Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XIV, Issue 2 - 2015, pag. 212 - 217

DEVELOPMENT OF OPERATIONAL QUALITY CONTROL METHOD FOR MEAT PRODUCTS

Olha LYUBCHYK[1], Mykola MYKYJCHUK[1], *Mariya VOROBETS[2]
[1]*National University "Lviv Polytechnic", Department of Metrology, Standardization and Certification, 12, S.Bandery str., Lviv, Ukraine, 79013*
[2]*Yury Fedkovych National University of Chernivtsi, Ukraine,* m.vorobets@chnu.edu.ua
* Corresponding author
Received March 14th 2015, accepted June 17th 2015

Abstract: *Assortment of finished products of meat in the consumer market in Ukraine is quite wide, but a large number of products are very varied in quality. Today quality control of meat and meat products is very important. Doing assessing of a quality of meat, the importance is focused on meat organoleptic characteristics which shall identify the most characteristic features of a particular type of meat for the consumer and classify them. The following distinguishing features of meat freshness are: the number of fibers, medium size, color, edge definition fibers. A method for operational quality control for meat products by customers in the points of product sale based on the optical methods using modern digital optoelectronic has been developed. In the article are described problems that shall be solved to implement optical method of operational identification of a meat type. The operational analysis method allows getting fast results and assesses the structure of most types of meat products, which gives reason to recommend it for quality control and detect adulteration of meat products.*

Keywords: *pattern recognition, adulteration, microstructural analysis, meat products, operational quality control*

1. Introduction

Today a consumer has an opportunity to choose a product from a wide range of goods with the same (or similar) consumer properties, but here he encounters another problem – how to evaluate a product quality with the optimal properties out of this range. Under these conditions of commodity sufficiency the consumer should be provided with as much information as possible to enable him to identify the product properly and buy the one quality product that will satisfy his needs to the fullest extent.

An important factor in assurance of the required quality of the food products is the availability of the objective information about the quality parameters obtained by measurements using appropriate methods and techniques. The correct choice of the measurement methods and techniques is essential to ensure the information adequacy on the actual level of the food product quality. In determining the quality of meat the most typical features of a particular type of meat shall be identified for the consumer, classified, for example, using the pattern identification theory and up-to-date programming units.

The operational impact on the production process of meat and meat products shall be an objective of the modern process organization in order to minimize the consumer and environmental risks.

2. Materials and Methods

The range and sales of meat products have significantly increased over the recent years. In the meat market, being in the steady demand of consumers, its various types are available and it is sometimes hard to the customer to choose a quality product out of this variety.

Increase in the production rates and volumes of output of the meat industry requires improvement of existing and development of new production processes, which ensure efficient use of raw material resources, increase in the output and improvement in the product quality.

The following parameters play the main role in assessing the quality of meat:

• contents of ingredients used by the body for biological synthesis and covering the metabolic cost;

• organoleptic characteristics (appearance, odor, color, texture);

• absence of toxic substances and pathogens.

According to Law of Ukraine "On the Safety and Quality of Food Products" all food products getting to the consumer market shall pass the safety check during the compulsory certification. It is practically impossible to detect adulteration using conventional methods, because one has to check not only the type and grade of products, but also to carry out their identification by ingredients making it possible to identify and verify the adequacy of the information specified on the label, compliance with the formulation, type and name of the product [1].

Enzyme immunoassay methods, chromatographic methods and PCR diagnostics are used most of all. They are highly sensitive, accurate and fast. However, they are difficult to adapt to such complicated multicomponent systems as meat products and with all the advantages of these methods they are not able to detect substitution of meat with other animal ingredients – lacteal gland, liver, vascular glands and other by-products. Application of chemical, physicochemical and biochemical methods provides information about the energy value of meat products [1].

The existing control methods shall be improved towards their cheapening and approaching the point of sale to increase the reliability and efficiency of identification of the meat quality.

3. Results and Discussion

The range of end products of meat is quite wide in the consumer market in Ukraine, but a large number of products vary in quality. As studies show [2], in many cases while producing food items from meat, producers substitute meat with the phytogenic products, including soy protein, introduce low value additives, which were not provided by formula, and often use tainted meat or reused materials. Quality control of meat and meat products is the most topical issue today. The control methods in Ukraine are obsolete and do not enable to determine all modern adulterations. Forthis purpose many European countries such as Germany, Austria, and Russia apply microstructure analysis of meat products based on the principles of histopathological and histochemical examinations.

