Some methodological aspects of sensory measurement of textural characteristics*

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Rheological properties and texture of foods

Rheological properties of foodstuffs are of interest for food technologists for two main reasons:

1. because they are related to the processing conditions – it is true primarily for products under processing, and

2. because they are related to the quality of foods and can be used in quality control.

In this second aspect they are interesting and useful as far as they reflect sensory characteristics known under a common name of "texture"

Texture is a composite property. Undoubtely, it is related to viscosity, elasticity and other physical properties of foods, but the relationship is complex. There is no complete agreement about the definition of texture. According to *Matz* (9) texture can be defined as "mingled experience deriving from sensation of skin in the mouth after ingestion of food and beverage. It relates to density. viscosity, surface tension and other physical properties of the material being sampled." According to *Amerine, Pangborn* and *Roessler* (1) texture is defined as "complex properties of foodstuff aprehended both by eyes and by the skin and muscle senses in the mouth, embracing roughness, smoothness, graininess etc."

The complex nature of texture is stressed also by *Szczesniak* (11) She classified textural characteristics into mechanical and geometrical qualities and into properties related to moisture and fat content. The primary parameters of mechanical characteristics are: hardness, cohesiveness. viscosity, elasticity and adhesiveness; the secondary are: brittleness, chewiness and gumminess.

Kramer and *Twigg* (8) classified texture characteristics as finger feel firmness, softness or yielding quality and juiceness.

In Polish standardized terminology for sensory analysis (10) the texture is defined as "composite property of food, including cohesiveness among particles and its structure evaluated by kinesthetic and tactile senses and in some cases also visually, consisting of several elementary factors as hardness, elasticity, tenderness, juiceness, smoothness, fibrousity, viscosity and others depending on the kind of food being evaluated."

Although above definitions are different, they all stress the complexity of texture and point that it includes among others the tenderness and juiceness of food.

To explain this complexity let's re-call briefly the mechanism of tactile and kinesthetic sensory perception. As we know, specialized mechanoreceptors are

* A III. Nemzetközi Élelmiszeranalitikai Módszertani Szimpóziumon elhangzott előadá-adás. Szentendre 1975. október 8–11.

located in the skin and mucous membrane in oral cavity. By mechanical stimulation of the skin various tactile and kinesthetic sensations are initiated. Stimulation of mechanoreceptors arises as a result of pressure or deformation of the skin or other tissues (muscle fibers, joins). Mechanoreceptors are very sensitive and show a short time of reaction. For example, Pacinian corpuscules react on deformations of 0,5 um in 0,1 sec. The deformation is transferred through concentric layers of tissue divided by fluid layers to the center of corpuscule, where the free nerve ending is located. Mechanical energy is there transformed into information coded as electrical signal. As it is known, it is the only form of information which can be handled by nervous system.

The electrical impulses are then transported via nerve fibers to the reception centers in cerebral cortex. There are two main systems of transferring of coded impulses from the skin to the reception centers: it is the middle band and the pathway of medula oblongata and thalamus. The first one transfers tactile and kinesthetic signals, the second – pain and temperature signals. (2).

As in all nervous processes, transferring of signals is simultaneous with their transformation and integration, which take place on consecutive levels of sensory analysers. Therefore, informations arriving the cerebral cortex – which are the basis for decisions made in sensory evaluation – are synthetic, integrated, not direct and simple. One shall keep that in mind by developing or adapting methods for sensory evaluation of texture. One shall also remember, that it put some limitations on the possibility of correlation of sensory perceived textural characteristics and their instrumental counterparts.

Methods of sensory evaluation of foods

Let's look now briefly on sensory evaluation of texture from the point of view of psycho-physiological processes.

