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SEVENTH MEETING OF EUROPEAN MEAT RESEARCH WORKERS

WARSZAWA, SEPTEMBER 18th to 22nd, 1961

RELATIONSHIP BETWEEN ORGANOLEPTIC AND OBJECTIVE METHODS FOR THE EVALUATION OF CANNED HAM QUALITY"

by

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Relationship between organoleptic and objective methods for the evaluation of canned ham quality.

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The problem of objectification of organoleptic estimates has,since many years,been studied by numerous research workers/centers/.A statement issued on basis of objective,instrumental investigations is an important supplement to organoleptic estimates.Methods where instruments are used eliminate the human factor and provide results,which are free from any conscious or subconscious aperception.The main advantage of these methods is reproducibility of results obtained from estimating in identifical samples under conditions, which would be liable to influence the accuracy of the organoleptic estimations.

The elaboration of adequate physical and chemical determinations which would properly reflected the organoleptic quality is both difficult and complex.The procedure is such,that physical or chemical measurements are performed on the individual properties of the pro-

duct and their correlation is investigated parallel with organoleptic estimations carried out on the same material.The compliance with results of organoleptic evaluations is decisive with regard to the utility of the given instrumental method.The organoleptic evaluation serves as a reference scale for the determining of the respective instruments.It is therefore very important,when performing this kind of work,to use an exact and reproducible working panel.

The problem of objectification of organoleptic assessment is especially actual with regard to the quality evaluation of canned ham.

Ham is one of the most complex and difficult products to evaluate.It is composed of a number of muscles destined to accomplish various functional tasks. The chemical and histological composition of the muscles in a living organism varies in reason of the different functions they are called to perform.Less mobile muscles contain a smaller amount of connective tissue and,at the same time,they are marked by a larger quantity of interstitial fat.These muscles,when it comes to estimating a canned ham,are far more tender and succulent. On the other hand groups of more mobile muscles,such as for example m.quadriceps femoris are far more supple, less tender principally because of their higher content of connective tissue.

In this way when estimating a product featuring such a wide variety of properties the respective method must be extremely accurate so as to provide results ,which are reliable and may be compared.

In practice,methods employed for estimating hams are,as a rule,celected optionally.Discrepant results may be also observed on the part of persons examining one and the same product.This fact has been already pointed out in 1950 by Tilgner and Osińska /1/ and since that time,only small progress has been noted in this domain.

According to these authors discrepancies of this kind are the outcome of methods of procedure where,among others,morphological differences occuring in the different group of muscles and their varying quality,as well as the individual characteristics of persons performing the tests are often underrated.On the basis of performed investigations the authors found significant differences in texture,tenderness,succulence and saltiness between the different parts of the ham /muculus semimembranaceus,m.biceps femoris,m.quadriceps femoris/.

This is the reason why the scoring system for hams suggested by Tilgner/2/ and including 23 quality factors of a commercial,technological and organoleptic character precisely determined which part of the

ham should form a basis for evaluating each quality factors.The system has been adopted and is employed in research centres occupied in studying the quality of hams.

The Tilgner system allows to evaluate the quality of the ham with far higher accuracy than it happened under currently employed methods.

The next step in the direction of attaining high accuracy is the elaboration of objective /instrumental/ indices with regard to the quality factors of the ham. A procedure of this kind will allow to determine boundary values i.e.values which express the critical character of the particular quality determining property which occurs in the particular quality classes of the product.

Among the various properties which together build up the general quality of the ham,the most important are: colour,bounding,flavour,succulence and tenderness.

A character note of colour is the subject of separately conducted research and is discussed in numerous papers /3,4,5/.

Bounding means the compactness of a slice of ham of definitive thickness.A technologically satisfactory product should feature good bounding and a lack of splits and gaps.In no case may a slice of ham fall to pieces.The degree of bounding is a very important property from the commercial standpoints as ham is mostly

sold sliced in small packages.

So far no mention is made in literature on any objective method for estimating the bounding in hams. It seems that the measure of good bounding is the force required for rupturing a slice of ham of definite thickness.