Method of microstructural analysis is a methodological approach to the study of short-term cognitive and executive actions. It is assumed that in each time interval after receiving instructions for the execution of action – specific input data conversion happens due to inclusion of a particular functional unit [3].

Meat products at various stages of processing treatment, as well as finished products retain their morphological features. Therefore, using microstructure analysis of raw materials, semi-finished or finished products, we can determine the

presence of certain types of tissues, organs, spices, and low-grade additives [2, 4–6]. The microstructure analysis makes it possible not only to detect adulteration but also to control the compliance of the ingredients of the meat products with the approved formula [7].

The conclusion on the meat freshness is drawn based on the test results [8], according to the distinguishing features shown in Table 1.

Table 1

Organoleptic indicators of meat of different grade of freshness

Indicator	Characteristic feature of meat		
	Fresh	**Doubtful freshness**	**Tainted**
Color and appearance of product	Drying crust is pale pink or pale red	Wet in places, slightly sticky, darkened	Very dried, covered with grayish-brown slime or mold
State of fat	Beef has a white, yellowish or yellow color; firm texture, crumbles when squeezing Pork has a white or pale pink color, soft, elastic Chicken has a pale yellow or yellow color	Has a grayish-matte shade, slightly sticks to fingers Chicken has a pale yellow or yellow color	Has a grayish-matte shade, smears when squeezing. Pork fat can be covered with a bit of mold. The smell is rancid (expresses bitterness). Chicken fat has a pale white color with a gray shade
Muscles in the cut	Slightly wet, do not leave wet spots on filter paper; color is common to this type of meat	Wet, leave wet spots on filter paper, are slightly sticky; have a dark red color	Wet, leave wet spots on filter paper, are sticky; have a red-brown color
Texture	The meat is dense and elastic in the cut; flexible, when pressing with a finger a dent appears, which is quickly recovered	The meat is less dense in the cut, when pressing with a finger a dent appears, which is slowly recovered	The meat is flabby in the cut, when pressing with a finger a dent appears, which is not recovered
Odor	Peculiar, specific to each type of fresh meat	Slightly acid with a hint of mustiness	Acid or musty or slightly odorous
State of tendon	Tendons are elastic, dense, articular surfaces are smooth, shiny	Tendons are less dense, have a dull white color. Articular surfaces are slightly covered with slime	Tendons are softened, have a grayish color. Articular surfaces are covered with slime

The choice of the characteristic features was made based on the study results specified in [1, 2] and on their control availability using simple optical devices (digital cameras).

For the application of the proposed approach for the operational control of the meat quality, it is necessary to identify the most characteristic features of a particular type of meat for the consumer and classify them, for example, using pattern recognition theory and up-to-date programming units. A pattern recognition system involves the following three aspects [9]: data acquisition and preprocessing; data representation; decision making.

Pattern recognition presents one of the most significant challenges for scientists and engineers, and many different approaches have been proposed [10].

Within the artificial intelligence theory pattern recognition is included in the broader science discipline – computer-assisted instruction theory, which purpose is to develop algorithm design methods able to learn. Machine pattern recognition mainly has two basic methods: statistics

pattern recognition and structure pattern recognition [11].

Pattern recognition is widely applicable and is used in the creation of all computer systems having intellectual functions, i.e. functions related to decision making instead of a human: computer-aided diagnosis, criminalistics expert examination, information search and data mining, etc.

Each image is a set of numbers that describe the properties and are called attributes. Ordered set of attributes of an object is called feature vectors. Feature vector is a point in the space of features.

The classifier or the decision rule is a function that assigns a class to the feature vector pattern, to which it belongs.

The problem of pattern recognition can be divided into a number of subtasks.

1. Generation of signs - measurement or calculation of numerical features that characterize the object.
2. Selecting features - identifying the most informative features for classification (both early signs, and their functions can be included in this set).
3. Building the classifier formation of the decision rule, under which the classification is made.
4. Evaluation of the classification quality - calculation of the rate of classification accuracy (accuracy, sensitivity, specificity, first and second kind errors).

Let us introduce the notation and formulate a mathematical classification problem.

We use the following classification problem model [12]:

Ω – a set of recognition objects (pattern space).

ω: $\omega \in \Omega$ – recognition object (pattern).

g (ω): $\Omega \rightarrow M$, $M=\{1, 2, ..., m\}$ – indicator function that breaks up the pattern space into Ω to m of disjoined classes Ω^1, Ω^2, ..., Ω^m. Indicator function is unknown to the observer.