Evaluation of unknown sample is a comparison of its texture with the texture of similar product which memory pattern is stored in the gnostic regions of tactile and kinesthetic reception centers in the cortex. These patterns consist of complex perception of texture. Professor Konorski a worldfamous Polish neurophysiologist, who studied integration activity of the brain developed a concept of "gnostic units" – which says, that there is a special region of reception center in the cortex in which the patterns of perceptions are stored in separate gnostic units, like the informations stored in magnetic memory of computer. By sensory evaluation these pattern are re-called from the memory for comparison with evaluated sample.

Thus, by sensory evaluation of texture the primary tendency is the valuation of textural characteristics as a whole; it can be followed by the assessment of separate textural factors as hardness, fibrousness, scheweiness etc from which it is consisted.

One shall keep all above facts in mind when choosing or developing proper methods for sensory evaluation of rheological characteristics of food.

Generally, commonly used sensory methods applied for evaluation of flavour and taste can be also applied for texture evaluation: difference methods, scaling methods, sealing and special methods are the main groups to be mentioned.

Difference methods

The advantage of difference methods is their relative simplicity from psychological point of view. They can be used when judges are untrained, or product being evaluated not well known to them. Difference methods are applicable of course in the cases when more than one sample has to be evaluated; often one of two compared samples is the reference sample of standard texture. Two appro-

aches can be applied in differential methods: in classical methods as pair comparisons, triangle, due-trio only a fact of existence of difference between samples is noted. It is very simple task, easy and elegant in statistical treatment, but in many instances it is not sufficiently informative. In those cases when we are interested in the degree and direction of differences in texture of evaluated sample comparing with standard one – the method illustrated in Fig. 1. can be used.

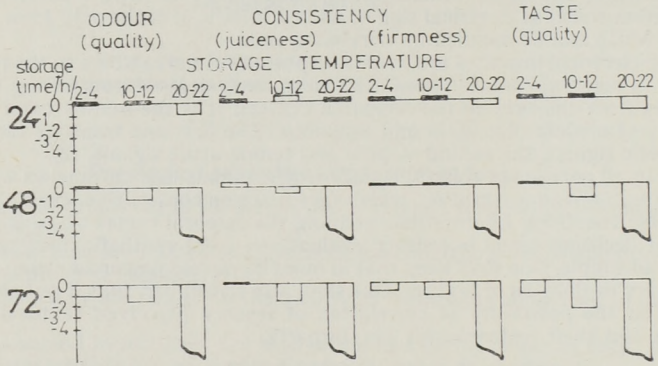

Fig. 1.
Changes in odour, consistency (juiciness, firmness) and taste of sliced carrot as a function of different time and temperature of storage. Changes have been measured comparing with fresh reference sample using the method of difference scaling

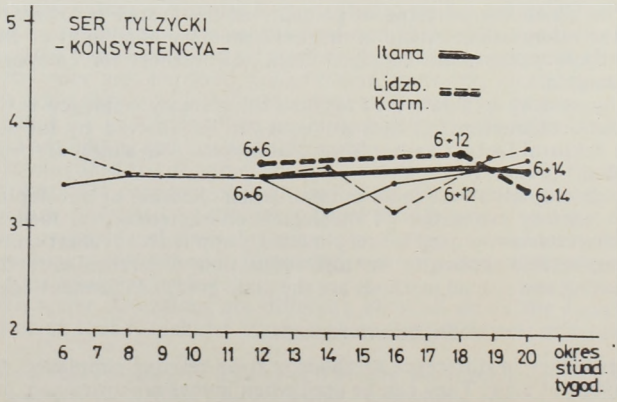

Fig. 2.
The consistency of fermented cheese (tilsit type) from two different processing plants, evaluated by 5-point scoring method. No significant differences due to time were observed

In this method the texture of unknown sample is compared with the standard one and degree as well as direction of difference noted. Among evaluated samples also the reference standard is usually included as unknown sample, what is a kind of internal control of the discrimination ability of the judges. In the example illustrated in fig. 1 the object of the study was fresh, sliced ready-to--use carrot stored at different temperature (6) Freshly prepared, (sliced just before evaluation) carrot served as reference. Besides texture also changes in odour and taste were evaluated.