The notion of odour includes all olfactory effects. These effects are, as a rule, determined by descriptive terms and so far no possibilities have been found to exist for their precise determination.

The term of succulence is understood as the first impression received at the first chew of the sample. This sensation fades if the external fatty tissue has not been removed. Even very small quantities of fatty tissue in a sample of ham prevent a correct sensory determination of succulence/1/.

The necessity of comprehending the first quantitative impression of succulence received by the judge is of primary importance. Impressions of the degree of succulence fade when the meat has a definite fat content or is pickled as in the case of ham, because of the influence of other factors such as flavour and saltiness causing an increased exsudation of saliva which creates an impression of apparent succulence and at that time it is already very difficult to determine the differences/2/.

It is actually this first impression of succulence which should form a basis for a comparison with objective methods employed in measuring this property.

A method currently employed for measuring succulence consists in determining the quantity of juice squeezed out of the meat tussue under a determined pressure and constant time in the laboratory Carver press /6,7/. There exist also modifications of the Grau and Hamm filter paper methods initially developed for determining the water-binding capacity of raw meat /8,9/.

Tenderness consists of the resistance offered by the meat tissue to chewing. The smaller this resistance i.e. the smaller the effort required to chew the tissue the higher the degree of tenderness /2/. Tenderness is related in a considerable degree to succulence. It has been proved when comparing succulence and tenderness of hams pasteurized under different methods that a higher degree of succulence and tenderness are found in hams psteurized slowly i.e. under gradually rising temperatures and with the maximum temperature to which the ham centre is exposed not exceeding 68° C /10/

Significant differences in the degree of tenderness of the particular groups of ham muscles/1/ has been also demonstrated. The quadriceps femoris is the most tender portion of the ham, the biceps femoris on the other hand is the toughest.

There is a wide range of instruments used for the estimation of tenderness among which we have the Warner-Bratzler shearometer, the Christel texturemeter, the Höppler consistometer, the Tilgner penetrometer, the Hamilton-Beach food grinder and recently the Kramer shear press /11,12,13,14/. Results of measurements, however, conducted with these instruments do not always show satisfactory correlation with organoleptic evaluations /15/. A unified method for measuring tenderness is lacking what is the reason why almost every research centre works with different instruments and the issued results consequently cannot be compared. With the Kramer shear press an improvement in this regard may be expected /16/.

It is very important that always the same part of ham is used for conducting organoleptic and instrumental estimations of succulence and tenderness. A correct determination of the difference in tenderness between the hams can only be conducted on morphologically uniform samples.

Each of these properties should be estimated on a part of the ham where the intensity of the particular property is the least. Thus succulence should be determined on musc. semimembranaceus which displays the lowest degree of succulence, while tenderness should be estimated on the biceps femoris as the toughest part

of the ham.

Flavour is composite oral impression received under the influence of olfactory and taste stimulants.

The flavour of canned ham has been determined by the 5-point score method,under which the quality is conventionally expressed.For the time being there exists no physical or chemical method capable of estimating flavour/2/.The authors tried to establish objective indices for some of the afore-mentioned quality factors in canned ham.

Experimental procedure.

The material used for investigations consisted of hams processed under the standard method /curing,dripping,smoking and canning/ and pasteurized uniformly at temperatures of 100/72° C.

Ready hams after 6 weeks storage in cold stores were subjected to a detailed analysis of partial and total quality by a panel employing the 5-point score method/2/.

Instrumental determination of bounding,tenderness and succulence were conducted parallel on the same material.

. Bounding was measured with a very simple apparatus shown on Diagram I.,consisting of a tripod with a limb fitted with a jaw clamp holding the slice of ham always

of 3 mm uniform thickness.The bottom part of the slice is lightly held in another jaw clamp,capable of being loaded.Measurements were carried out under a successively increasing load:30g-50g-80g-100g-130g 150g-180g-200g until rupturing occurred.Time of action of each load was 30 seconds.