X – space of observations perceived by the observer (feature space).

x (ω): $\Omega \rightarrow X$ – function that assigns to each object ω point $x(\omega)$ in the feature space. Vector $x(\omega)$ is the pattern of the object perceived by the observer. In the feature space disjoint set of points is determined $Ki \cap X$, $i=1, 2 ..., m$, corresponding samples of one class.

$\hat{g}(x)$: $X \rightarrow M$ – decision rule – estimation for $g(\omega)$ based on $x(\omega)$, that is $\hat{g}(x) = \hat{g}(x(\omega))$.

Let $(x_j)=x(\omega_j)$, $j=1, 2 ..., N$ – the information about function $g(\omega)$ and $x(\omega)$ be available the observer but most of these features are unknown to the observer. Then (g_j, x_j), $j=1, 2 ..., N$ – there are many precedents.

The problem is to construct such decision rule $\hat{g}(x)$ to make the recognition with the minimum number of errors.

The usual case - to consider the feature space as Euclidean of $X = R^1$. The quality of decision rule is measured with the frequency of proper solutions. Usually it is estimated by providing a certain probability measure to a set of objects Ω. Then the problem is written as $min\ P\{\hat{g}(x(\omega)) \neq g(\omega)\}$.

The following problems shall be solved to implement optical method of operational identification of a type of meat:

1) determine the characteristic features of a particular type of meat based on a number of pictures of different types of meat;
2) create a mathematical model of types of meat that will consider its characteristic features (virtual standards of types of meat);
3) develop algorithms for operational identification, which based on the pattern recognition theory will quickly identify a type of meat and its level of quality by a consumer himself.

Operational quality control method for meat products was developed based on the analysis made, shown in Figure 1.

At the first stage we determine identification characteristics of different

types of meat: number of fibers, average fiber size, color, and edge definition of fibers. The color of meat is one of the main quality indicators, estimated by a consumer, by which a marketable appearance of products is judged, as well as some chemical transformations, which may take place in the meat. Muscular tissue is the main edible part, which consists of separate long thin fibers covered with a thin translucent membrane. The basis of connective tissue is collagen and elastin fibers. There are following types of connective tissue depending on their ratio and location: loose, dense, elastin and reticular.