Scoring methods

Scoring methods can be also applied for the evaluation of texture and its changes. But since the precision of the evaluation depends mainly on memory pattern of this, what shall be judged as "good" and "bad" – scoring is not very exact and can show some shifting in time.

The illustration of using above method for evaluation of textural properties in cheese is shown in fig. 2. It is taken from the study of influence of cheese storage by temp. of 5 °C and 15 °C on consistency of cheese (7). Two methods have been used parallel: scoring shown in the figure and differential (pair comparison) of cheeses stored the same time in both above mentioned temperatures. By scoring no changes were observed, as illustrated by fig. 2. by pair comparison quite distinctive better consistency showed cheeses stored at 5 °C.

Special methods

Studying more deeply complex feature called texture it is useful to evaluate separate elements or notes from which it is consisted. For this purpose a concept of sensory profiling developed originally in A. D. Little laboratories in early 1950-ties (3) calls for attention. In this method a sensory characteristic, as for example flavour or texture is separated on several single notes, which are evaluated for their quality, intensity and order of appearance.

		-4	-3	-2	-1	ref	+1	+2	+3	+4
TEXTURES	STICKY					X				
	COARSE					X				
	DRY					X				
	HARD					X				
*	OFF TASTE					X				
	aroma or perfume *					X				
	MILKY					X				
	SWEET					X				
	COCOA					X				
	ASTRING.					X				
	BITTER					X				
	ACID					X				

*: FRUITY FLOWERY HONEY SPICY LIQUORICE .... BISCUIT CAILLER VANILLA TOFFEE ....

×: RAW BRUNT SHARP CARDBOARD ..... COOKED .... METALLIC MOULDY JUTE ....

Fig. 3.
The evaluation sheet used in quality profiling according to Daget (4). Four texture characteristics are listed

Contemporary version of the method has been presented by Daget in 1974 for quality evaluation of chocolate of various brands. Most popular brand of chocolade was used as reference sample. (4).

The first and perhaps most important task in this method is choosing most important factors or notes which give whole sensory quality characteristics of tested product. Notes choosen for chocolate characterization and the example of sheet used in the study is given in fig. 3. The difference of tested sample from the reference one was evaluated for each of mentioned quality factors using twodirectional 4-point scale, easy convertuable into onedirectional 9-point scale.

The results obtained using this method show good session-to-session reproducibility what has been illustrated in fig. 4.

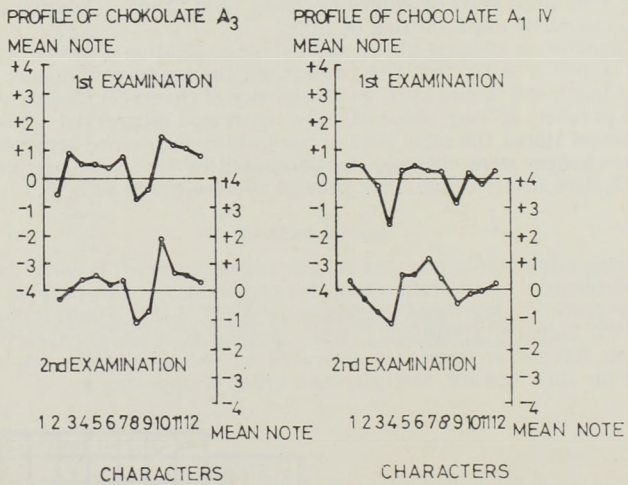

Fig. 4.
Reproducibility of quality profiling method. Note very similar pattern of results obtained in two separate assessment sessions

The precision of evalation of separate quality factors listed on the sheet was checked by assessing of reference sample versus identical one which showed very flat profile as given in the fig. 5.

The above method has been applied in our laboratory for detailed evaluation of textural characteristics of chicken meat, by studying the influence o: the method of cooling after slaugheering and freezing on the quality of chicken meat, taking as reference an unfrozen chicken meat, chilled in water. (5) Following texture characteristics notes were chosen for the evaluation: hardness, fibrousness, tenderness, and juiciness. They were evaluated using the same construction of the scale as shown on Fig. 4.

