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UTILIZATION OF HOPPLER'S CONSISTOMETER FOR EXAMINATION OF RHEOLOGICAL PROPERTIES OF SOME MEAT PRODUCTS

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Determination of quality of food products through organoleptic examination has its disadvantages because of the physiologically conditioned subjectivity of an examiner. To remove these disadvantages of subjective evaluation respective apparatus for measurement of physical properties of food products have been constructed. Apparatus for measuring colour intensity and flavour, as well as those for determination of rheological properties of food products, are in usage or are being tested.

Rheological properties of food products are very important indicators of their quality and can be of great use for improving of production, as it was proved in the production of milk products. (5) Therefore, it is quite understandable why experts have taken an interest in rheological properties, especially in firmness of meat and meat products. (6) As it is known, there are several types of apparatus for determination of firmness of these products. (1,3,6,7,8)

Besides these apparatus the Höppler's consistometer is well known. This consistometer has some advantages of its own because it has parts necessary for measuring firmness, plasticity and elasticity, viscosity and quasiviscosity, so that it is possible to determine several rheological properties of an examined sample with the same apparatus.

Having these advantages of Höpplers's consistometer in view we have decided to examine the firmness and plasticity of

fat and of some semi-perishable and commercially sterilized canned meats.

Experimental

Materials and sampling

10 x 10 cm samples of back fat were taken from the sides, from 9 th to 12 th thoracic vertebrae, cutting through the whole thickness of fat.

Samples of canned pork loin, pressed ham and luncheon meat were taken out of the middle of cans by cutting slices about 2 cm thick.

The skin was removed from fat by a slicing machine. Than 10 mm thick pieces of upper and lower layer of fat were separately cut by the same slicing machine. For measurement of firmness from each of so prepared pieces six round pieces were cut by Ø 24 mm cork-borer, and the same number by Ø 13 mm cork-borer for measurement of plasticity.

Samples of canned meats, p.l.,p.h. and l.m. were prepared in the same way by cutting ten pieces from each sample,i.e. the same part of a can.

Before measuring these pieces were cooled to the temperature of + 10°C.

Methods

Firmness and plasticity were measured as instructions for work with Höppler's consistometer require (2), by means of weight of 250 g., for 1 min.

For calculation of firmness formula $F_k = \frac{4\,G}{T^2 \pi}$ kg/cm^2, was used, where G is weight in kg., and T a corrected depth in cm. of penetration of the consistometer needle. Plasticity was calculated as a percentage of decrease in the former height of a piece, using the formula: $Pl = \frac{h \times 100}{H}$ %, where H is the height of a piece and h decrease in height.

Quantity of lard of back fat was determined by the Gerber method, with babcock for cheese by van Gulik, taking 1 g.of sample, and multiplying by 3 the obtained value.

Results and discussion

F a t

The most typical results of the investigation of firmness and plasicity of 81 samples of back fat are given in Table 1.

The given results show that average values of firmness of layers of back fat vary within the limits of 0,570 to 2,254 kg/cm^2 (№ 4 and 2). The average value of firmness of upper layer of fat is greater in 58 or 71,6% of samples than that of the lower layer, minimum and maximum average firmness of examined samples are also greater in upper layers (0,763 and 2,254 kg/cm^2 - № 37 and 2) than in lower ones (0,570 and 2,130 kg/cm^2 - № 4 and 31).

Analysis of particular values for firmness of each sample shows that the maximum difference among these values is 1,835 (№ 66) and the minimum one 0,111kg/cm^2 (№ 28).

Analysis of results reveals that mean values for plasticity of upper layers vary from 1,48% to 19,2% (№ 29 and 7) and of lower ones from 1,29 to 18,73% (№ 29 and 80).

The results also indicate that the upper layer is more plastic and firm than the lower one in 45 samples or 55% of samples. It would be natural to expect that an increased amount of connective tissue will increase firmness and plasticity of fat. But our investigations do not confirm the assumption. Namely, the upper layer of fat is firmer than the lower one in 58 samples or 71,6% of samples, but the quantity of lard in the upper layer is less in 56 or 69,2% of samples. Then, only in 37 samples or 45,7% of samples of the upper layer of fat with greater firmness the quantity of lard is less than in the lower layer.