The bounding strength is expressed by the force required for rupturing a 3 mm thick slice of ham under the aforesaid conditions with the ham at 16-18°C.

Succulence was also determined on the m.membranaceus at that portion of the ham where this feature is lowest.

Measurements were carried out under two methods:

1.-in the laboratory Carver press

2.-in the Błaszkiewicz-Bykowski apparatus.

Succulence determined in the Carver press consists in assaying the quatity of meat juice squeezed out of a 20 g sample of ham,desintegrated beforehand under the pressure of 3000 lbs/sq.inch/210 kg/sq.cm./ during 5 minutes.This property is expressed by the quantity of juice in weight per cents of the sample.

In the Błaszkiewicz-Bykowski apparatus succulence is determined by measuring the quantity of juice absorbed by filter paper /VEB No.388/ under a constant difference of pressure /0,4 atm/.on a given surface /28,23 sq.cm/.and during a determined period/40 sec/.

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The result is expressed in miligrams of meat juice absorbed by the filter paper.

Measurements were also carried out on the biceps femoris.

Tenderness was determined in two ways:

1.-with the Höppler consistometer

2.-with the Tilgner penetrometer.

The principle of measurements carried out with the Höppler consistometer consists in determining the depth /expressed in milimeters/ to which a steel pin penetrates into the sample under a constant load of 250 g at room temperature.

A wedge-shaped pin was used of the following characteristics:

- blade thickness	0,12 mm
- blade width	6.00 mm
- wedge angle	20°

The measurement of tenderness performed with the Tilgner penetrometer consists in determining the force /in g/ required for puncturing a 9 mm thick sample at room temperature.The force is applied continuously to the penetrating pin/a stream of water of flow rate 41 G/sec/.

Tests were also carried out with three differently shaped pins for the purpose of selecting the best:

I. Flat-sheared pin of 1,5 sq.mm.

II. Wedge-shaped pin measuring:

- blade thickness 0,3 mm
- blade width 4,0 mm
- wedge angle 20° 6

III. Wedge-shaped pin measurings:

- blade thickness 0,12 mm
- blade width 4,0 mm
- wedge angle 20°

Finally the correlation between the individual measurements and the organoleptic determinations the three investigated factors were calculated /17/.

Regression next calculated for measurements proved a suitably high correlation.

Results and discussion.

Table 1 displays the results of the aforesaid investigations, which prove a certain relationship between part of the instrumental and organoleptic determinations. An especially high correlation at the level of significance =0.01 and 0.001 proved the measurement of the bounding strength in a slice of ham and by the measurement of tenderness carried out with the Höppler consistometer using pin III and with the Tilgner penetrometer using pins I and II.

An objective measurement of the bounding strength by determining the force required for rupturing a 3 mm

thick slice of ham appeared to be actually co-dependent of the organoleptic determination of this property in accordance with the 5-point score method.

Diagram I presents the line of regression for bounding upon which are plotted the various magnitudes of forces required for rupturing the slice corresponding to various degrees of organoleptically determined boundings /very good,good,sufficient,insufficient,bad/.The graph proves that the rupturing force ranges from 28 g for unsatisfactorily bounded hams /1 point in organoleptic estimation according to the 5-point scale/,to 192 g for hams where the bounding is good /5 points/.

/Table I attached at the end of the papaer/.

A significant variation of this kind in the instrumental values makes a precise determination of differences in the degree of bounding possible and to measure it in a uniform objective manner.In this way optional estimation of bounding might be avoided.

The determination of succulence by way of the Carver press proves only a slight relationship with organoleptic evaluations/the level of significance =0.1/.This low correlation is probably due-among others-to a lack of sufficient experience of panel members.As it has been mentioned before the organoleptic assessment of succulence is an especially difficult test,because of it being necessary to compre-

hend the first impression of succulence prior to the appeareance of other factors,which tend to dispel or entirely obliterate this impression/1/.An analysis of organoleptic notes proves that actually those of succulence show the highest degree of disparity.

