CHOPPED MEAT FRESHNESS ASSESSMENT BY TEXTURE PROFILE ANALYSIS

Gh. Gutt[1*], S. Paduret[1], Sonia Amariei[1], M. Chelaru[1]

[1]*Stefan cel Mare University of Suceava, Romania*

Abstract

The possibility of correlating parameters of primary and secondary texture of chopped beef type Hamburger, with composition for Arab countries, with its freshness was the goal of this study. Texture profile analysis (TPA) was made for six days and the samples were kept refrigerated between analyzes at 6^{0}C. Sample sizes were: height of 30 mm and diameter of 35 mm. The texture profile analysis of fried Hamburger for 10 minutes at 300^{0}C was conducted for comparison. For tests an electronic texturometer was used. Follow texture parameters were hardness, viscosity, gumozitatea, adhesiveness, cohesiveness, elasticity, chewability. The texture parameters such as: hardness, viscosity, gumminess, adhesiveness, cohesiveness, elasticity, chewability were analyzed. Pearson analysis of these texture parameters was used to establish their relevance. Analysis of the most representative texture parameter in Pearson hierarchy was made according to the sensitivity of the test method defined by the slope of the growth curve of force - displacement and the correlation coefficient R^2. The final analysis showed that the texture parameter that highlights the best chopped meat freshness of beef Hamburger, with composition for Arab countries, is the hardness.

Key words: chopped meat, freshness, TPA

INTRODUCTION

Between guarantee term of meat and its real shelf life there are often large differences. The causes are multiple, they are due to refrigeration conditions**,** packing, storage, and transport. Determining the real shelf life requires laborious operations related to spectrometric and chromatographic analytics. Given that meat freshness is reflected in her behavior to mechanical stresses, textural analysis methods can be useful means for a rapid testing of meat freshness. Results are enlightening for chopped raw meat because of its pronounced anisotropy. Textural characterization [1],[2],[3],[4] can provide quick and valuable indications on the state of chopped meat freshness more isotropic than the massive meat. Currently, to characterize the texture of food several international standards [5], [6], [7], and several internal norms of different countries are elaborated. Standardization refers mainly to defining, classifying and quantifying the scales type panel of primary and secondary parameters of texture. Currently, there are no international standards for test methods and techniques for the types of equipment and their calibration and uniform expression of measured sizes.

MATERIAL AND METHODS

Currently, to characterize the texture of food several international standards [5], [6], [7] and several internal norms of different countries are elaborated. In principle two directions are followed: one involves using specific testing techniques to each parameter of texture [8], [9], and other technique involves using texture profile analysis (TPA) [10], [11], [12]. In this paper the authors opted for the technique of TPA[13],[14] due to the rapidity of determining and obtaining values of a variety of primary and secondary texture parameters that results from one mechanical testing of food. Basically, texture profile has two load cycles of raw materials or finished food product[11],[12].

In the first cycle a compression of sample is done to a degree of deformation between 30 and 80% depending mainly of solid- plastic state, elastic solid state, semisolid-visco-plastic state, semi visco-elastic and after a discharge occurs with the same speed as the load until

*Corresponding author: g.gutt@fia.usv
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zero load is reached. The sample is maintained unloaded a time and the evolution of dynamometer is recorded and after a new loading cycle of the sample analyzed occurs, until the same rate of deformation is obtained. The height of the sample is remained the same as in the first load cycle.

Registration of loading and unloading force by moving platen [13], [14], or its travel time [1], in terms of loading speed or its travel time [1], under a constant load speed for the two cycles shows that in Figure 1. Primary and secondary texture parameters currently defined by ISO standard 11036/2007 [5] and related popular adjectives are shown in Table 1. Also in this table are presented and those of texture parameters, determined instrumentally whose value can be obtained from a double cycle loading - unloading of the type shown in Fig. 1.

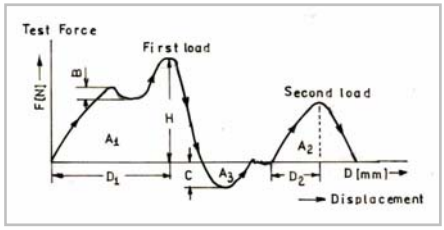

Figure1 Load diagram in two cycles used for texture profile analysis (TPA)

Table 1 Primary and secondary texture parameters defined according to ISO 11036/2007 [5]