It should be noted that in 15 samples or 18,5% of samples the quantity of lard in both layers is equal; in 13 of these samples the upper layer is firmer.

Comparing plasticity of layers with quality of lard in them shows that plasticity is greater in a layer with less quantity of lard in 44 samples or 54,3% of samples.

We can assume, on the basis of these results, that firmness and plasticity are also influenced by consistency of lard in fatty tissue.

Results of measurements of firmness and plasticity of fat are influenced by varying temperatures of samples. However, to secure conditions which prevent warming of samples during measuring makes work more difficult.

Calculation of firmness by means of Höppler's formula requires much time. In order to simplify the procedure 10 first samples in Table 1 are simply expressed as penetration depth in mm. These values are shown in Table 2.

Comparison of the results expressed in kg/cm^2 and pene - tration in mm., reveals that these values stand in inverted proportion, i.e. when the firmness in kg/cm^2 is less, the depth of penetration is higher. This is logical because firmness calculated according to Höppler's formula is in inverted proportion to the square of penetration depth. This is the reason why the differences among values for firmness expressed in kg/cm^2 are by far greater in firmer samples where penetration depth is less, and vice versa.

Firmness expressed by penetration depth in mm. is seen directly on the measuring instrument of the apparatus, with exactitude of 0,005 mm. Therefore, the expression of firmness by penetration depth is much simpler and at the same time precise to a satisfying degree,

Pork loin

Results of investigation of firmness and plasticity of 18 cans of pork loin from 3 lots of production of cans are given in Table 3.

Analysis of the results reveals differences in firmness of various lots of production. These differences are also clearly shown by comparison of mean values which are:

for the first lot of production	(№ 1-6)	0,774 kg/cm^2
for the second " " "	(№ 7-12)	1,049 "
for the third " " "	(№ 13-18)	0,944 "

The minimum difference in values obtained by measuring one sample is 0,382 (№ 6) and maximum 1,182 kg/cm^2 (№ 12).

By comparing plasticity with firmness we cannot ascertain-that these values are corresponding.

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Pressed ham

Results of investigation of firmness and plasticity of 14 samples of cans of p.h. of various production are given in Table 4.

Analysis of these results shows that differences in firmness of samples of particular lots of production are similarly expressed as in the case of pork loin samples.

The minimum difference in values obtained by measurements of one sample is 0,311 (№ 8) and the maximum one 1,144 kg/cm^2 (№ 14).

Comparing the results of measurements of plasticity and firmness we cannot discover that they are corresponding.

Luncheon pork

Only firmness was measured in 11 samples of cans, produced in two different lots of production (Table 5).

The results show that differences obtained by measurement of one sample are by far less than the differences registered by measuring samples of fat and canned pork loin and pressed ham. The minimum difference in these samples is 0,043 (№ 3) and the maximum one 0,243 kg/cm^2 (№ 7).

The reason for that may be greater comminution of mass used for producing this canned products which enables better homogenization. (Very similar results were obtained in an earlier paper of ours where firmness of canned comminuted pork meat was also examined by means of the Höppler's consistometer (4). There we have found out that this apparatus can be

successfully used for determination of firmness of more comminuted canned meat.

Differences in firmness of samples of two lots of production are not expressed.

The results given in this paper show that values for firmness obtained by measurements of the same sample, differ among themselves in all kinds of products. This variation is certainly due to the difference in histological structure of tissue of the same sample. It is probable that with the greater number of measurements of one sample, which would include all variations of the structure of tissue, a constant average value would be obtained.

In order to see what number of measurements is necessary to do for determination of such value, respective investigations shoud be done.

Since it is necessary to do several measurements for the determination of firmness of each sample, the conversion of obtained values into kg/cm^2 requires a great deal of time. Therefore, this way of expressing values is not suitable for examination of a greater number of samples.

