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Instrumental and Sensory Measurements of Ezine Cheese Texture

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ABSTRACT

Instrumental and sensorial methods of texture profile analysis (TPA) were used to describe textural properties of Ezine cheese. Ezine cheeses produced by a local producer were stored in tin plate containers (2 kg each) at 2-4°C for 12 months, and textural changes of cheese samples were determined during storage. Results of instrumental texture profile analysis showed that aging made cheese samples more adhesive and less cohesive. In sensory analysis, springiness and number of particles scores were lower at the end of the ripening than other days. Significant correlations were found between sensory attributes including rate of recovery and number of particles with instrumental springiness, instrumental gumminess, instrumental chewiness and instrumental resilience.

Key Words: Ezine cheese, Texture, Sensory, Texture profile analysis

Ezine Peyniri Tekstürünün Enstrümental ve Duyusal Olarak Belirlenmesi

ÖZET

Bu çalışmada enstrümantal ve duyusal tekstür profil analizi (TPA) yöntemleri Ezine peynirinin tekstürel özelliklerini tanımlamak için kullanılmıştır. Lokal bir peynir üreticisi tarafından üretilen Ezine peynirleri teneke ambalajlarda (2 kg) 2-4°C'de 12 ay boyunca depolanmış ve depolama süresince peynir örneklerinin tekstürel değişimleri belirlenmiştir. Enstrümantal tekstür profil analiz sonuçları peynirlerde olgunlaşma süresince iç yapışkanlığın arttığını ve dış yapışkanlığın ise azaldığını göstermiştir. Duyusal analizde depolama sonunda esneklik ve partikül sayısı değerlerinin azaldığı görülmüştür. Duyusal parametrelerden olan elastikiyet oranı ve partikül sayısı ile enstrümantal ölçümlerden olan esneklik, sakızımsılık, çiğnenebilirlik ve elastikiyet arasında yüksek korelasyon olduğu belirlenmiştir.

Anahtar Kelimeler: Ezine peyniri, Tekstür, Duyusal, Tekstür profil analizi

INTRODUCTION

Texture has an important effect on the consumer acceptance of foods. Texture and food structure are linked, and structural composition of foods determines the sensory perception [1]. International Organization for Standardization [2] defines texture as a sensory characteristic perceived largely by way of the senses of movement and touch. Both sensorial and instrumental methods can be used to determine textural properties of foods. Instrumental texture profile analysis (ITPA) imitates the actions of the human mouth. Due to limitations of time, panel training, panelist psychology and labor-intensive nature of sensory analysis, instrumental methods have been designed to measure food properties that relate to relevant sensory characteristic [3]. Texture Profile Analysis is used as common instrumental measurement for cheese-texture evaluation [4].

Relationship between instrumental and sensory measurements of cheese texture was investigated by Drake et al. [5]. These authors analyzed different kinds of cheeses including Cheddar, Brie, Feta, Muenster, Parmesan and processed cheeses. Multivariate analysis showed that many of the sensory and instrumental analysis were highly correlated to each others. Textural properties of different cheeses were also studied [6, 7, 8]. Some texture descriptors for full fat and low fat cheeses were firmness, cohesiveness, slipperiness of mass, stickiness to teeth, adhesiveness in the mouth [8]. Attributes evaluated by hand were firmness, rubberiness, brittleness, stickiness and slipperiness. Adhikari and coworkers [6] investigated texture attributes of low fat, full fat and smoked cheeses (Cheddar, Gouda and Swiss). Some texture terms developed for these cheeses were grainy, hardness, first bite-sticky, creamy and mouth coating.

In a study, textural properties of 10 Cheddar cheeses were investigated by sensory and instrumental methods over a 9-month ripening period, and significant correlations between sensory and instrumental parameters were found [9]. For example, sensory rubbery correlated with instrumental firmness, chewiness, fracture stress and springiness [9]. Romeih and coworkers [10] determined the textural properties of low fat white-brined cheeses made from bovine milk and fat mimetics by instrumental and sensory analysis. They did not find any significant relationship between sensory attributes and mechanical parameters.

Ezine cheese is a semi hard cheese and has a salty and sour taste. It is a full fat white cheese made from a mixture of cow, sheep and goat milk. It is ripened in tinplate packages for at least 8 months [11]. Karagul-Yuceer and coworkers [11] determined the sensory descriptors for 22 Ezine cheese samples provided from local market, and they generated 10 texture terms by hand, mouth and residual techniques.