Consequently prior to starting any new investigation the panel should pass a course of specialized training in evaluating succulence,for the purpose of obtaining more uniform and convergent results.In this way one of the sources of variability would be eliminated or else considerably reduced.

Measurements of succulence carried out with the Błaszkiewicz-Bykowski apparatus proved a complete lack of relationship to organoleptic evaluations.

In order to determine an objective method for measuring tenderness correlated optimally with the organoleptic evaluations series of measurements were performed with the Höppler consistometer using a wedge-shaped carving pin and with the Tilgner penetrometer with three types of pins:flat-cut/cylindrical/ and two wedge-shaped pins of different dimensions.

Results proved that both measuerements performed with the consistometer and penetrometer using pins I and II show a correlation with organoleptic determinations on the level of significance α =0.01 and higher.Graphs 2,3 and 4 present the straight li-

ne of regression for consistometric and penetrometric measurements performed with pins I and II.The preliminarily determined boundary values for the various levels of organoleptic quality are the following:

TABLE II.

The boundary values for the various levels of organoleptic quality.

Objective measurement method	Degree of tenderness determined under the 5-point scale				
	/v.good/ 5	/good/ 4	/suff./ 3	/insuff./ 2	/bad/ 1
Höppler consistometer/wedge-pin II/mm	7,22	6,40	5,06	3,76	2,44
Tilgner penetrometer/cylindrical pin I/g	598	506	415	323	231
Tilgner penetrometer/wedge-pin II/ g	1268	1067	866	666	465

It is an interesting fact that the highest correlation with organoleptic character notes were proved by penetrometric measurements performed with pins with blunt profile /blade 0,3 mm/ a pin whose shape most approaches that of a tooth.A certain difficulty accompanying this kind of measurement is the necessity of applying a relatively high puncturing force/as far as 1300 G/ tending thus to somewhat prolong the time of determination,but the final results show a greater uniformity.

Discussion.

Results of investigations presented above provide preliminary objective indices for the three selected properties of organoleptic quality of pasteurized hams and indicate which methods are best suited for further investigations.

It would be necessary,however,to to conduct a new series of analogous determinations on a matter presenting a wide and more varied range of quality before their final establishment.

Another very important problem in the light of the aforesaid investigations is the degree of accuracy and repeatability of results of panel assessments.Since the determination of organoleptic properties carried out by the panel is treated as reference data ,it is especially important that this evaluation be as accurate and precise as possible.It is conditioned by the qualifications of the panel members,their experience and ability as well as the degree of interest they bear in their work and their capacity to concentrate when performing the determinations,finally by external conditions /suitable laboratory,individual work cabines/.

When the work described in this paper was being carried out,the environment corresponded to usual conditions of modern laboratories/2/,but on the other hand the experience,ability to concentrate and the interest

borne by the panel members for the evaluation was rather inadequate,what was proved by the difference in the individual results.This is a fact which no doubt did not remain without influence and proved detrimental to results.It was also proved that the number of ham samples investigated during a single session had a big influence on the precision of results.An example of this are the organoleptic determinations of the tenderness of the ham carried out for determining correlation between determinations of tenderness performed with the Höppler consistometer.The same group/panel members/carried out these evaluations twice and for the first series of evaluations at a single session the members were given 2-3 pairs of samples /4-6 hams/,while during the second 6 pairs /12 hams/,Results are presented on the following table.

TABLE III.

Correlation between organoleptic assessment of tenderness and measurements performed on the Höppler consistometer by different number of evaluated samples.

Series of dtermination number of evaluated ham samples	Number of individual notes	Correlation coefficient with determinations performed with the Höppler consistometer	
		Empirical	Theoretical
1-st series 4-6 ham samples	25	0,5013	0,4969 x/
2-nd series 12 ham samples	29	0,388	0,3620 xx/

x/ on the level of significance = 0.01
xx/ on the level of significance = 0.05

It appears from the above data that an increased number of samples supplied for organoleptic evaluation during a single session under identical working conditions resulted in a decrease in the degree of correlation between organoleptic notes and instrumental results.