In earlier investigations we have ascertained that the results of measurement of firmness of fat are strongly influenced both by the smallest layer of skin, left over after the removal of skin, and by the left connective tissue among the layers of back fat. Therefore, it is better to measure the firmness of fat from the inner surface of lower layer which i recomended by Volovinskaja and Kel'man as well (8). If firmness of fat layers is measured separately, skin and connective tissue among layers should be thoroughly removed.

Analyzing irregularities in relation between firmness and plasticity, revealed in the course of examination of the material, it might be assumed that they are caused by technical mistakes during the work. Namely, the moment when the metal rod with weight touches the cylinder above a sample is marked by ear and therefore mistakes are possible. These mistakes must have an effect on the exactitude of results, especially in samples with greater plasticity. This disadvantage of the Höppler's apparatus may be removed by means of appropriate instrument which enables the rod with weight to touch the cylinder above a sample without pushing it down at the same time.

C o n c l u s i o n s

On the basis of the analysis of the results obtained by the described investigations it may be concluded that:

1) results obtained by 6 or 10 measurements of the same sample vary among themselves; these differences are the greatest in the case of back fat, less in the case of canned pork loin, still less in the case of canned pressed ham, the least in the case of canned luncheon pork.

2) degree of firmness of fat is influenced not only by the amount of connective tissue but probably also by the chemical composition of fat

3) calculation of firmness by means of Höppler's formula is a work requiring a good deal of time and therefore, it is not suitable for the examinations of a great number of samples.

4) firmness may be expressed in a simpler way by the penetration depth of the consistometer needle.

5) it is necessary to find out the minimum required number of measurements of the same sample to ensure the exactitude of average value for firmness and plasticity.

6) correspondance between results for firmness and plasticity has not been found out which is probably due to subjective mistakes in the course of measurements. of plasticity.

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RESULTS OF MEASUREMENT OF FIRMNESS, PLASTICITY AND PERCENTAGE OF LARD IN BACK FAT

Table 1

No of sample	Firmness in kg/cm²				Plasticity in %		Lard in %	
	Upper layer		Lower layer					
	Average value	Min. / Max.	Average value	Min. / Max.	Upper layer	Lower layer	Upper layer	Lower layer
2	2,254	1,799 / 2,554	1,262	0,765 / 1,778	8,75	8,61	87,0	90,0
4	0,949	0,753 / 1,168	0,570	0,497 / 0,755	11,76	15,80	91,0	91,5
7	0,777	0,636 / 0,899	0,900	0,757 / 1,048	19,20	8,48	96,0	97,5
28	0,791	0,751 / 0,862	0,911	0,709 / 1,080	4,92	7,33	94,5	93,0
29	1,811	1,419 / 2,361	2,011	1,349 / 2,620	1,48	1,29	97,5	97,5
31	1,870	1,482 / 2,456	2,130	1,337 / 2,852	2,03	1,85	94,5	97,5
37	0,763	0,663 / 0,911	0,903	0,720 / 1,076	2,63	1,99	96,0	97,5
66	1,602	1,382 / 1,932	1,412	0,884 / 2,719	2,61	1,73	94,5	97,5
80	1,422	1,080 / 1,738	1,119	0,821 / 1,634	17,03	18,73	96,0	96,0