The primary parameters of texture		
Parameter texture	Popular adjectives	Notation (Figure1)
Hardness	Soft, firm, hard	**H**
Cohesivity	Brittle, crisp, friable, chewable, hard, soft, short and farinaceous, pasta gummy	**A_2/A_1**
Viscosity	Fluid, thin, viscous	**C**
Elasticity	Plastic, malleable, elastic	**D_2/D_1**
Adhesiveness	sticky, gummy, greasy	**A_3**
Secondary parameters of texture		
Fractura-bility (Fragility)	It is related to the primary parameters of hardness and cohesion	**B**
Gumminess	It is related to the primary parameters of hardness and cohesion of semisolid foods when cohesion is reduced	**H×A2/A1**
Chewiness	It is related to primary parameters of hardness cohesion and elasticity	**$H×A2/A1×D_2/D_1$**

Texture profile analysis was performed daily for samples tested consisting in chopped beef meat type Hamburger, with the composition for Arab countries. Recipe of the mincemeat is as follows: 80 kg frozen beef, 20 kg fresh beef and 200 g salt, without any enrichment. After passing the mixture through the machine for producing Hamburger this is obtained in the form of discs of 80 mm diameter and height of about 7-8 mm.

Discs with a diameter of 35 mm were cut from Hamburgers with a special device [15] and four sliced discs overlapped until they formed a sample of about 30 mm height. Weight of sandwich structures thus obtained ranged between 26.6 - 28g. Mechanical tests have been carried out with a texturometer Mark 10, with a loading speed of 10 mm / min using aluminum compression discs having a diameter of 50 mm. Compression of 50% height and 15 mm respectively was the first, and the second compression was done for the remaining height of 50% after the first compression.

RESULTS

In Figures 2-4 are shown the curves profile of texture for chopped beef according to Hamburger recipe for the first day of testing (Fig. 2), the sixth day of the test (Fig. 3) and for a fried Hamburger (Fig. 4). For reasons of space the values for the 2th, 3th, 4th and 5th days are not presented in the paper instead the values of primary and secundary parameters of texture defined according to SR ISO 11036/2007 [5], are found in the Table 2.

DISCUSSION

Texture profile analysis (TPA) was performed using load samples into two cycles, for chopped beef with composition of Hamburger for Arab countries in order to establish law-like dependent between the degree of freshness and some parameters of the primary and / or secondary texture. There are such dependencies as results of analysis secondary texture parameters that were determined from the TPA. The result is that the hardness is the most representative texture parameters.

Taking into account the sensitivity of method expressed by the growth of the characteristic curve slope, the curve which in turn represents the evolution of a texture

parameter (y-axis) depending on the test day (x-axis), Figures 5-11 and having in consideration the fact that precision of determination has the highest value when approaching this characteristic as much as a right regression equations were established for the evolution of all texture parameters determined by the time (test day). The results are presented in the table 4.

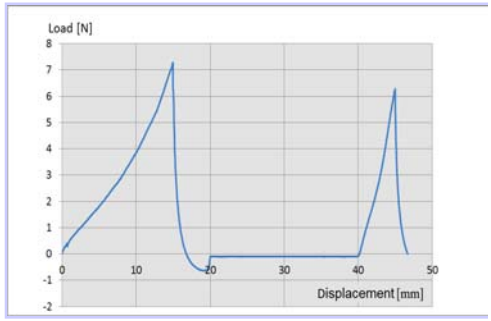

Figure 2 TPA diagram application for the composition of Hamburgers on the first day of testing

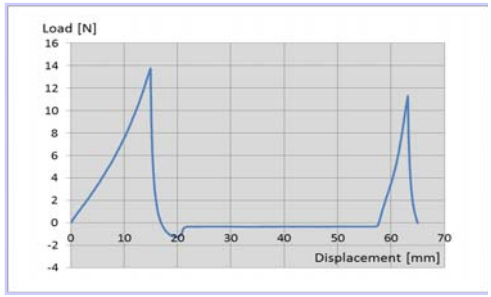

Figure 3 TPA diagram application for the composition of Hamburgers on the sixth day of testing

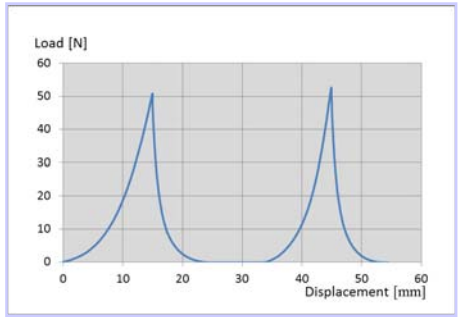

Figure 4 TPA diagram for the composition of Hamburger baked at 300^0 C for 10 minutes on a hot plate special thermostated

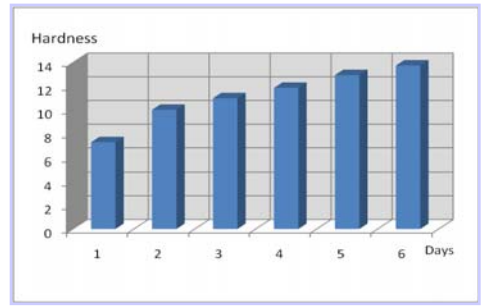

Figure 5. Evolution of Hamburgers hardness samples from the TPA, depending on test day