It may be assumed that this decrease is due to increased variation in the results of organoleptic evaluations.

This effect points to the necessity of observing strictly similar conditions of work carrying out estimations of a similar type.

The interpretation of obtained results is a separate problem that the values of the correlation coefficient /r/allow to replace organoleptic evaluations by instrumental measurements.It is a subject dealt with by Kramer/18/.Beside the correlation coefficient Kramer introduces the value of the determination coefficient/the square of the correlation coefficient -r^2/.Kramer is of the opinion that an objective method can only be useful in cases when the coefficient of correlation with organoleptic estimations is higher than 0,8 meaning that the coefficient of determination may not be smaller than 0,64 /18/.

The advantage of the determination coefficient consists in the facility of its interpretation,which is far higher than that of the correlation coefficient.

/r/It seems however, that the correlation coefficient /r/ is a far more correct measure of the correlation between the two methods of determination.

It is obvious that a higher coefficient of correlation denotes a closer relationship between two variables, however the stipulation that the coefficient of correlation has to exceed the determined boundary /0,8/ does not seem to be statistically justified, The proving of the significance of the correlation coefficient allows to compute the coefficient of regression and to determine the straight line of regression/17/. It is this procedure which was adopted in the present work.

The procedure in question seems to be justified in preliminary work on finding a method satisfactorily correlated with organoleptic assessments.

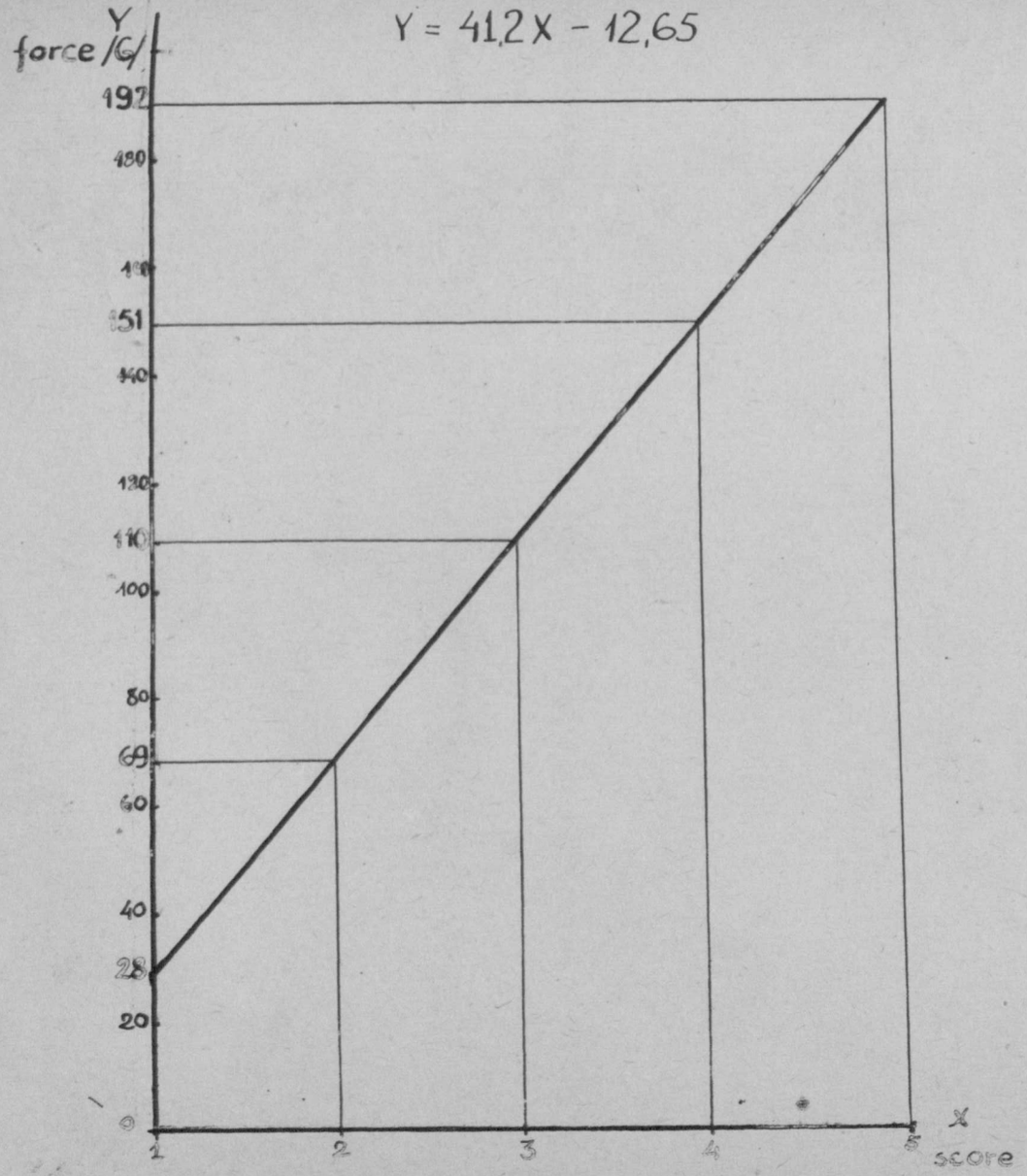
The next stage of work should consist in a detailed investigation of the selected methods/taking into account different parameters of measurement such as the type of the pin, magnitude of the operating force, time of measurement etc/. using the organoleptic evaluation as a reference measure with all sources of variability eliminated as afar as possible.

