METHOD OF QUANTITATIVE ESTIMATION OF MEAT PRODUCTS QUALITY DEPENDING ON THE COMPOSITION AND WAYS OF RAW MATERIALS PROCESSING

V.I.Khlebnikov, I.A.Zhebeleva

Moscow Cooperative Institute, Moscow, USSR.

INTRODUCTION

In the world there is a steady tendency of producing mixed products with the usage of raw materials having the necessary food components which previously were not utilized for their production; application of intensive methods and raw materials, got from the cattle breed by industrial methods. All this and in some cases the non-observance of technological conditions lead to the emergence of poor quality products during realization. Nontraditional food products should become adequate in a sense to traditional, usually eaten products. At the same time, traditional products, produced at different enterprises or form different batches of initial raw materials should meet the appropriate requirements, characterizing the quality of the final product. These factors determine the necesssity of motivated approach to the improvement of existing and elaboration of new criteria of quantitative estimation of the product quality taking into account the modern ideas about the adequate human nutrition/2,3,4,5,7,8/.

Nowadays science of commodities restrictively studies some organoleptic, physico-chemical and other properties of the product from the view of their adequateness to certain indices of normative-technical documentation, but it does not undertake the task of estimation the role of each property in the whole qualitative assessment. That is why we need such a method for estimation of product quality, which could help to make a complex assessment of the final product. Various number of indices is included into the notion "quality" by different authors /2,8,9/. However, in all the cases it is possible to state, that the product quality should be characterized by the sum of consumers properties, which include organoleptic indices, nutritive and biological values, harmfulness and also a number of physico-chemical, structurally-mechanical and other indices, sufficiently influencing the formation of the product main properties.

All these properties of the product are characterized by certain indices, having different measurements. Consequently, a quantitative estimation of product quality may be carried out only abstractly. In this case any product may be characterized with certain allowance, by the index "K", which shows the degree of interaction between the product and its consumer. That is "K" must represent the integral totality of certain consumers properties, characterizing the product quality quantitatively as an unmeasurable value.

Qualimetricy studies the main forming principles of numerical estimation of quality as the function of certain properties. If we regard quality as a dynamic combination of properties, any of which being able to have different significance/different degree of influence/for general numerical estimation of quality, than with some allowance this method could be considered as a long-range trend in the development of one of the food products sciences-science of commodities. The major problem of qualimetric estimation of product quality comes to the finding of the rules for construction" of the properties tree, that is to the determination of "integral quality" through the structure of certain properties. It should be noted, that apparently, it is not possible to expect in full measure the adequacy of the product quality reflection, using qualimetricy. Numerical estimation of the products quality with the help of qualimetricy, as A.M.Brazhnikov points out/1/, includes the following operations:

-Marking out certain properties of the product, the change of which during the process of its quality estimation and concrete technological process is essential. It is worth noting, that the principle of marking out the most essential product properties is itself somehow difficult, because up till now there is no common opinion how to decide this question and also no reliable information about independence /dependence/ of certain properties.

-Classification of marked out properties should be conducted in accordance with their ponderability. The ponderability of index properties is its ability to make influence on the complex estimation of the product quality "K".

Proceeding from the given above information, we recommend the following grouping of properties:

A-group of properties, determining the possibility to consume food products according to sanitary and hygienic considerations /the presence of toxic microflora, heavy metals salts, chloro-organic and other combinations, which are harmful for human organism/.

Б-group of properties, characterized by organoleptic and structurally-mechanical indices.

B-group of properties, determining nutritious, biological and energetic value of the product.

Г-group of properties, characterizing physico-chemical changes /denaturational, hydrolytic, oxidative and other changes influencing the quality of the product/ and product stability during its long-term storage.

Д-group of properties, the presence of which is desirable but not obligatory, for example: the package design and so on. This group of properties may be conventionally called "aesthetic".

For concrete products and technological processes the qualimetric model may be simplified by excluding the properties, the changes of which in the given process and for the given product could be considered unessential or, on the contrary, complicated by forming/adding/ an independent group, including certain properties.