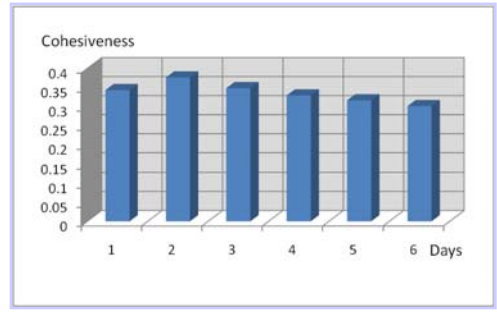

Figure 6. Evolution of Hamburger samples cohesivity from the TPA, depending on the test day

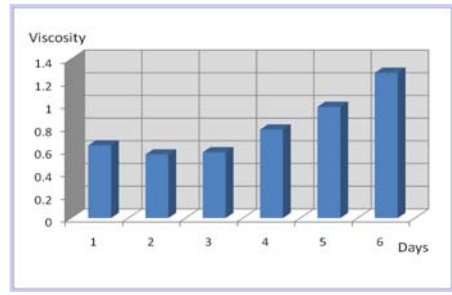

Figure 7 Evolution of Hamburger samples viscosity from the TPA, depending on the test day

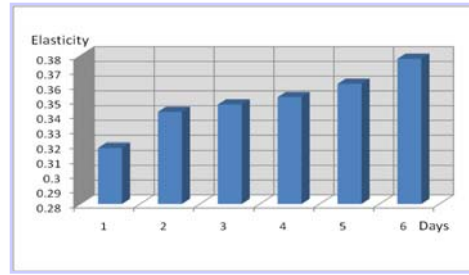

Figure 8. Evolution of Hamburger samples elasticity from the TPA, depending on the test day

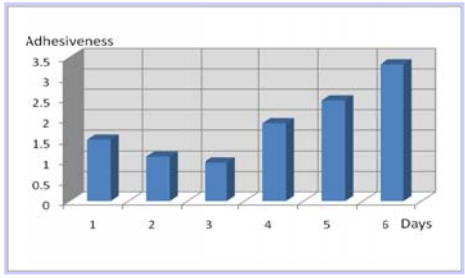

Figure 9 Evolution of Hamburger samples adhesiveness on from TPA depending on the test day

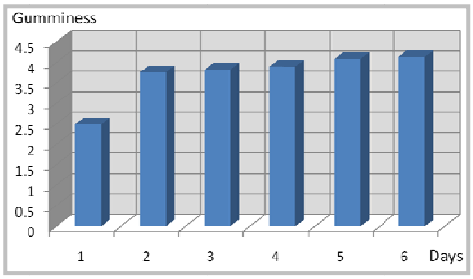

Figure 10. Evolution of Hamburger gumminess samples from the TPA, depending on the test day

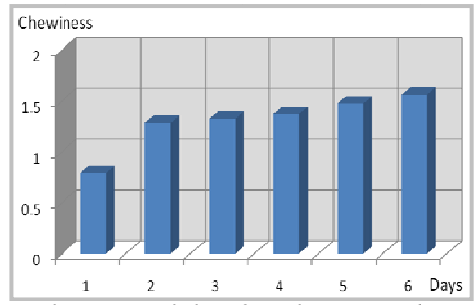

Figure 11 Evolution of Hamburger samples chewiness from the TPA, depending on the test day

For simplicity of determination, productivity and full automation is proposed to determine the freshness of chopped beef meat Hamburger-type by loading the sample only up to the maximum prescribed deformation, the force being in this case the hardness sample (under the TPA).

Table 2 Texture profile analysis values for the composition of chopped beef with crude Hamburger and fried Hamburger

TPA Parameter /day of testing	Hardness	Viscosity	Adhesive-ness	Cohesi-vity	Elasticity	Gummi-ness	Chewi-ness
	H	C	A3	A2/A1	D2/D1	HxA2/A1	HxA2/A1x D2/D1
1	7.28	0.64	1.487	0.343	0.318	2.497	0.794
2	10.02	0.56	1.088	0.376	0.342	3.767	1.288
3	11	0.58	0.942	0.348	0.347	3.828	1.328
4	11.87	0.78	1.89	0.329	0.352	3.905	1.374
5	12.95	0.98	2.45	0.316	0.361	4.092	1.477
6	13.76	1.28	3.333	0.301	0.378	4.142	1.566
Baked Hamburger	50.82	-	-	0.819	0.735	41.62	30.59

Table 3 Pierson correlation for primary and secondary texture parameters versus time for crude Hamburger