SURVEY OF FIRMNESS OF BACK FAT IN KG/CM^2 AND IN DEPTH OF PENETRATION IN MM EXPRESSED COMPARATIVELY

Table 2

Nº of sample	Firmness of upper layer in kg/cm^2		Firmness of upper layer in mm of penetration		Firmness of lower layer in kg/cm^2		Firmness of lower layer in mm of penetration	
	Average value	Min. Max.	Average value	Min. Max.	Average value	Min. Max.	Average value	Min. Max.
1	0,777	0,636 0,899	6,66	5,95 7,34	0,900	0,757 1,048	5,98	5,51 6,48
2	0,949	0,753 1,168	5,83	5,22 6,50	0,570	0,497 0,755	7,49	6,49 8,00
3	1,151	0,884 1,359	5,31	4,84 6,00	1,417	1,052 2,626	4,93	3,48 5,50
4	1,235	1,048 1,682	4,95	4,35 5,30	1,258	1,000 1,746	4,76	4,27 5,31
5	1,347	1,064 1,492	4,89	4,62 5,47	1,240	0,946 1,593	4,97	4,29 5,80
6	1,398	0,997 1,885	4,87	4,11 5,65	0,988	0,744 1,331	5,78	4,88 6,54
7	1,408	0,930 1,864	4,79	4,20 5,85	0,860	0,682 1,036	6,13	5,54 6,83
8	1,479	1,015 1,714	4,69	4,31 5,60	1,283	1,004 1,651	5,05	4,39 5,63
9	1,626	1,080 2,540	4,56	3,54 5,43	1,303	1,209 1,522	4,95	4,57 5,13
10	2,254	1,979 2,554	3,97	3,53 4,61	1,262	0,765 1,778	5,22	4,23 6,45

RESULTS OF MEASUREMENTS OF FIRMNESS AND PLASTICITY OF CANNED PORK LOIN

Table 3

№ of sample	Firmness in kg/cm²		Firmness in mm of penetration		Plasticity in %
	Average value	Min. Max.	Average value	Min. Max.	/Average value/
1	0,517	0,317 0,861	8,79	5,97 10,02	21,48
2	0,689	0,542 1,044	6,69	5,52 7,60	8,58
3	0,798	0,655 1,108	6,39	5,36 7,07	11,92
4	0,805	0,586 1,068	6,35	5,46 7,37	7,56
5	0,887	0,589 1,321	6,75	4,90 7,35	7,09
6	0,949	0,800 1,182	5,83	5,19 6,31	7,69
7	0,847	0,650 1,636	6,01	4,41 7,06	9,17
8	0,988	0,727 1,268	5,76	4,99 6,62	6,57
9	1,005	0,736 1,150	5,68	5,26 6,58	8,02
10	1,064	0,753 1,448	5,56	4,63 6,53	6,33
11	1,085	0,864 1,417	5,47	4,74 6,20	7,47
12	1,207	0,807 1,989	5,26	4,00 6,28	5,73
13	0,832	0,606 1,177	6,39	5,20 8,09	15,41
14	0,869	0,669 1,273	6,12	5,00 6,90	9,98
15	0,957	0,669 1,186	5,86	5,23 6,91	9,26
16	1,000	0,523 1,441	5,64	4,70 7,80	7,54
17	1,000	0,705 1,133	5,68	5,35 6,72	8,21
18	1,004	0,779 1,299	5,69	4,95 6,39	7,24

RESULTS OF MEASUREMENT OF FIRMNESS AND PLASTICITY OF CANNED PRESSED HAM

Table 4

№ of sample	Firmness in kg/cm² — Average value	Firmness in kg/cm² — Min. / Max.	Firmness in mm of penetration — Average value	Firmness in mm of penetration — Min. / Max.	Plasticity in % /Average value/
1	0,806	0,612 1,060	6,26	5,48 7,21	8,83
2	0,849	0,650 1,168	6,21	5,22 7,00	12,10
3	0,873	0,697 1,052	6,08	5,40 6,76	11,40
4	0,778	0,501 1,168	6,68	4,78 8,34	7,09
5	0,790	0,595 0,969	6,45	5,73 7,31	8,49
6	0,796	0,663 1,141	6,43	5,28 8,33	6,22
7	0,864	0,674 1,015	6,17	4,60 6,87	8,35
8	0,899	0,729 1,040	5,99	5,53 6,61	4,76
9	0,956	0,644 1,142	5,91	4,50 7,03	9,25
10	0,974	0,680 1,163	5,65	4,47 6,84	9,05
11	1,109	0,924 1,299	5,38	4,95 5,87	3,80
12	1,136	0,997 1,364	5,31	4,83 5,65	
13	1,324	0,820 1,824	4,99	4,18 6,23	7,32
14	1,329	0,714 1,858	5,02	4,14 6,68	4,01