The objectives of this study were to determine the changes in texture properties by both instrumental and sensory texture profile analyses using both hand and mouth evaluated terms by experienced panel members during storage, and to correlate, if any, texture attributes measured by these two methods.

MATERIALS and METHODS

Cheese Samples

Cheeses were produced by a local producer in May. Samples were stored in tin plate containers (2 kg each). Cheeses were analyzed every 3-month. Duplicate cheese samples were used for each period. Cheeses were ripened at 2-4^{o}C for 12 months.

Texture Profile Analysis (TPA)

Texture properties of the cheese samples were determined by a Texture Analyzer TA-XT2 (Stable Micro Systems Ltd., Surrey, the UK). Cheeses were carefully cut into pieces (15 x 15 mm) with a cheese slicer. At least ten measurements were performed on each cheese. American Association of Cereal Chemists (AACC) standard 36 mm cylinder probe with radius P/36 R and 25 kg load cell was used. TPA parameters recorded were hardness, adhesiveness, springiness, gumminess, chewiness, cohesiveness, and resilience measured by the software at 40 % compression with pre-test speed 1.0 mm/sec, test speed 0.4 mm/sec, post test speed 0.4 mm/sec and a rest period of 5 s between two cycles.

The data obtained from the force relaxation curve were used to calculate maximum and residual force, while the data obtained from TPA curve were used for the calculation of textural parameters (Figure 1). Amongst the TPA parameters, hardness was expressed as maximum force for the first compression, whereas adhesiveness was expressed as negative force area for the first bite or the work necessary to pull the compressing plunger away from the sample. Cohesiveness was a measure of the degree of difficulty in breaking down the internal structure. Cohesiveness and springiness were reported as ratios between areas under second and first compression and the height that the sample recovers during the time that elapses between the end of first bite and initiation of the second one, respectively. Resilience reflects the redeformation capacity of tissue after penetration [12, 13].

Sensory Analysis

A nine-member panel (four female, five male) evaluated cheeses in terms of textural properties during 12-month storage. Panelists were staff members and graduate students in the Department of Food Engineering at Canakkale Onsekiz Mart University. Panelists' ages ranged from 24 to 39y. Texture terms developed by Karagul-Yuceer and coworkers [11] for Ezine cheese were introduced to panelists. Definitions of the terms were listed in Table 1. Panelists quantified the attributes using 15-point product specific scales anchored on the left with 'not' and on the right with 'very' [14]. The panel received about 50h of training during generation and definition of descriptive terms. Each training session was about an hour. Cheeses were presented in 3-digit coded styrofoam plates. Duplicate samples were served in different sessions. All panelists evaluated the same cheese sample in a randomized order.

Table 1. Sensory descriptors and definitions used to evaluate Ezine cheese texture [11]

Descriptor (Abbreviation)	Definition
Hand evaluation	
Firmness *(hfrm)*	Amount of force required to completely compress the sample
Springiness *(sprg)*	Total amount of recovery after press
Rate of recovery *(ror)*	Rate at which the sample returns to its original shape
Mouth-first bite	
Firmness *(mfrm)*	Amount of force required to completely bite the sample.
Fracturability *(frac)*	Amount of fracturability in the sample after biting.
Mouth-chew down	
Number of particles *(nop)*	Amount of particles after mastication of the sample
Cohesiveness *(coh)*	Degree to which the chewed mass sticks together.
Adhesiveness *(adh)*	Degree to which the chewed mass sticks to mouth surface
Smoothness of mass *(som)*	Smoothness of the chewed mass surface
Mouth-residual	
Smoothness of mouth coating *(somc)*	Degree of smoothness felt in the mouth after expectorating the sample

Acronyms: *hfrm*: hand firmness, *sprg*: springiness, *ror*: rate of recovery, *mfrm*: mouth firmness, *frac*: fracturability, *nop*: number of particles, *coh*: cohesiveness, *adh*: adhesiveness, *som*: smoothness of mass, *somc*: smoothness of mouth coating