	Time	Hard-ness	Visco-sity	Adeziv-eness	Cohesi-vity	Elasti-city	Gummi-ness	Chewa-bility
Time	1							
Hardness	.970**	1						
Viscosity	.887*	.764	1					
Adhesivity	.842*	.704	.990**	1				
Cohesivity	-.830*	-.677	-.909*	-.907*	1			
Elasticity	.966**	.981**	.821*	.758	-.681	1		
Gumminess	.813*	.930**	.498	.423	-.360	.896*	1	
Chewiness	.886*	.970**	.621	.549	-.480	.953**	.988**	1

** Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed)

Table 4 Regression equations and correlation coefficient R^2 for the evolution of primary and secondary texture parameters depending on time

Regr. eq. / Param.	Regression equations	correlation coefficient R^2
Hardness	y= 1.201x+6.940	0.941
Elasticity	y= 0.010x+0.313	0.933
Viscosity	y= 0.133x+0.337	0.785
Chewiness	y=0.127x+0.857	0.784
Adhesiveness	y=0.407x+0.438	0.709
Cohesivity	y= -0.011x+0.376	0.689
Gumminess	y= 0.265x+2.777	0.661

This way allows not only the automation of attempt but also the developing a minimum software that in achieving the desired degree of deformation (gave by the displacement sensor of texturometer) automatically converted hardness values in units of chopped beef meat freshness.

CONCLUSIONS

From the texture profile analysis of chopped beef meats results in a good enough dependence between some parameters of primary texture and degree of meat freshness.

The hardness as a primary parameter of texture has the highest relevance, established by Pearson analyzing. Taking into account the sensitivity criterion of method and the value as close to one of the linear regression coefficient R^2 (as an expression of the precision of determination), calculated for regression equations describing the evolution of primary and secondary texture parameters versus time (day attempt) the most representative parameter texture is also hardness proof. The option is still the hardness when it is take into account the simplicity of testing, working time and the possibility of fully automated attempt and of a specific software which allows the possibility of displaying the degree of meat freshness after texture profile. More precisely in the case of samples with a height of 300 mm samples will deforme up to 15 mm, the force value (hardness test according TPA) read to this deformation being inversely proportional to the freshness of the meat. Considering these findings and that hardness is determined from the first cycle of loading the sample the proposal is to carry out only the first part of the first cycle of testing, the degree of deformation being recommended of 50% from the initial height of meat sample.

REFERENCES

[1] Bourne M., Food Texture and Viscozity, Concept and Measurement, Second Edition, Academic Press, New York, 2002, p.65-90

[2] McKenna B.,M Texture in Food, Volume 1-semi-solid foods, CRC PRESS Boca Raton, Boston, 2003, p.86-103,

[3] Amariei S., Device for determining food adhesiveness, proposal of invention, OSIM file, A00225/2013

[4] Bulancea, M., & Iordăchescu, G., (2006), Textura produselor alimentare, Editura Aius, Craiova.

[5] XXX SR ISO 11036/2007- Senzory analysis - Methods- Texture profile

[6] XXX - ISO 5492/1992 -Senzory analysis - Vocabulary

[7] XXX - ISO 6658/1985-Senzory analysis - Methodology- General guidance

[8] Amariei Sonia, Gutt Gheorghe, Hretcanu Cristina-Elena, Oroian Mircea - Adrian, Apparatus and devices for determining food texture and advanced characterization of their behavior to mechanical stresses, proposal of invention, OSIM file A00322/2012

[9] Gutt G., Amariei S., Oroian M., A., Hretcanu E., C., Portable equipment for advanced characterization of food texture. First part- Equipment, Food and Environment Safety**,** 2013, Vol, 12 Issue 4, p**.**36-37

[10] Chen, L., & Opara, U., L., (2013), Texture measurement approaches in fresh and processed foods, Food Research International 51, 823–835

[11] Dan, H., & Kohyama, K., (2007), Interactive relationship between the mechanical properties of food and the human response during the first bite, Archives Of Oral Biology 52, 455–464.

[12] Amariei Sonia, Gutt George Oroian Mircea Adrian, Sanduleac Elena, Paduret Sergiu, Automated process for achieving food texture profile, proposal of invention, OSIM file A00673 / 2013.

[13] Amariei Sonia, Gutt Gheorghe,Oroian Mircea Adrian, Sanduleac Elena, Paduret Sergiu, Device for determining food anisotropy, proposal of invention, OSIM file A00674/ 2013

[14] Amariei Sonia, Gutt Gheorghe, Oroian Mircea Adrian, Sanduleac Elena, Paduret Sergiu, Advanced thermostatic device used for textural characterization of food, proposal of invention, OSIM file, A00672/ 2013

[15] Gutt Gheorghe, Device for achieving specimens in food texture determination, proposal of invention, OSIM file, A001019/17.12.2012.