RESULTS OF MEASUREMENT OF FIRMNESS OF CANNED LUNCHEON PORK

Table 5

Nº of sample	Firmness in kg/cm²		Firmness in mm of penetration	
	Average value	Min. Max.	Average value	Min. Max.
1	0,518	0,496 0,594	7,84	7,61 8,01
2	0,562	0,516 0,608	7,54	7,24 7,85
3	0,571	0,551 0,594	7,47	7,32 7,60
4	0,577	0,521 0,623	7,44	7,15 7,81
5	0,581	0,528 0,614	7,41	7,20 7,76
6	0,606	0,579 0,641	7,25	7,05 7,41
7	0,768	0,641 0,884	6,47	6,00 7,05
8	0,591	0,530 0,628	7,34	7,12 7,75
9	0,690	0,576 0,754	6,81	6,49 7,44
10	0,729	0,639 0,823	6,66	6,22 7,18
11	0,744	0,619 0,810	6,56	6,24 7,17

ИСПОЛЬЗОВАНИЕ ХЕППЛЕРОВОГО КОНСИСТОМЕТРА ДЛЯ ИССЛЕДОВАНИЯ РЕОЛОГИЧЕСКИХ КАЧЕСТВ НЕКОТОРЫХ МЯСНЫХ ИЗДЕЛИЙ

С.Рахелич, Р.Реде, Е.Николич

Авторы публикуют в этом труде результаты исследования плотности и пластичности при помощи Хепплерового консистометра 81-ого образцов спинного шпика, 18-и образцов консерв кореики, 14-и образцов консерв спрессованной ветчины / pressed ham / и плотности 11-и образцов консерв свинины рубленной.

Плотность и пластичность шпика определяли на основании 6-и измерении каждого образца, а у остальных пересмотренных изделии на основании 10-и измерении образцов.

В настоящем труде изображены подготовка образцов и техника исследования.

Авторы указывают подводя итог, что а/ результаты полученные при 6-и т.е. 10-и измерениях того-же самого образца между собои различны.

Самая большая разница отмечена у шпика, меньшая разница в консерве кореики, еще меньшая в консерве спрессованной ветчины, а самая маленькая в консерве свинины рубленной.

Они считают что на плотность шпика б/ не влияет только количество соединительной ткани, а вероятно, хемическии состав жира в этои ткани.

Расценивая удобство применения Хепплерового поступка для определения плотности, авторы приходят к заключению, что в/ высчитывание плотности по данной формуле является длительным трудом и потому не может быть применен при пересмотре большего числа образцов.

Наоборот, г/ определение плотности на основании глубины пенетрации иглы в мм. гораздо проще и достаточно точное.

Затем, авторы предлагают д/ необходимо определить самое меньшее число измерении того-же самого образца, которое обеспечивает точность средней величины плотности и пластичности.

И в конце отмечают что е/ не определено соответствие между результатом плотности и пластичности, что оказывается вероятно последствие субъективных ошибок при определении пластичности.

UTILISATION DU CONSISTOMÈTRE PAR HÖPPLER POUR EXAMINER LES PROPRETÉS RHEOLOGIQUES DE CERTAINS PRODUITS DE VIANDE

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SOMMAIRE

Dans ce travail les auteurs publient les résultats d´exploration de la fermeté et plasticité au moyen de consistomètre par Höppler, de 81 échantillons du lard dorsal, 18 échantillons de conserves de pork loin, 14 échantillons de pressed ham et la fermeté de 11 échantillons de conserve de luncheon pork.

La fermeté et la plasticité du lard furent détérminées à base de six épreuves du même échantillon et chez les autres produits examinés à base de dix épreuves. Dans ce travail on a décrit la prise et la préparation de ces échantillons, ainsi que la technique de l´exploration.