- Giving an unmeasurable form to certain properties.

Food products are of various physico-chemical nature and, consequently, their properties are of different measurements. To correlate these properties within the bounds of one mathematic model, all the properties must be given an unmeasurable form, that is:

$$K_i = f\,(P_i^{n} / P_i^{эт}) \qquad /1/$$

where K_i - unmeasurable meaning of i - property;

P_i^n - index of i-property;

$P_i^{эт}$ - standard meaning of property.

In case of a sharp P_i^n increase in relation to $P_i^{эт}$ a supplementary coefficient is introduced. For example, in the process of canned meats sterilization the contentents of hydrogen sulphide increases several ten times in comparison with its contents in raw meat, which is taken for a standard in this case /6/.

The choice of $P_i^{эт}$ value, given in the formula/1/, leads to some subjectivity as well as the choice of the standard itself.

In this case the standard meaning represents the most desirable meaning of the i-property or the meaning, obtained during the testing of a standard, elaborated in accordance with requirements of adequate nutrition.

Brazhnikov A.M./1/ points out,

any declination of from causes the decreasing of the product quality, that is

$$P_i = P_i^{эт} \pm \Delta P_i \Rightarrow 0\ ;\quad K_i = 0\ ;$$

Consequently, "K" changes in the following limits:

$$0 \leq K_i \leq 1\ ;$$

- Determination of ponderability coefficient is carried out with the help of expert avaluation method. On the basis of the represented above material, we propose a generalized expression, characterizing the quality of food products:

$$K = M_A \Phi \Big[M_{Б} \sum_{i=l+1}^{i=z} m_{Б_i} K_{Б_i} + M_{В} \sum_{i=z+1}^{i=g} m_{В_i} K_{В_i} + M_{Г} \sum_{i=g+1}^{i=n} m_{Г_i} K_{Г_i} + M_{Д} \sum_{i=n+1}^{i=o} m_{Д_i} K_{Д_i} \Big], \qquad /2/$$

where K - integral, unmeasurable index of quality,

M - "veto" coefficient according to microbiological indices

Φ - "veto" coefficient according to other indices.

In case of the product adequateness to the permissible standards these coefficients are equal to 1. If the indices /or even one of them/, characterizing these coefficients, exceed the permissible standards, they become equal to 0, and consequently, the product can not be subjected to realization.

$M_Б, M_В, M_Г, M_Д$ -relative ponderability for groups of properties, characterizing, respectively, organoleptic indices /Б/, nutritious and biological value /В/, physico-chemical indices /Г/ and "aesthetic" /Д/. Ponderability of coefficients submits to the given below regularity:

$$M_Б \geq M_В > M_Г > M_Д\ ;\quad M_Б + M_В + M_Г + M_Д = 1\ ;$$

$m_{Б_i}; m_{В_i}; m_{Г_i}; m_{Д_i}$ -relative ponderability of i-property for each group, while

$$\sum_{i=l+1}^{i=z} m_{Б_i} = 1\ ;\quad \sum_{i=z+1}^{i=g} m_{В_i} = 1\ ;$$

$$\sum_{i=g+1}^{i=n} m_{Г_i} = 1\ ;\quad \sum_{i=n+1}^{i=o} m_{Д_i} = 1\ ;$$

$K_{Б_i}, K_{В_i}, K_{Г_i}, K_{Д_i}$ -unmeasurable value, characterizing the meaning of each property.

MATERIAL AND METHODS

Carrying out of investigations on the quantitative determination of quality, as it was mentioned before, starts from the selection of elaboration of a standard for an appropriate group /sort/ of products in accordance with the requirements of the adequate nutrition theory. In case of elaboration of a standard the studies, aimed at determining standard indices, are carried out, the latter characterizing its nutritious, biological, structurally-mechanical, physico-chemical and other properties. The highest mark, according to the scale, accepted by the researcher, is taken for a standard evaluation. Then, using qualimetricy, it is possible to determine quantitative criteria, characterizing the quality of the final product, to calculate the generalized index "K", to make quantitative evaluation of the studied product quality in comparison with the standards and to give appropriate recommendations.