On the basis of results it can be stated that the combined influence of chilling and freezing is quite clearly pronounced. (5) The best results in tenderness and juiceness were obtained by quickly chilled and quickly frozen samples. The method gives generally more informations than simple scoring of whole consis-

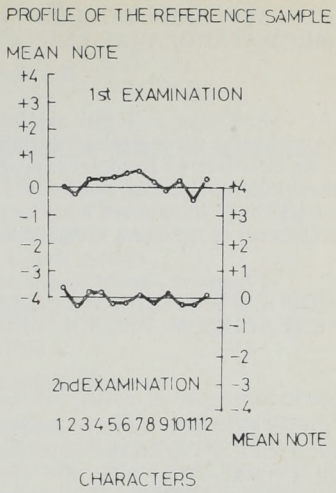

Fig. 5.
„Flat" characteristc of reference sample profiling (comparison of reference sample given as unkown with the same one given as a standard)

tency of chicken meat, although there is a definite correlation between those two methods.

Conclusions

Above presented examples show that the results of sensory evaluation of rheological properties of various foodstuffs depend to a great extent on the method used. It shall be kept in mind when studying correlation between instrumental and sensory characteristics of texture; the success or the failure of this kind of study is highly related to both, sensoryandinstrumental methodological aspects.

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ÉLELMISZEREK REOLÓGIAI SAJÁTSÁGAINAK ÉRZÉKSZERVI MEGHATÁROZÁVAL ÖSSZEFÜGGŐ MÓDSZERTANI KÉRDÉSEK

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Az élelmiszerek reológiai sajátságairól és szerkezetéről ad áttekintést, továbbá azokkal a nehézségekkel foglalkozik, melyek a pontos meghatározást nehezitik. Az élelmiszerek reológiai sajátságainak vizsgálatánál érzékszervi mérőmódszereket (különbségmérés, pontozásos értékelés és egyéb különleges módszerek) ir le, értékeli a felhasználási lehetőségeket és példákat mutat be. Röviden értékeli az érzékszervi és műszeres vizsgálatok közötti összefüggéseket is.

ВОПРОСЫ МЕТОДИКИ СВЯЗАННЫХ С ОРГАНОЛЕПТИЧЕСКИМ ОПРЕДЕЛЕНИЕМ РЕОЛОГИЧЕСКИХ ОСОБЕННОСТЕЙ ПИЩЕВЫХ ПРОДУКТОВ

Н. Барилко – Пикиелна

Автор передает обзор о комплексном характере реологических свойств, консистенции и структуре пищевых продуктов, о трудностях точной дефиниции (определении) понятий. Излагает методы сензорических измерений применимых для испытания реологических особенностей пищевых продуктов (измерения разницы, балловые и специальные способы). Критически оценивает их и на примерах ознакомляет их применение. Коротко занимается корреляцией между сензорическим и приборным измерением.

ÜBER MIT DER SENSORISCHEN BESTIMMUNG DER RHEOLOGISCHEN EIGENSCHAFTEN DER LEBENSMITTEL ZUSAMMENHÄNGENDE METHODOLOGISCHE PROBLEME

N. Barylko-Pikielna

Es wird eine Übersicht über die komplexe Natur der rheologischen Eigenschaften, Konsistenz und Struktur der Lebensmittel, ferner über die Schwierigkeiten der genauen Bestimmung der Begriffe gegeben. Die zur Untersuchung der rheologischen Eigenschaften der Lebensmittel verwendbaren sensorischen Messmethoden (Differenzmessung, auf Punktwertung fussende und spezielle Verfahren) werden beschrieben, dann kritisch ausgewertet und ihre Verwendungsgebiete durch Beispiele illustriert. Der Zusammenhang der sensorischen und instrumentalen Messungen wird kurz besprochen.