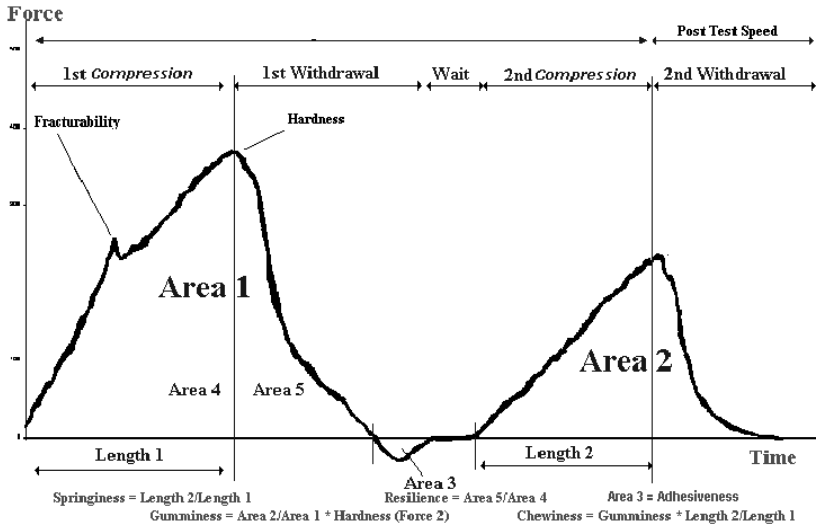

Figure 1. Representation of Texture Profile Analysis Results and Calculation of TPA terms [15].

Statistical Analysis

One way analysis of variance (ANOVA) was used to compare the cheeses with respect to their texture attributes by instrumental and sensory analyses. Pearson correlation coefficients were calculated to determine linear relations between the characteristics of Ezine cheeses. Tukey multiple range test were applied to determine differences among different groups using SAS 9.1.3. SPSS for Windows (version 15.0) was used for correlation analyses.

Model for one way analysis of variance

$$y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

y_{ij}= Effect of the i th treatment in the j th replication
μ= Overall mean
τ_i= The effect of the i th treatment
ε_{ij} = Residual error

RESULTS and DISCUSSION

Table 2 shows the changes in texture attributes measured by the texture profile analyzer. ITPA results showed that as the cheeses aged, they became more adhesive and less cohesive during ripening. Specifically, these changes were clear during 9-month storage. However, other attributes did not significantly change over storage ($p>0.05$) (Table 2). In a study, textural properties of Cheddar cheeses with a range of moisture contents and pH values were determined by sensory and instrumental methods during 9-month storage [9]. Firmness, springiness, cohesiveness, adhesiveness and chewiness were measured as instrumental parameters in Cheddar cheeses by using a texture analyzer. This study also indicated that firmness, springiness, cohesiveness and chewiness of Cheddar cheese decreased, but adhesiveness significantly increased during ripening [9]. In the present study, we also found similar results for Ezine cheese.

Table 2. Instrumental measurements of Ezine Cheese with mean and standard deviation ($\overline{X} \pm S_{\overline{X}}$)

ITPA attributes (Abbreviation)	Ripening Period (month)*			
	3	6	9	12
Hardness (IHRD)	1051.40±210.98 ^{A}	1179.05±107.96 ^{A}	1533.17±304.91 ^{A}	898.02±84.98 ^{A}
Adhesiveness (IADH)	47.11±15.50 ^{B}	96.64±4.88 ^{A}	142.21±3.68 ^{A}	97.34±0.29 ^{A}
Springiness (ISPR)	0.74±0.01 ^{A}	0.66±0.01 ^{A}	0.62±0.00 ^{A}	0.63±0.06 ^{A}
Cohesiveness (ICOH)	0.57±0.02 ^{A}	0.46±0.00 ^{AB}	0.34±0.00 ^{B}	0.39±0.06 ^{AB}
Gumminess (IGUM)	593.75±95.89 ^{A}	547.54±65.48 ^{A}	528.65±115.57 ^{A}	348.07±26.85 ^{A}
Chewiness (ICHE)	447.65±81.30 ^{A}	370.80±53.47 ^{A}	333.28±77.57 ^{A}	223.92±39.47 ^{A}
Resilience (IRES)	0.25±0.00 ^{A}	0.16±0.00 ^{AB}	0.14±0.01 ^{AB}	0.14±0.03 ^{AB}

* Means in the same row followed by different capital letters represent significant differences ($p< 0.05$).