The methods of investigation for each group of the food products should be chosen, considering their properties and the theory of adequate nutrition.

Numerical estimation of quality, for example, of meat products may be carried out in accordance with ponderability coefficient and expression/2/ by the formula, written as follows:

$$K = M\Phi\Big[M_Б \Big(m_{Бар} \frac{P^n_{ap}}{P^{эт}_{ap}} + m_{Бв} \frac{P^n_{в}}{P^{эт}_{в}} + \ldots + m_{БН} \frac{P^n_{Н}}{P^{эт}_{Н}} + m_{Бвсс} \frac{P^n_{всс}}{P^{эт}_{всс}} + m_{Бнс} \frac{P^n_{нс}}{P^{эт}_{нс}} + \ldots + m_{Бсп} \frac{P^n_{сп}}{P^{эт}_{сп}}\Big) + M_В \Big(m_{Вб} \frac{P^n_{б}}{P^{эт}_{б}} + \ldots$$

$$+m_{Вж}\frac{P^n_{ж}}{P^{эт}_{ж}}+\ldots+m_{Ввит}\frac{P^n_{вит}}{P^{эт}_{вит}}+$$

$$+m_{Внжк}\frac{P^n_{нжк}}{P^{эт}_{нжк}}+\ldots+m_{Вку}\,U+$$

$$+m_{Вnси}\,\sigma_c+\ldots+m_{Впер}\frac{P^n_{пер}}{P^{эт}_{пер}})+$$

$$+M_Г(m_{ГSH}\frac{P^n_{SH}}{P^{эт}_{SH}}+m_{ГSS}\frac{P^n_{SS}}{P^{эт}_{SS}}+\ldots$$

$$\ldots+m_{Гaw}\frac{P^n_{aw}}{P^{эт}_{aw}}+m_{ГpH}\frac{P^n_{pH}}{P^{эт}_{pH}}+\ldots$$

$$\ldots+m_{Гпч}\frac{P^n_{пч}}{P^{эт}_{пч}}+m_{Гкч}\frac{P^n_{кч}}{P^{эт}_{кч}})+$$

$$+M_Д(m_{Дуп}\frac{P^n_{уп}}{P^{эт}_{уп}}+m_{Дэт}\frac{P^n_{эт}}{P^{эт}_{эт}}+\ldots$$

$$\ldots+m_{Дсх}\frac{P^n_{сх}}{P^{эт}_{сх}})\Big]\quad; \qquad /3/$$

$m_{Бар}, m_{Бв},\ldots, m_{Бн}, m_{Бвсс}, m_{Бнс},\ldots, m_{Бсп}$ -unmeasurable values,characterizing numerical meani ngs of every index,determining organoleptic,structurally-mechanical properties: $m_{Бар}$ - flavour, $m_{Бв}$ - taste and so on. $m_{Бн}$ -tenderness, $m_{Бвсс}$ -waterbinding capacity, $m_{Бнс}$ - section tension,etc., $m_{Бсп}$ -degree of penetration and others.

$$m_{Бар}+m_{Бв}+\ldots+m_{Бн}+m_{Бвсс}+\ldots+m_{Бсп}=1;$$

$P^n_{ар}$,..., $P^n_{сп}$ -values of certain indices of the studied product, characterizing organoleptic, structurally-mechanical properties,water-binding capacity. $P^{эт}_{ар}$,.... $P^{эт}_{сп}$ - the same values of a standard product;