Table I. Correlation and regression of objective measurements and organoleptic evaluations of bounding, succulence and tenderness of pasteurized hams.

Quality factors	Method of determination	Degrees of freedom/n/	Coeficient of correl. /r/ empiric.	theoretic.	Coeef. of regression	The equation of a regress. line
Bounding	Rupture by loading/g/	54	+0,396	0,3541 xx	41,2236	Y=41,2235X-12,65
Tenderness	Höppler consistometer/penetration in mm/	24	+0,5013	0,4969 xx	1,32	Y=1,32x-1,125
Tenderness	Höppler consistometer pin penetration in mm	28	+0,388	0,3620 xxx	-	-
Tenderness	Tilgner penetromeeter pin I /g/1.5 sq.mm	24	-0,5966	0,5974 xxxx	-91,52	Y=-91,52X+689,3
	pin II /g/ wedge/0,3mm -20°/	24	-0,6571	0,5974 xxxx	-200,61	Y=-200,61 X+1458,45
	pin III/g/wedge/0,12mm 20°/	28	-0,314	0,3069 x	-	---------
Succulence	Carver press/% of squeezed juice under standard conditions/	24	+0,355	0,3306 x	-	----------
Succulence	Bykowski apparatus /mg of squeezed meat juice under standard conditions/	24	+0,238	0,3306 x	--	----------

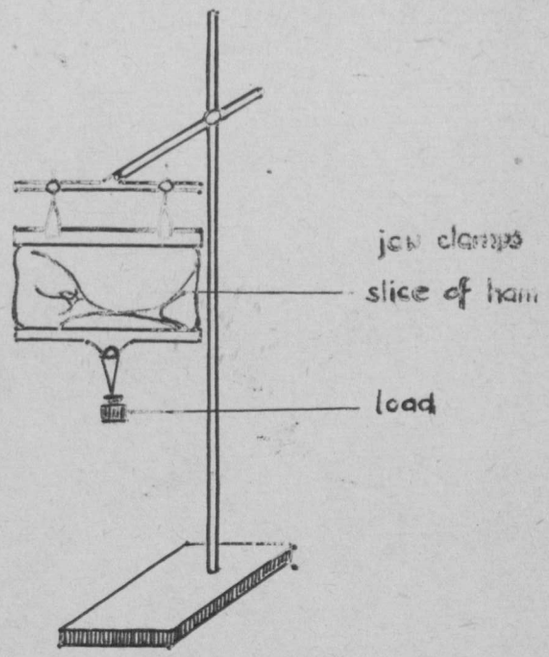
x - significance on level 0,1
xx- " " " 0,01
xxx- " " " 0,05
xxxx- " " " 0,001