Table 3 shows the changes in the intensities of sensory attributes during ripening. Insignificant differences were observed in cheeses during ripening in terms of hand firmness, rate of recovery, mouth firmness, adhesiveness, smoothness of mass and smoothness of mass coating. The intensity of springiness determined by sensory analysis was the lowest at 12th month of storage, but the same with 9th month of storage. In addition, fracturability and number of particles scores were significantly low at further ripening periods ($p<0.05$). Textural attributes of 22 Ezine cheese samples collected from local producers were previously determined by Karagul-Yuceer and coworkers [11]. In general, the cheeses showed differences in terms of texture attributes. The authors stated that Ezine cheeses had soft and semi-hard texture properties

based on texture evaluations. The results of the present study agreed with the findings on textural properties of Ezine cheeses by Karagul Yuceer et al. [11]. Hand and mouth evaluations were used to discriminate texture of some cheeses including Cheddar, Feta, Parmesan, Brie and Muenster by Drake et al. [8]. As similar cheese to Ezine cheese, the findings for Feta cheese by Drake and coworkers [8] agreed with our results. For example, mouth firmness of Feta cheese was 6.7, while hand firmness was 6.2 based on 15-point numerical intensity scale [8].

Table 3. Mean sensory attributes of Ezine Cheese ($\overline{X} \pm S_{\overline{X}}$)

Sensory attributes	Ripening Period (month)*			
	3	6	9	12
Hfrm	5.33±0.05 ^{A}	6.43±0.12 ^{A}	6.08±0.47 ^{A}	5.73±0.26 ^{A}
Sprg	4.69±0.22 ^{A}	5.29±0.29 ^{A}	3.87±0.04 ^{AB}	2.45±0.68 ^{B}
Ror	4.12±0.01 ^{A}	4.05±0.19 ^{A}	3.34±0.29 ^{A}	2.25±0.58 ^{A}
Mfrm	4.27±0.08 ^{A}	4.52±0.08 ^{A}	4.70±0.29 ^{A}	4.66±0.16 ^{A}
Frac	6.63±0.41 ^{A}	4.56±0.09 ^{B}	5.29±0.04 ^{B}	4.86±0.05 ^{B}
Nop	5.73±0.29 ^{A}	5.12±0.20 ^{AB}	5.02±0.0.0 ^{AB}	4.47±0.16 ^{B}
Coh	5.00±0.36 ^{B}	6.80±0.16 ^{A}	6.72±0.30 ^{A}	6.73±0.09 ^{A}
Adh	5.45±0.31 ^{A}	6.93±0.26 ^{A}	6.75±0.05 ^{A}	6.58±0.30 ^{A}
Som	7.15±0.31 ^{A}	7.56±0.09 ^{A}	7.84±0.23 ^{A}	7.84±0.26 ^{A}
Somc	7.55±0.01 ^{A}	7.65±0.34 ^{A}	8.30±0.08 ^{A}	8.02±0.16 ^{A}

Means in the same row followed by different letters represent significant differences ($p< 0.05$). Acronyms: hfrm: hand firmness, sprg: springiness, ror: rate of recovery, mfrm: mouth firmness, frac: fracturability, nop: number of particles, coh: cohesiveness, adh: adhesiveness, som: smoothness of mass, somc: smoothness of mouth coating

Texture attributes measured by only instrumental method (ITPA) showed that springiness (ISPR) was significantly correlated with cohesiveness (ICOH) and adhesiveness (IADH) (Table 4). Chewiness (ICHE), measured by the texture profile analyzer, was significantly correlated with springiness (ISPR) and gumminess (IGUM). In addition, significant correlation was observed between resilience and some other instrumental attributes including IADH, ISPR, ICOH and ICHE (Table 4).

Correlations among sensory attributes were also shown in Table 4. Hand firmness (hfrm) was correlated with mouth firmness (mfrm) and cohesiveness (coh). Significant correlation was determined between rate of recovery and both sprg and nop. In addition, there was a significant positive correlation between fracturability and number of particles. However, fracturability was negatively correlated with cohesiveness and adhesiveness. Number of particles was negatively correlated with cohesiveness and smoothness of mass. Cohesiveness was correlated with adhesiveness and smoothness of mass. Adhesiveness was also positively correlated with smoothness of mass. These results were supported by some of the findings reported by Brown and coworkers [7] and Karagul-Yuceer and coworkers [11].