$m_{Вб}, m_{Вж},\ldots, m_{Внжк},\ldots, m_{Вку}, m_{Вnси}, m_{Впер}$- unmeasurable values,characterizing numerical meaning of every index,determining nutritious and biological values of the product:
$m_{Вб}$-protein contents, $m_{Вж}$-fat contents, $m_{Ввит}$- vitamins contents, $m_{Вку}$ - value of utility coefficient(calculated on formula 4), $m_{Вnси}$ - value of index of "comparable redundancy"(calculated on formula 5), $m_{Впер}$-value of digestibility.

$$m_{Вб}+m_{Вж}+\ldots+m_{Ввит}+m_{Вку}+m_{Вnси}+m_{Впер}=1;$$

$P^n_б, P^n_ж,\ldots, P^n_{вит},\ldots, P^n_{пер}$ -values of certain indices of the investigated product,characterizing its nutritious and biological value;
$P^{эт}_б, P^{эт}_ж,\ldots, P^{эт}_{вит},\ldots, P^{эт}_{пер}$ -the same values of a standard product;
$m_{ГSH}, m_{ГSS},\ldots, m_{Гaw},\ldots, m_{Гпч}, m_{Гкч}$ -unmeasurable values,characterizing numerical meanings of each index,determining physico-chemical properties of a product/denaturation,hydrolysis,oxidation and other changes,expressed by these indices,for example,total contents of disulphides/ $m_{ГSS}$ /, sulphohydrates/ $m_{ГSH}$ /, weak-reacting and easy-accessible sulphohydrates and other groups, number of proteins,extracted by buffers of high and low ionic strength and others,acidic/ $m_{Гкч}$ /, peroxidic/ $m_{Гпч}$ / fats number,disaggregation of collagen according to the number of products, which became dissoluble,pH/ $m_{ГpH}$ /, water activity / $m_{Гaw}$ / and others.

$$m_{ГSH}+m_{ГSS}+\ldots+m_{Гaw}+m_{ГpH}+\ldots+m_{Гпч}+m_{Гкч}=1;$$

$P^n_{SH}, P^n_{SS},\ldots, P^n_{pH},\ldots, P^n_{кч}$ -values of certain indices of the investigated product,characterizing its physico-chemical properties.
$P^{эт}_{SH}, P^{эт}_{SS},\ldots, P^{эт}_{pH},\ldots, P^{эт}_{кч}$ - the same values of a standard product;
$m_{Дуп}, m_{Дэт},\ldots, m_{Дсх}$ -unmeasurable values,characterizing numerical meaning of aesthetic and technological properties of the

product/package,mark,shelf-life and so on/.

$m_{\text{Дун}} + m_{\text{Дэт}} + \ldots + m_{\text{Дсх}} = 1;$

$P^{н}_{ун}, P^{н}_{эт}, \ldots, P^{н}_{сх}$ - values of indices,characterizing aesthetic and technological properties of the investigated product;

$P^{эт}_{ун}, P^{эт}_{эт}, \ldots, P^{эт}_{сх}$ - the same values of a standard product.

While estimating the product biological value,quantitative evaluation of correspondence between the contents of certain irreplaceable amino-acids and their total balance in the protein of a new product or its adequateness to standard becomes very important.

In accordance with this task, it is advisable to use the coefficient of amino-acids contents utility/U/ and coefficient of comparable redundancy / σ_c /,suggested by Lipatov N.N. / 10 /

$$U = \frac{C_{min} \cdot \sum_{j=1}^{K} A_{эj}}{\sum_{j=1}^{K} A_j} \quad \text{part of a unity} \quad (4)$$

$$\sigma_c = \frac{\sum_{j=1}^{K} (A_j - C_{min} A_{эj})}{C_{min}} \quad \text{where} \quad (5)$$

U-coefficient of amino-acids contents utility,numerically characterizing the balance of irreplaceable amino-acids in relation to the physiologically necessary norm /standard/.

$A_{эj}$ - mass part of j-irreplaceable amino-acid,corresponding to the physiologically necessary norm/standard/, g/100g of protein.

A_j - mass part of j-irreplaceable acid in the product, g/100g of protein;

C_{min} - minimal score of the irreplaceable amino-acid in the estimated protein corresponding to the physiologically necessary norm/standard/, % or part of a unity.