Relationship between determinations of bounding by the organoleptic evaluation /X/ and an instrumental method



Diagr. 1

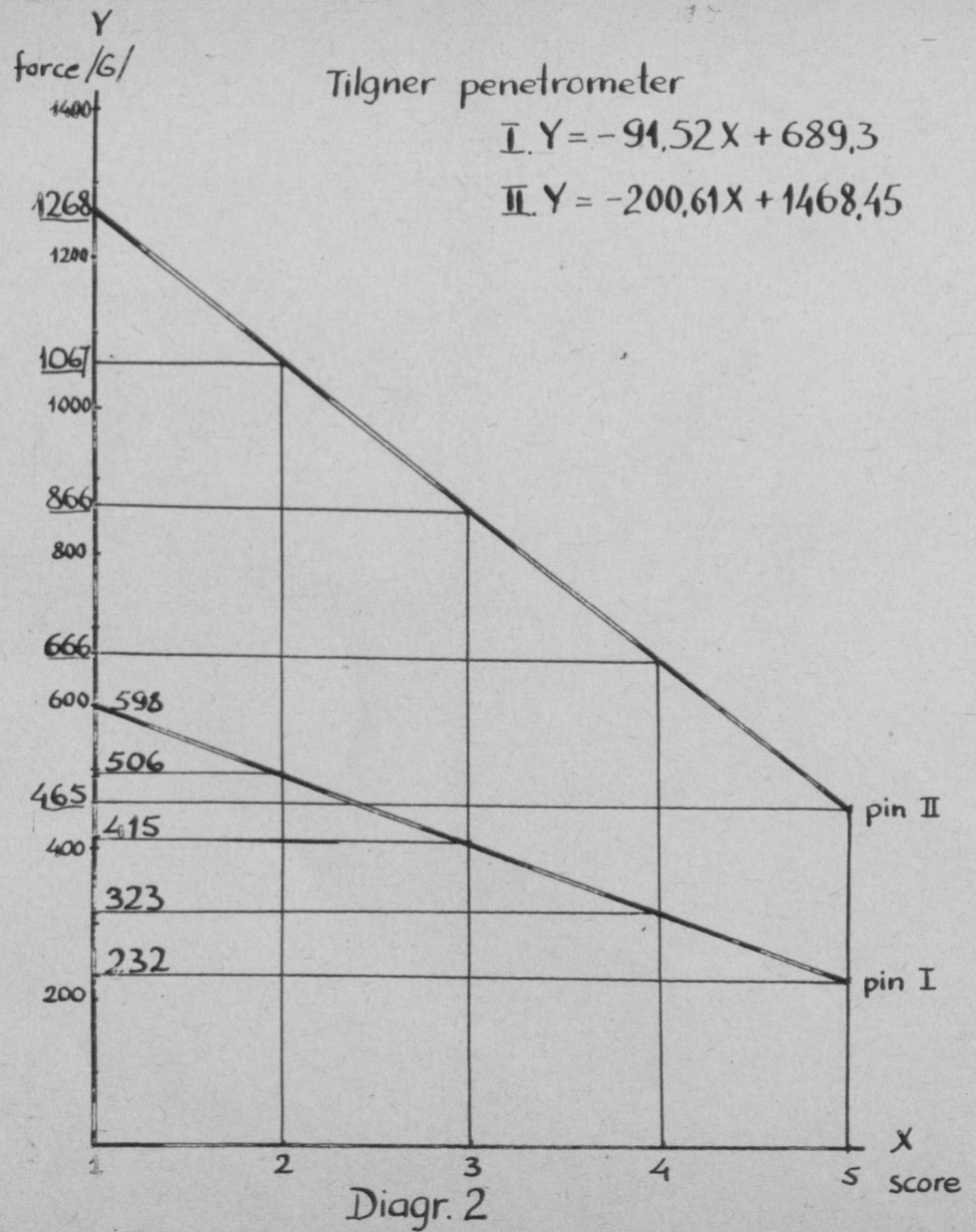
Fig. 1.



