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TEXTURE OF BREAD SUPPLEMENTED WITH FRUITS AND VEGETABLES TREATED BY OSMOTIC DEHYDRATION IN SUGAR BEET MOLASSES
TEKSTURA HLEBOVA SA DODATKOM OSMOTSKI DEHIDRIRANOG VOĆA I POVRĆA U MELASI ŠEĆERNE REPE

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SUMMARY

The concept of texture profiling is based on the same elements as in flavour profiling and includes all the mechanical, geometrical and surface attributes of a product perceptible by tactile, visual and auditory receptors. The mechanical attributes are those related to the reaction of the product to press: they are divided in five primary characteristics (hardness, cohesiveness, viscosity, springiness and adhesiveness) and three secondary characteristics (brittleness, chewiness and gumminess). The geometrical attribute are those related to the size, shape and arrangement of particles within a product. The surface attributes are those related to the sensations produced by moisture and/or fat content. In the mouth they are also related to the way in witch these constituents are released. Texture of bread (crust and crumb) with addition of fruits (apple, plum) and vegetables (carrot, cabbage) dehydrated in sugar beet molasses was examined for sensory properties (chewiness, grain structure, elasticity) and instrumentally (Warner Vratzler, penetrometer).Sensory and instrumental properties were correlated. It found differences between textures of breads in relation to the kinds and quantity of fruits and vegetables osmotically dehydrated in sugar beet molasses.

Key words: *Texture, sugar beet molasses, osmotically dehydrated fruits and vegetables, bread*

REZIME

Koncept profila teksture zasnovan je na istim elementima kao i profil ukusnosti i obuhvata sva mehanička, geometrijska i svojstva površine proizvoda. Navedene osobine mogu da se opaze taktilnim, vizuelnim i auditivnim receptorima. Mehanička svojstva su ona koja su u vezi sa reakcijom proizvoda na pritisak; podeljena su na pet primarnih (tvrdoća, kohezivnost, viskoznost, elastičnost i adhezivnost) i tri sekundarna parametra (lomljivost, žvakljivost, gumoznost). Geometrijska svojstva su ona koja su u vezi sa veličinom, oblikom i uredjenošću cestica u proizvodu. Svojstva površine su svojstva koja se odnose na osećaje koje izazivaju sadržaj vlage i/ili lipida; odnose se i na način na koji se vlaga ili lipidi oslobadjaju u ustima.U radu su ispitani uzorci hlebova sa dodatkom osmotski dehidriranog voća i povrća u melasi secerne repe. Tekstura je odredjivana i senzorski ocenjivana na kori i sredini hlebova preko više pokazatelja (senzorski: žvakljivost, poroznost, elasticnost; instrumentalno:Varner Bratzler, penetrometar). Utvrdjena je korelacija izmedju senzorskih i instrumentalnih odredjivanja, a utvrdjena i razlika izmedju teksture hlebova zavisno od vrste i količine osmotski dehidrinanog voća i povrća.

Ključne reci: *Tekstura, melasa šećerne repe, osmotski dehidrirano voće i povrće, hleb*

INTRODUCTION

Texture includes all mechanical, geometric and surface attributes of a product. Mechanical attributes are those that refer to the reaction of product against the action of force and consist of five basic characteristics (hardness, cohesiveness, viscosity, elasticity and adhesiveness) *(Senzorske analize, 1998)*. Hardness is the peak force needed to deform or penetrate the product. Cohesiveness is how well the product withstands the deformation before it fractures. Viscosity is a resistance to flowing. Elasticity is how well the product retains its original condition after it has been deformed and a degree to which the product springs back after a load is removed. Adhesiveness is a property related to the force needed to remove the material that has adhered to substrate or to surface of oral cavity.

Cohesiveness encompasses three secondary parameters: fracturability, chewiness and gumminess. Fracturability is a property related to the force required to crumble, crack or shatter the product. Chewiness is the sensation of mastication due to elastic resistance of food and is related to the number of chews or time needed to reduce the particle size and form a bolus for swallowing. Gumminess is related to the cohesiveness and motility processes required to breakdown food in the mouth.

Geometrical properties are those related to size, shape and particle arrangement within the product and include attributes such as granularity and structure. Granularity is an observation of size and shape of particles in the product whereas structure includes the observation of shape and orientation of particles.

Surface attributes are those related to the sensation of moisture and/or lipids present on the product surface *(Senzorske analize, 1998)*.