σ_c - index of "comparable redundancy" of irreplaceable amino-acids contents,characterizing the total mass of irreplaceable amino-acids,which are not used for anabolic needs in such a quantity of protein in the estimated product,which is equivalent by their potentially utilized contents to 100g of protein in a standard, g.

The main point of the qualitative estimation of the proteins under comparison,using the formalized indices,consists in the following: the higher is the U value or the lower value /ideally U=1, σ_c =0/,than the irreplaceable amino-acids are better balanced and may be more rationally used by the organism.

In relation to other products the number of groups may be increased or, on the contrary, reduced. Depending on the task of the study the number of investigated indices may be also increased or reduced.

An idealized product with protein fat I: 0,9 ratio may be taken as a standard,at the same time the irreplaceable amino-acids contents should correspond to the scale FAO/VOZ,the contents of polyunsaturated fatty acids in % by the total contents of fatty acids in the product and other substances,according to the requirements of health services.

The highest /standard/ organoleptic estimation is 5 or 9 points /according to 5 or 9 points scale, respectively/.

Let us study as an example the quantitative estimation of canned meats quality depending on the methods and conditions of sterilization until reaching a similar lethal effect in relation to Cl. Sporogenes-25 /6/. Sterilization of canned meats was carried out in noncontinuous autoclave without rotation (A) and with rotation (Б) of cans at the temperature of heating media 115-130°C and sterilized in the ultrahigh frequency chamber (B), the temperature of heating being 120-135°C.

Table 1 shows the data about the influence of the method and temperature of sterilization, until reaching similar effect, on the value of a complex index of quality "K" of canned meats.

Table 1.

Temperature	Method of sterilization		
	A	Б	B
115	0.705	-	-
120	0.850	0.866	0.874
125	0.835	0.896	0.920
130	0.826	0.890	0.937
135	-	0.880	0.831

The comparison of a complex quality index of canned meats, subjected to sterilization by different methods at temperature, providing a better quality of the product, showed, that the canned meats, sterilized by ultrahigh frequency, surpass the ones, sterilized in rotational autoclave, by 4.6% and the ones e in stationary autoclave - by 11.3%.

CONCLUSION

I. The suggested method can be used for integral estimation of meat products quality.

2. We substantiated the expediency of elevating the temperature of canned meats sterilization in non-continuous autoclave from 115°C to 120°C without rotation of cans, to 125°C with rotation of cans and to 130°C in ultrahigh frequency chamber.

REFERENCES

1. Brazhnikov A.M. Qualimetricy of meat products. Meat Industry in the USSR, 1971, N3.
2. Brazhnikov A.M. Thermal processing theory of meat products. - A: Agroproduct, 1987.-271 p.
3. Tolstoguzov B.V. Artificial food products.-M: Nayka, 1987.
4. Ugolev A.M. Digestion evolution and evolutional principles of functions. Elements of modern functionalism. -L.: Nayka, 1985, 544 p.
5. Ugolev A.M. New theory of nutrition. - Nayka i zhizn, 1986, N 8, pp. 14-19, N 9, pp. 57-60.
6. Khlebnikov V.I., Chernova G. G., Stephanova I.L. Validity of conditions and methods of sterilization using qualimetricy.-M: Canned and vegetable-drying industry, 1981, N12, p. 23-26.
7. Chernikov M.P. Classification of comestible proteins and some problems of nutrition.- Problems of nutrition, 1987, N5, pp. 35-38.
8. Prost. Criterion for determining the notion "quality of food products". Die Fleischwirtschaft, 1986, N7, 1114-1115.
9. Hofmmann K. The notion of "meat quality". Der Begriff, Fleischynalitet. Die Fleischwirtschaft, 1986, N1, s. 44-49.
10. Lipatov N.N. Some aspects of modelling amino-acids balance in food products. Food and processing industry, 1986, N4, p. 48-52.