Table 4 shows the correlations between texture measurements by the texture profile analyzer and sensory evaluation techniques. Instrumental measurement of springiness (ISPR) was positively correlated with sensory terms including rate of recovery (ror) and number of particles (nop). However, a negative but significant correlation was determined between mouth firmness and instrumentally measured springiness and cohesiveness. Instrumental measurement of gumminess (IGUM), chewiness (ICHE) and resilience (IRES) were correlated with rate of recovery and number of particles. ITPA resilience was correlated with fracturability (frac), but it was negatively correlated with sensory cohesiveness (coh). Romeih and coworkers [10] did not find any significant relationship between sensory attributes and mechanical parameters for low fat white-brined cheeses made from bovine milk and containing two commercial hydrocolloid-fat replacers. However, significant correlation between instrumental and sensory measurements for Cheddar, Brie, Feta, Muenster, Parmesan and processed cheeses by Drake et al. [5]. TPA parameters including hardness, springiness and gumminess were correlated with sensory firmness [5]. They also found insignificant correlation between TPA adhesiveness and sensory stickiness attributes [5].

In the cases of instrumental hardness (IHRD) and smoothness of mass coating (somc), insignificant correlation was determined with any attributes. Sensory and mechanical aspects of cheese texture were reviewed by Foegeding and coworkers [16] who stated that sensory and instrumental terms related to firmness and resiliency are highly correlated. In contrast, sensory attributes that show the chewdown characteristics are less correlated with instrumental measurements. Our findings for Ezine cheese texture agreed with their results.

In conclusion, insignificant changes were found in terms of texture attributes by these methods after 3 month storage. These results also indicated that good correlation was determined between some of the parameters measured by both techniques. Specifically, first bite and chewdown characteristics evaluated by mouth and rate of recovery were better correlated with instrumental texture terms. This study suggests that only a few mechanical texture parameters can be used to

Table 4. Pearson correlation coefficients between and within instrumental and sensory texture attributes for Ezine cheese.

	IADH	ISPR	ICOH	IGUM	ICHE	IRES	hfrm	sprg	ror	mfrm	frac	nop	coh	adh	som
IADH	1	**.70(*)**	**.88(**)**	.15	.34	**.79(*)**	-.50	.29	.35	-.55	.52	.43	-.68	-.64	-.56
ISPR		1	**.92(**)**	.54	**.72(*)**	**.94(**)**	-.55	.58	**.72(*)**	**-.75(*)**	.63	**.74(*)**	-.69	-.51	-.47
ICOH			1	.39	.58	**.94(**)**	-.48	.60	.68	**-.72(*)**	.55	.68	-.68	-.53	-.50
IGUM				1	**.96(**)**	.55	.14	.66	**.81(*)**	-.19	.44	**.70(*)**	-.34	-.25	-.63
ICHE					1	**.71(*)**	-.05	.68	**.84 (**)**	-.39	.57	**.79(*)**	-.51	-.40	-.69
IRES						1	-.52	.55	**.70(*)**	-.64	**.75(*)**	**.80(*)**	**-.78(*)**	-.66	-.60
Hfrm							1	.15	.04	**.72(*)**	-.67	-.30	**.71(*)**	.62	.09
Sprg								1	**.95(**)**	-.47	.13	.65	-.21	.01	-.29
Ror									1	-.47	.34	**.78(*)**	-.36	-.15	-.43
Mfrm										1	-.53	-.61	.70	.47	.26
Frac											1	**.77(*)**	**-.94(**)**	**-.92(**)**	-.67
Nop												1	**-.79(*)**	-.66	**-.71(*)**
Coh													1	**.95(**)**	**.71(*)**
Adh														1	**.77(*)**
Som															1

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed) Acronyms: Instrumental terms: IADH: Instrumental adhesiveness, ISPR: Instrumental springiness, ICOH: Instrumental cohesiveness, IGUM: Instrumental gumminess, ICHE: Instrumental chewiness, IRES: Instrumental resilience. Sensory terms: hfrm: hand firmness, sprg: springiness, ror: rate of recovery, mfrm: mouth firmness, frac: fracturability, nop: number of particles, coh: cohesiveness, adh: adhesiveness, som: smoothness of mass.

predict some sensory texture parameters for Ezine cheese. Instrumental measurement of texture can be attractive because of its simplicity, reproducibility and speed, but sensory evaluation should also be used to better understand texture of cheese.

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