Texture of food product is formed due to the presence of its constituents, their interrelations and applied processing methods (grinding, homogenization, fermentation, thermal processing). Food can be liquid, semi solid and solid depending on the chemical composition (proteins, lipids, carbohydrates and water). The other food constituents present in smaller quantities in the food (minerals, vitamins, hormones, enzymes, etc.) exhibit minor influence.

Substantial influence on the texture attributes has been exerted by additives from various functional groups: thickeners, stabilizers, emulsifiers, emulsifying salts, gelling agents, humectants, raising agents, firming agents, modified starches *(Pravilnik...[11], 2003)*. The food texture can be assessed by sensorial and instrumental methods.

A sensory assessment of texture (by palpation or mastication) is produced by mechanical stimulation of the sense of touch that corresponds to a particular group of regions within the brain where the electric signals are received and interpreted. In the somatosensory area of the brain (which is located near to the

sensitive zone of sight and hearing), sensation, initiated by external stimuli of receptors, is formed and as a result, a response is formed in the associative zone. Tactile sensations are formed in the corpuscular tactile receptors located in different areas of skin: Fater-Pacinian, Meissner's, Ruffini's and Krause's corpuscles and Merkel's discs.

A competent assessment of sensory and texture properties can be provided only by methods complying with standards for sensory analyses *(Senzorske analize, 2000.; Senzorske analize, 2002.; Senzorske analize, 1998.)* which refer to sensory panel, object of analysis, method of analysis, type of tests, conditions and mathematical methods for data processing.

In sensory assessment, the most complicated is the sense of touch because it is hard to define general conditions. Each food requires specific conditions for the assessment of textural properties and common phases of their evaluation include:

- Visual assessment of shape, texture and perception of greasiness,
- Assessment of textural properties by palpation in solid food (estimation of hardness, elasticity, plasticity, moisture, greasiness);
- Assessment of textural properties by mastication (solid food), swallowing (semi solid and liquid food) (estimation of mechanical structural attributes, viscosity, perception of grease and wetness).

In order to simplify the texture assessment in a given standard *(Senzorske analize, 1998)*, general profile terms have been defined for the texture parameters: hardness (soft, firm, hard), cohesiveness (intensity described through different degrees), fracturability (crumbly, crunchy, brittle, crustal), chewiness (tender, chewable, tough), gumminess (farinaceous, dusty, doughy, gummous), elasticity (plastic, elastic, flexible, contracted), adhesiveness (sticky, pliable), granularity (smooth, sandy, gritty, coarse), structure (fibrous, cellular, crustal), moisture (dry, humid, wet, juicy, watery), greasiness (oily, smeared, greasy) *(Senzorske analize, 2000.; Senzorske analize, 1998.)*.

The aforementioned descriptors have been assigned with adequate numerical values which enable data processing and quantitative comparison of the samples.

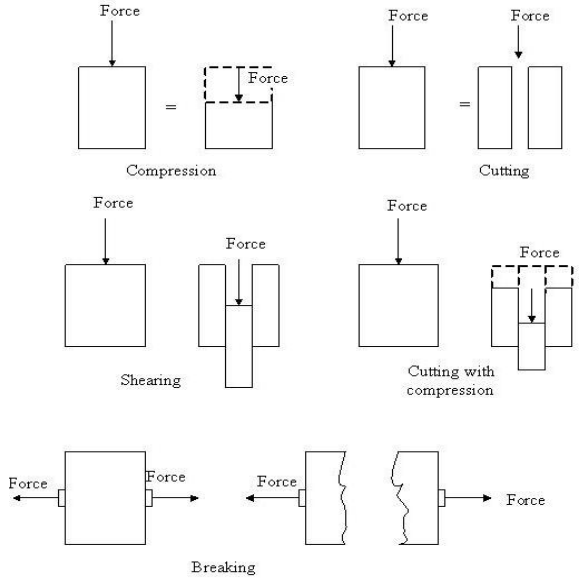

Fig. 1. Modes of force action in texture measurement
Sl. 1. Načini delovanja sile kod merenja teksture

Depending on the type of parameter measured, the instruments are classified as consistometers, penetrometers, viscosimeters, tenderometers, gelometers, texturometers, etc.