L´analyse des résultats a permis aux auteurs de constater (a) que les valeurs obtenues par six ou dix épreuves diffèrent. La plus grande différence est constatée chez le lard, elle etait moindre chez les conserves de pork loin, encore moindre chez les conserves de pressed ham et la moindre chez les conserves de luncheon pork. On présume que ce n´est pas seulement la quantité de tissu connectif qui a une influence sur la fermeté du lard (b) mais aussi, probablement, la composition chimique de graisse dans ce tissu . Evaluant la méthode de Höppler, on a conclus (c) que le calcul de la fermeté d´après cette formule est un travail long et on ne peut pas l´appliquer en cas d´examination d´un plus grand nombre d´échantillons. Par contre, exprimer la fermeté par la profondeur de pénétration d´aiguille en mm, est plus simple et quand même suffisamment précis.

Les auteurs proposent de détérminer le moindre nombre d'épreuves necessaires d'un échantillon pour assurer l'exactitude d'une valeur moyenne de fermeté et de plasicité. A la fin ils soulignent qu'on n'a pas constaté la corrélation entre les résultats d'exploration de la fermté et de plasticité, ce qui est probablement la consequence des fautes subjectives à la détérmination de la plasticité.

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ANWENDUNG DES KONSISTOMETERS NACH HÖPPLER ZUR PRÜFUNG DER RHEOLOGISCHEN EIGENSCHAFTEN GEWISSER FLEISCHPRODUKTE.

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Zusammenfassung

Die Autoren veröffentlichen in diesen Versuchsarbeiten die Prüfungsresultate auf Festigkeit und Plastizitat mit dem Höppler'schen Konsistometer von 81 Mustern Rückenspeck, 18 Mustern Konserven Pork Loin, 14 Mustern Pressed Ham und die Festigkeit von 11 Mustern - Konserven Lunchen Pork. Die Festigkeit und Plastizität wurde auf Grund 6-maliger Abmessungen eines jeden Musters festgestellt, und bei den sonstigen überprüften Erzeugnissen, auf Grund 10-maliger Abmessungen der Muster, - In der Prüfungsarbeit wurde die Entnahme und Vorbereitung der Muster, so sowie die Untersuchungstechnik beschrieben.

Durch die Analysierung der Resultate haben die Autoren festgestellt /a/ dass die Werte gelegentlich der 6. beziehungsweise 10. Abmessungen desselben Musters, sich untereinander unterscheiden. Die grössten Differenzen sind beim Speck festgestellt worden, beim Konserven Pork Loin weniger, bei den Konserven Pressed Ham noch weniger und die wenigsten Unterschiede bei den Konserven Lunchen Pork. Bezüglich der Festigkeit des Specks, ist man der Ansicht /b/, dass hier nicht nur die Menge das Bindegewebe einen Einfluss haben, sondern wahrscheinlich auch die chemische Zusammensetzung des Fettes in diesem Stoff. Bei der Beurteilung der Zweckmässigkeit des Höppler'schen Verfahrens zur Bestimmung der Festigkeit, wird abgesshlossen /c/, dass die Berechnung der Festigkeit, laut den gegebenen Formeln eine zu langandauernde

Arbeit ist und dass es deshalb bei der Überprüfung einer grösseren Anzahl von Mustern nicht angewendet werden kann. Hingegen /d/ ist die Festsetzung der Festigkeit durch Einstich beziehungsweise Eindringen in die Tiefe mit der Nadel in mm, viel einfacher und genügend präzis. Ausserdem schlagen die Autoren als notwendig vor /e/ die kleinste erforderliche Anzahl von Abmessungen desselben Musters festzusetzen, wodurch ein genauer Durchschnittswert der Festigkeit und Plastizität sichergestellt werden könnte.

Zum Schluss wird die Meinung geäussert /f/, dass die Uebereinstimmung zwischen den Resultaten der Festigkeit und Plastizität nicht festgestellt wurde, was ja wahrscheinlich auch die Folge der subjektiven Fehler bei der Bestimmung der Plastizität, ist.