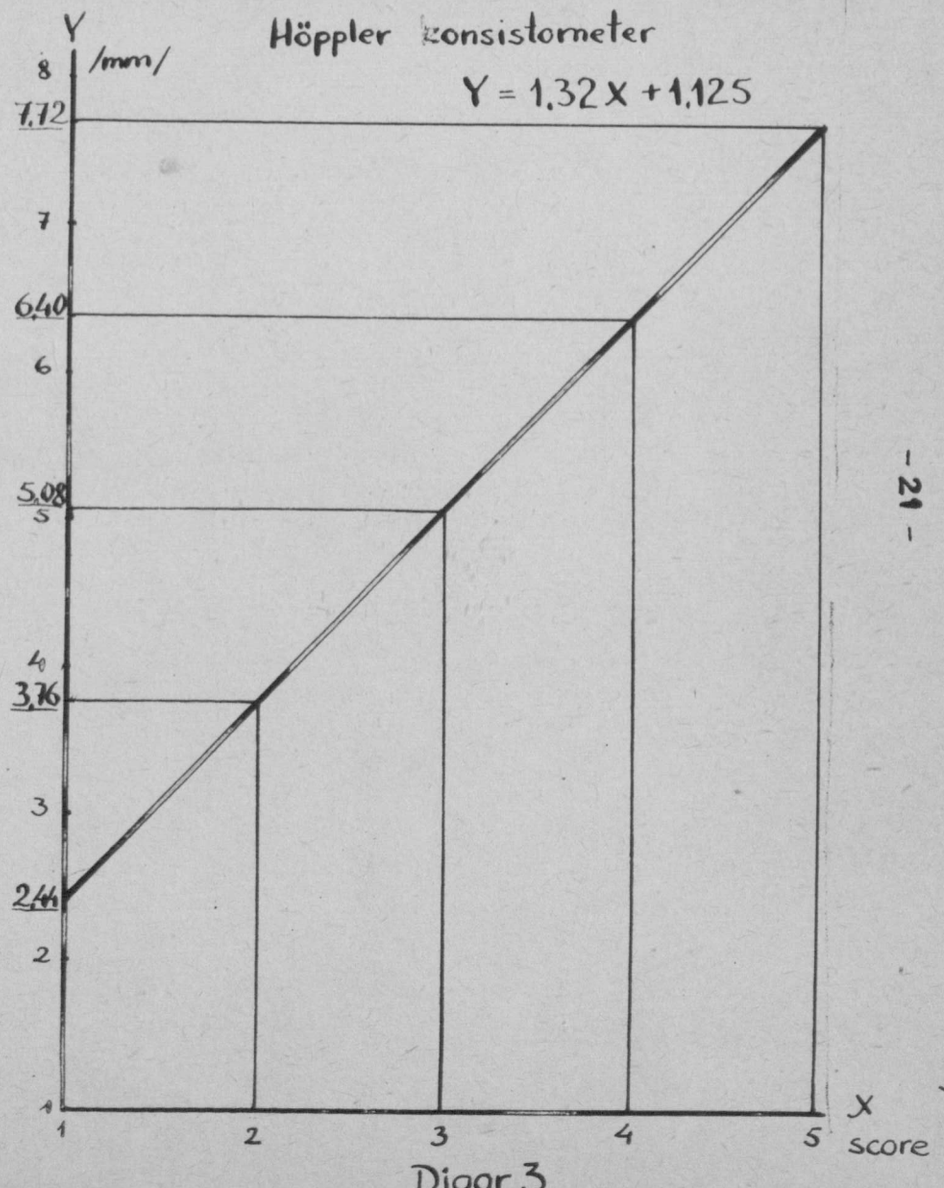
The simple appliance for measure of bounding

Fig. 1

Relationship between determinations of tenderness by the organoleptic evaluation and instrumental results



Diagr. 2



Diagr. 3.

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