Objective assessment of texture attributes comprises a number of methods and different instruments. Viscosimeters have been used for liquid and semi solid food. For most solid food, the texture attributes can be measured by various devices differing in construction. However, two principles have been used in the measurement of response to the action of force:

In food processing, there have been many investigations on enhancing the nutritive value and improving the attributes of products. This led to an increase of so-called functional food. One potentially valuable ingredient for the formulation of functional food is sugar beet molasses. Molasses is a by-product of sugar processing industry. Molasses is a rich source of many bio-active substances (amino acids, vitamins, minerals, organic acids, pectin, sugars, etc.) *(Filipčev at al, 2005.; Filipović at al, 2007.; Hough at al, 1993.; Lević at al, 2008.)*. It can be applied directly as an ingredient to some products; however, it can also be used for the preparation of new ingredients. For example, molasses can be incorporated indirectly to the product formulation through fruits and vegetables treated by osmotic dehydration in molasses. Osmotic dehydration is a process for partial removal of water from fruits and vegetables and diffusion of solute from osmotic solution into plant tissue *(Pribiš at al, 2005.; Pribiš at al, 2006.; Pribiš at al, 2008.; Svrzić at al, 2006.)*. Fruits and vegetables treated in this way can be added to various products or can be pulverized and as such used in product formulations.

Bread is regarded as a suitable commodity for broadening the assortment of functional food products and thus, the main goal of this paper was to deliver a new formulation for the enriched bread with ingredients made from dried plant materials previously treated by osmotic dehydration in sugar beet molasses. Textural characteristics of the enriched bread were at the center of attention.

MATERIAL AND METHODS

The following formulations of enriched bread were investigated:

- Control bread and bread supplemented with molasses (5% and 10%, flour basis),
- Bread supplemented with pulverized apple and plum, previously treated by osmotic dehydration in sugar beet molasses (5% and 10%, flour basis),
- Bread supplemented with pulverized carrots and red cabbage, previously treated by osmotic dehydration in sugar beet molasses (5% and 10%, flour basis).

Bread was prepared under laboratory conditions. The bread was made from wheat flour type 400 and other ingredients usually applied in the bread making process. Bread making process was adequate to the experimental conditions of preparation and baking *(Kaluđerski & Filipović, 1998.; Pravilnik…[10])*.

For the preparation of ingredients, sugar beet molasses from the sugar factory Bač was used. The pulverized ingredient was prepared by osmotic dehydration of plant material (molasses to ingredient ratio was 4 : 1) at 55°C for 5 h. After dehydration, the fruit samples (apple and plum) and vegetable samples (carrot and cabbage) were dried at 105°C until constant weight. The dried samples were cooled, grinded and used in bread making.

The following parameters were investigated:

- Sensory assessment of crumb cohesiveness; chewiness (number of chews);
- Sensory assessment of crumb elasticity (palpatory technique);
- Sensory assessment of crumb porosity (crumb pore uniformity and quality);
- Crust and crumb firmness (by cutting) according to W.B.;
- Penetrometer number for crumb.

The sensory panel consisted of three specialists according to valid standards for sensory analyses.

The cohesiveness was evaluated by mastication of a crumb piece (4x4x2 cm) using incisors and molars, counting the number of chews needed to form a bolus easy to swallow.

The elasticity was evaluated by lightly pressing the cut surface of bread loaf with the thumbs of both hands. The ability of crumb to retain its original position was observed (scores: excellent-5.0; good-3.0; not satisfactory-1.0).

The porosity of crumb was assessed by scoring two parameters – uniformity and pore quality. Uniformity of pores was estimated by observing the pore size evenness (scores: uniform-5.0; slightly uniform-3.0; uneven-1.0). The pore quality was determined entirely by the sense of touch, by lightly rubbing the fingers against the cut surface (score: spongy-5.0; fine-3.0; distinctively coarse-1.0).

The firmness of bread crumb and crust was instrumentally determined on a SHEAR apparatus by Warner-Bratzler (W.B.). From each sample two pieces of crust located on the upper side of loaf (2 cm in width and 0.5 cm thick) and crumb (2 x 2 cm) were taken and subjected to shear force expressed in lb.

Penetrometer number was determined using a penetrometer SUP PNR 6. The depth to which the probe penetrates into the crumb during 5 sec was measured. Three measurements were taken from each bread slice, performing the measurements on different positions on the crumb. The slice was 2 cm thick.

RESULTS AND DISCUSSION

Sensory evaluation of the attributes, scores and results are listed in Tables 1 and 1a. On the basis of chewiness estimation it was found that the control sample and the bread made with 5% osmodehydrated apple and cabbage were the coarsest. This finding is consistent with the estimations obtained for the crumb elasticity.

