hindsight we understand the recorder technology did not well-differentiate between peak forces due to fractures and peak forces due to stop the compression stroke. Dr. Bourne has noted that even small incremental compressive strains can result in very large increases in firmness values [5]. The hardness of certain food products are given below which are taken from the Predicting Sensory Cohesiveness, Hardness, and Springiness of solid foods from instrumental measurements in journal of texture studies.

Another problem researchers have with Hardness is that their correlations with sensory tests are not always as high as expected. Examine, for example, the test plots shown below for Hot Dogs. The hardness values for 25%, 50% and 75% strains are approximately 1,900 grams, 6,100 grams, and 6,600 grams, respectively. Obviously, when the hot dogs are compressed the incremental 25% to 75% strain the sum of the energy is greater (as shown by the area of work) than is apparent with the incremental peak force[5].

1.1.2 Brittleness:

Powell (1983) characterized brittle failure by the creation of new surfaces and fragmentation after the polymer has deformed to a small extent and Ward (1983) designated brittle behavior from the stress–strain response as failure at the maximum load which would normally occur at low strains (Brittle textures in processed food, A. C. Smith). Fracturability/Brittleness is the tendency of a material to fracture, crumble, crack, shatter or fail upon the application of a relatively small amount of force or impact [4].

Fracturability (single break) is usually represented by a characteristic sharp curve (usually a thin triangle shape). In a curve such as that shown, the following are often recorded:

• Distance at break = 'fracturability'/'brittleness' (mm)

• 'Force at break' = 'hardness' (g/kg)

• Gradient of slope = 'toughness'/'stiffness' (g/mm) ^{3}[1].

1.1.3 Cohesiveness:

A product is cohesive when it adheres to itself under some compressive or tensile stress. A piece of pork, for example, is highly cohesive when it takes a great many chews to break down. An extruded snack is cohesive when it can take a compressive deformation and its internal cell structure is not so damaged that it cannot substantially resist a subsequent deformation (think another chew)[5].

As a sensory attribute, hardness as well as springiness is predicted well by means of the instrumental parameters used. Instead, the instrumental prediction of cohesiveness is not so accurate. This may be because of the fact that analyzed samples are not uniformly distributed on a sensory cohesiveness scale and that the instrumental methods used do not break the samples, whereas the sensory evaluation technique of cohesiveness concerns the rupture of the samples[2].

In foods, the obvious way to experience cohesion is the energy or the number of times it takes to break down the product until it is palatable to be swallowed. Mechanically, many food products will experience a great deal of various stresses even before they are consumed. A product with strong cohesion will be more tolerant of manufacturing, packaging and delivery stresses and thus will be presented to the consumers in its expected state. A product with poor cohesion will not. Think of a loaf of bread that cannot tolerate the stress of being placed in shopping bags and transported home[5].

2. Two Bite Test:

The TPA test is a double-bite test providing more complex data including gumminess, springiness, chewiness, and adhesiveness. During the TPA test, a probe descends and makes contact with the sample. Once a minimum trigger force is achieved the probe descends for a set distance at a specified speed. The probe then ascends all the way back to its original position [5].

The two bite is generally done to check the textural properties of the food product which is an imitation of how the food behaves when it enters through the mouth. The product tensile strength, and it's characteristic is determined using two bite test.

Foods are a selection of semi-solid, soft-solid, viscoelastic materials, and occasionally hard solids. Oral processing of these foods starts with either biting a portion from a larger piece or placing a piece in the mouth. Food texture is one of the key properties consumers evaluate when determining food quality and acceptability and embraces a large number of textural characteristics or properties [4].

3. Texture Measuring Instruments:

There are many texture measuring instruments available in the market. We have to choose the instrument carefully with right parameters for certain products because different products have different properties, for example, chips have to be crispy, jelly should have the springiness in it and so on. So for different product, we have to choose the instrument that are designed in a certain way that can meet the requirements of the textural properties' measurement of the product. For example, The Chatillon MT150 Series is a manual mechanical tester suitable for determining the firmness of fruit and vegetables. Different types of testing instrumentation available from AMETEK STC range from manual and motorized food firmness testers to a fully software-controlled texture analyzer.

Some of the parameters that can be measured using a texture analyzer include adhesiveness, chewiness, cohesiveness, consistency, crispiness, crunchiness, elasticity, extensibility, firmness, fracturability, gel strength, gumminess, hardness, rupture strength springiness, stiffness, stringiness, texture profile analysis (TPA) toughness, work to cut, work to penetrate and work to shear[7].

Texture measurement instruments range from simple hand-held devices to the Instron machine and texture analyzer which provide time-series data of product deformation thereby allowing a wide range of texture attributes to be calculated from force–time or force–displacement data. In recent times, the application of novel and emerging non-invasive technologies such as near-infrared spectroscopy and hyper-spectral imaging to measure texture attributes has increased in both fresh and processed foods[21].

4. CONCLUSION

Textural instruments give us the steady results for textural profile analysis. Textural measurement is a complicated process as a small mistake in the process may leads to a great loss. Therefore, at most care must be given. The change in food texture during swallowing also should be identified for getting proper results in TPA analysis. There are wide parameters that are to be considered during textural analysis of a product. The textural parameter also differs for different products. Therefore, correct parameters should be known for accurate analysis. The texture of a product should be maintained from the processed product to reaching consumers mouth. Change in texture of a certain product indicates the spoilage of a food product.

REFERENCES

[1] Trinh, Tuoc. (2012).' On the texture profile analysis test'. Chemeca 2012: Quality of life through chemical engineering: 23-26, Wellington, New Zealand.