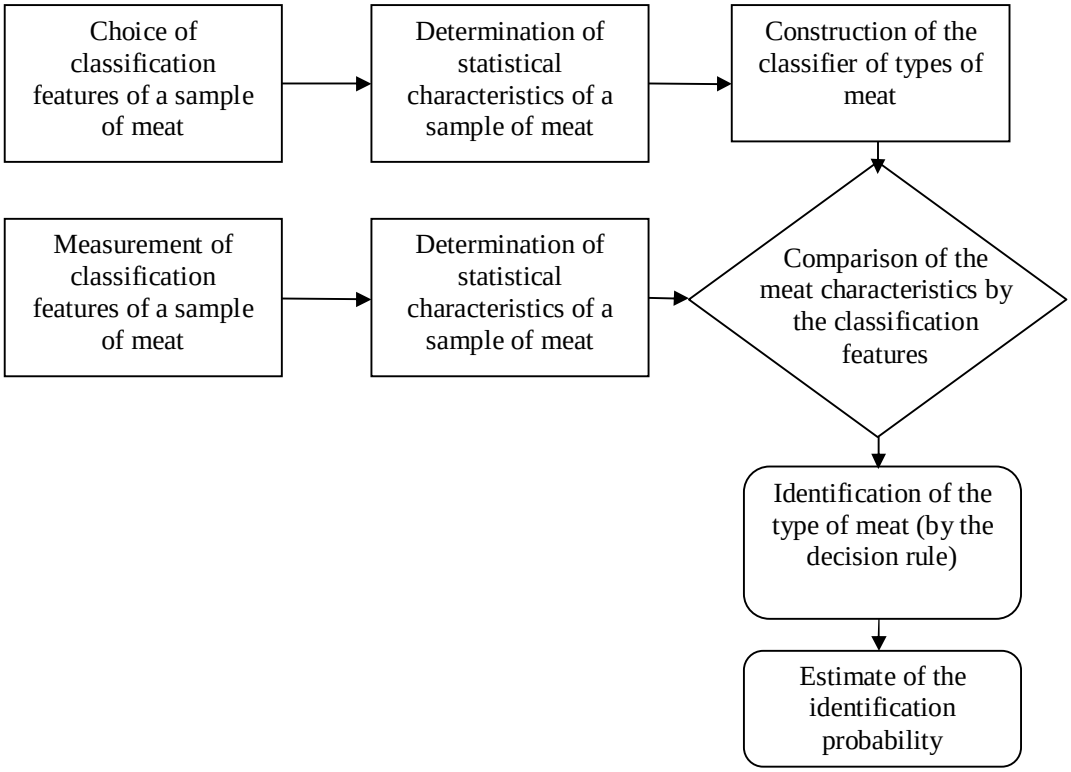

Fig.1. Algorithm of the operational quality control for meat products

In order to identify the type of the meat samples, one should determine their statistical characteristics of the meat features, such as mathematical expectation and dispersion.

According to the study it is necessary to create a classifier of types of meat, which shall include a database with statistical characteristics of meat features classification. This classification is shown in Table 2.

Its statistical characteristics are determined based on the results of estimate of the meat classification features and comparison is made by the features being in the classifier. The meat under examination is identified when comparing the characteristics and probability estimate is made by the decision rule.

Table 2

Meat features classification

Features	Pork	Beef	Chicken
Number of fibers	n_c	$n_т$	$n_к$
Average fiber size	d_c	$d_т$	$d_к$
Color	pale-pink to red	pale-pink to dark red	pale pink to pink
Edge definition of fibers	$ŋ_c$	$ŋ_т$	$ŋ_к$

4. Conclusions

Adulteration of meat not only has an effect on the lower quality of the finished products, but it may be a hazardous factor for consumers' health.

Operational analysis method enables not to conduct additional analyses to obtain characteristics of the sample under examination. This enables to use this method in different operating conditions and facilitates the analysis.

Use of operational analysis enables to identify adulteration, establish a grade of freshness and meat composition, its substitution with various ingredients.

Today there is an urgent need for means of quality control of meat products in the places of distribution. These facilities must meet two basic requirements: to provide a sufficient level reliability of information on the status of quality meat and have a low price that will contribute to mass use.

5. References

[1]. KOTSYUMBAS I.Y., KOTSYUMBAS G.I., SCHEBENTOVSKA O.M., Examination of semi-finished meat and meat-vegetable products using microstructure method, *Recommended practice.* Lviv: Afisha, 80, (2011).

[2]. KOTSYUMBAS G.I., BISYUK I.U., KOTSYUMBAS I.Y., SCHEBENTOVSKA O.M., RUDYK G.V., MYSIV O.V., KOZAK M.V., Microstructure study of raw materials in ground meat, *Recommended practice*, Lviv: Afisha, 48, (2006).

[3]. ZINCHENKO V.P., Image and activities, *Institute of Practical Psychology*, Voronezh: NPO MODEK, 608, (1997).

[4]. ADUTSKEVICH V.A., BELOUSOV A.A., Microstructural indicators of meat aging and taint, *XVII European Congress of Workers of Meat Industry*, England: 142, (1971).

[5]. BEEM R., PLEVA B., Microscopy of meat and raw animal materials, Moscow: 336, (1964).

[6]. GOREGLYAD H.S., Veterinary and sanitary examination with the basics of processing technology of animal products, Saint-Petersburg: Koloc, 584, (1981).

[7]. TINYAKOV G.G., Histology of meat animals, Moscow: Food Industry, 460, (1967).

[8]. http://medbib.in.ua/opredelenie-stepeni-svejesti.html, 1/2015.

[9]. JAYANTA KUMAR BASU, DEBNATH BHATTACHARYYA, TAI-HOON KIM, Use of Artificial Neural Network in Pattern Recognition, *International Journal of Software Engineering and its Applications*, Vol. 4, 2, 23-34, (2010).

[10]. DEVROYE L., GYORFI L., LUGOSI G. A., Probabilistic Theory of Pattern Recognition, New York: Springer-Verlag, (1996).

[11]. YOUGUO PI, WENZHI LIAO, MINGYOU LIU, JIANPING LU, Pattern Recognition Techniques, Technology and Applications, *Theory of Cognitive Pattern Recognition*, Vienna: In-Tech, 432-462, (2008).

[12]. MESTETSKY L.M., Mathematical methods of pattern identification. Course of lectures, Moscow: Faculty CMC of MSU, Department of MMP, 85, (2004).