The pore uniformity was propitious for all investigated samples; the sample with carrot was scored as excellent and this score was in agreement with the lowest number of chews obtained for this sample (Table 1). Crumb pore quality was propitiously scored in the control sample and sample with 5% molasses whereas slight coarseness was observed in the other samples.

After comparison of the aforementioned sensory assessments and the instrumental measurements, it was found that the crust of the control sample was the softest whereas the crust of the sample made with 5% molasses was the hardest presumably due to the increased sugar content in molasses. The bread types made with the addition of fruits/vegetables treated in molasses were similar among each other in the crust hardness except for the sample made with cabbage (10.4 lb). This is in agreement with the crumb hardness: the softest was the crumb of the control sample and the hardest were those of the breads made with apples, plums and carrots (Table 1).

The penetrometer data are in agreement with sensory elasticity determined in the crumb; the samples with the highest elasticity score were the highest in the penetrometer number: the control sample (51.7) and bread made with plum (77.0). The lowest elasticity score was given for the bread made with carrots which was coupled with the lowest penetrometer number (37.7), as expected.

By comparing the results obtained for the bread made with 10% molasses and powders of osmotically dehydrated fruits and vegetables (Tab. 1), it was found that the number of chews was slightly increased in the majority of samples. However, apparent differences were found in elasticity of the samples; higher dose of added molasses-based ingredient lowered crumb elasticity.

Table 1. Texture parameters of breads supplemented with sugar beet molasses and pulverized fruit/vegetables treated by osmotic dehydration in molasses (R – evenness; F – crumb pore quality)

Tabela 1. Tekstura hlebova sa dodatkom melase šećerne repe i osmotski dehidriranog voća i povrća u prahu (R – ravnomernost; F – finoća)

Parameter		Bread types					
		Control	Supplements				
			Molasses (5%)	Osmodehydrated fruits and vegetables (5%)			
				Apple	Plum	Carrot	Cabbage
Crumb Chewiness (count)		20	16	20	18	17	20
Crumb Elasticity (score)		2.8	2.5	1.8	4.0	1.5	2.0
Crumb Porosity (score)	R	3.0	3.0	4.0	3.0	5.0	4.0
	F	3.0	2.8	2.0	2.2	2.2	1.5
Hardness according to W. B. (l.b.)	Crust	9.8	14.5	13.3	14.0	13.7	10.4
	Crumb	1.9	2.4	2.9	2.9	2.8	2.5
Crumb Penetrometer		51.7	40.0	46.0	77.0	37.7	51.0

Table 1a. Texture parameters of breads supplemented with sugar beet molasses and pulverized fruit/vegetables treated by osmotic dehydration in molasses (R – evenness; F – crumb pore quality)

Tabela 1a. Tekstura hlebova sa dodatkom melase šećerne repe i osmotski dehidriranog voća i povrća u prahu (R – ravnomernost; F – finoća)

Parameter		Bread types				
		Supplements				
		Molasses (10%)	Osmodehydrated fruits and vegetables (10%)			
			Apple	Plum	Carrot	Cabbage
Crumb Chuwiness (count)		18	20	19	19	20
Crumb Elasticity (score)		1.2	1.5	1.5	1.2	1.2
Crumb Porosity (score)	R	4.0	5.0	5.0	4.0	5.0
	F	2.0	1.5	1.5	1.5	1.5
Hardness according to W. B. (lb)	Crust	14.1	13.7	14.2	12.1	13.0
	Crumb	2.7	3.6	2.8	3.1	2.8
Crumb Penetrometer		28.3	36.3	42.0	35.0	41.7

Somewhat different was the crumb porosity; all samples received excellent porosity scores but the pore quality was much lower. The increase in the supplementation level did not affect instrumental firmness (Table 1.a). The crumb hardness was slightly increased which is consistent with the reduction in penetrometer value.

CONCLUSION

The breads supplemented with 5 and 10% of molasses or fruits/vegetables treated by osmotic dehydration in sugar beet molasses were found satisfactory regarding the texture attributes. According to the majority of parameters, the crust and crumb of the control sample appeared to be the softest. The bread samples at lower supplementation levels were similar to the control as compared to those with higher supplementation level.

The results pointed that the investigated supplements can be incorporated as an ingredient in bread without marked adverse changes in the texture.

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