[2] R. Di Monaco, S. Cavella , P. Masi.(2008). "Predicting Sensory Cohesiveness, Hardness and Springiness of Solid Foods from Instrumental Measurements".Journal of Texture studies: A Journal for Food Oral Processing Research, 39(2), 129-149.

[3] Smith, A. (1991). Brittle textures in processed foods. In J. Vincent & P. Lillford (Eds.), Feeding and the Texture of Food (Society for Experimental Biology Seminar Series, pp. 185-210). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511600555.010.

[4] Stable Micro Systems. (2020), How to Measure Fracturability and Brittleness [Online] [Accessed on 3rd October 2020] https://www.stablemicrosystems.com/TextureAnalysisProperties.html .

[5] Texture technologies. (2020) Overview of Texture Profile Analysis.[Online] [Accessed on 10th October 2020] http://texturetechnologies.com/resources/texture-profile-analysis .

[6] Alina S. Szczesniak, Malcolm C. Bourne.(1969). " Sensory Evaluation of Food Firmness". Journal of Texture studies: A Journal for Food Oral Processing Research,1(1), 52-64.

[7] Ametek Sensors, Test and Calibration.(2015), What is Food Texture and How is it Measured [Online] [Accessed on 2nd October 2020] https://www.ametektest.com/learningzone/library/articles/what-is-food-texture-and-how-is-it-measured

[8] Margaret A. Brandt, Elaine Z. Skinner, John A. Coleman.(1963)." Texture Profile Method". Journal of Food Science,28(4),404-409.

[9] Arbro Pharmaceuticals Private Limited & Auriga Research Private Limited.(2020), Importance of Texture Analysis for the food Industry [Online] [Accessed on 2nd October 2020] https://testing-lab.com/2013/07/texture-analysis-for-the-food-industry/ .

[10] Mecmesin.(2020),Texture analysis [Online] [Accessed on 3rd October 2020] https://www.textureanalyzers.com/texture-analysis .

[11] Lu, R.. (2013). "Principles of solid food texture analysis". Instrumental Assessment of Food Sensory Quality, (pp.103-128) 10.1533/9780857098856.1.103.

[12] Joana F. Fundo, Cristina L.M. Silva.(2018)," Microstructure, composition and their relationship with molecular mobility, food quality and stability", Woodhead Publishing Series in Food Science, Technology and Nutrition, 29-41,ISBN 9780081007648.

[13] Malcolm C. Bourne.(2002), "Food Texture and Viscosity: Concept and Measurement" , A volume in Food Science and Technology. Elsevier Inc. , ISBN:978-0-12-119062-0.

[14] Ivan E. de Araujo and Edmund T. Rolls.(2004)," Representation in the Human Brain of Food Texture and Oral Fat". Journal of Neuroscience, 24 (12), 3086-3093.

[15] Nishinari, Katsuyoshi & Kohyama, Kaoru & Kumagai, Hitomi & Funami, Takahiro & Bourne, Malcolm. (2013). ' Parameters of Texture Profile Analysis'. Food Science and Technology Research. 19. 519-521. 10.3136/fstr.19.519.

[16] C.M. Christensen, (1984),'Food Texture Perception',Advances in Food Research, 29, pp. 159-199, ISSN 0065-2628.

[17] Jianshe Chen, Jason R. Stokes, 'Rheology and tribology: Two distinctive regimes of food texture sensation', Trends in Food Science & Technology, 25(1),2012, pp. 4-12, ISSN 0924-2244.

[18] C Wilkinson, G.B Dijksterhuis, M Minekus (2000) ,'From food structure to texture', Trends in Food Science & Technology,11 (12) , pp. 442-450, ISSN 0924-2244.

[19] Moskowitz, Howard R., (1987), 'Food texture: instrumental and sensory measurement', Agricultural Science and Technology Information ,(22), 335 p, ISBN:08-247-75856.

[20] Mitsuru Taniwaki, Takanori Hanada, Naoki Sakurai. (2006), 'Device for acoustic measurement of food texture using a piezoelectric sensor',Food Research International, 39(10), pp.1099-1105, ISSN 0963-9969.

[21] Lan Chen, Umezuruike Linus Opara,(2013). 'Texture measurement approaches in fresh and processed foods — A review', Food Research International, 51(2), pp. 823-835, ISSN 0963-9969.

[22] Abbott J.A. (2004) Textural Quality Assessment for Fresh Fruits and Vegetables. In: Shahidi F., Spanier A.M., Ho CT., Braggins T. (eds) Quality of Fresh and Processed Foods. Advances in Experimental Medicine and Biology, vol 542. Springer, Boston, MA.

[23] Wen Zhang, Di Cui, Yibin Ying,(2014), 'Nondestructive measurement of pear texture by acoustic vibration method', Postharvest Biology and Technology, vol 96, pp. 99-105, ISSN 0925-5214.

[24] S.U. Kadam, B.K. Tiwari, C.P. O'Donnell (2015),6 - Improved thermal processing for food texture modification, In Woodhead Publishing Series in Food Science, Technology and Nutrition, Modifying Food Texture,Woodhead Publishing, pp. 115-131,ISBN 9781782423331.

[25] Yi-Xiang Liu, Min-Jie Cao, Guang-Ming Liu,(2019). '17 - Texture analyzers for food quality evaluation, In Woodhead Publishing Series in Food Science', Technology and Nutrition, Evaluation Technologies for Food Quality,Woodhead Publishing ,pp. 441-463,ISBN 9780128142172.

[26] Karen Hiiemae, (2004). 'Mechanisms Of Food Reduction, Transport And Deglutition: How The Texture Of Food Affects Feeding Behavior', 35(2), pp. 171-200.