S4P26.WP

THE DEVELOPMENT OF TARGET QUALIMETRIC MODELS FOR SOLUTION OF TECHNOLOGICAL PROBLEMS

V.A. ANDREENKOV, A.B. LISTSYN, A.A. SEMENOVA and A.N. SPRIKIN

The All-Russian Meat Research Institute, Moscow

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ABSTRACT

The Target model for assessment of raw meat quality for whole-muscle smoked and baked products is developed. In accordance with this model, the comprehensive assessment of raw meat was conducted on the basis of measuring pH, water-holding capacity and structuro-mechanical properties.

Thirteen beef muscles of front, middle and hind cuts were examined.

The analysis of muscle distribution by quality groups has shown that PSE raw meat is characterized by low values of complex criterion in comparison with normal meat and DFD meat.

On the basis of resulting correlation on muscle classification by complex criterion and expert classification, it was concluded that the developed model is adequate.

The advantages of the suggested attitude are as follows:
the objectiveness of the method;
consideration of quality of the raw material (PSE, DFD, NOR)
and also the anatomic origin of the muscle; and
opportunity of utilization of quality assessment results for
solutions of technological problems.

INTRODUCTION

Fundamental investigations for development of general qualimetric model of quality of PSE and DFD raw meat have been carried out in the All Russian Meat Research Institute during the last years. The model is intended for analytical description and quantitative measurement of raw meat quality. The general character of raw material requirements, its suitability for industrial processing are taken into account in the model, including 12 indices determined by instrumental methods (Ivashov *et al.*, 1990).

However, the range of requirements can be different depending on conditions for the further processing or consumption. Therefore, the availability of both general qualimetric and target models are necessary for quality assessment of raw meat materials.

The target models of quality assessment permit one to shape special requirement characteristics for each particular case of raw meat material utilization.

An attempt has been made to solve the problem of development of a target model of quality assessment of raw meat material for whole-muscle smoked-baked product production. When these types of products are produced, the application of the traditional technologies to raw meat showing defects of quality, brings about substantial economic

losses. Therefore, the problem of objective classification of raw meat according to complex indices, and the problem of technological regimes selection in accordance with quality of raw material, are of special importance.

MATERIALS AND METHODS

When the target model was constructed, we proceeded from the general qualimetric model. Due to evident excessiveness of indices in the general model, the method used is known as "section of trees of properties" (Dmitrichenko *et al.*, 1986). The method implies finding such parameters of control, which could describe (may be indirectly) many possible quality indices and which could show the greatest significance.

Nowadays, the majority of specialists are inclined to consider pH, colour consistency, surface temperature and water-holding to be the most significant indices of meat. Differences in these indices allow easy classification of raw meat material (PSE, DFD, NOR) (Gorbatov *et al.*, 1991).

However, when raw material is selected for whole-muscle smoked-baked products, from the specialist's point of view, the most preferable is meat from which a product of predetermined consistency can be manufactured.

In accordance with modern point of view, the consistency is determined by three main factors: the rate of myofibrillar structure, the connective tissue structure and water-holding capacity of muscle proteins. Consequently, consistency is a complex characteristic and is an organoleptic expression mainly of mechanical properties of meat (Harris, 1988).

Colour characteristics as well as pH are significant only for initial classification of raw meat material and they do not strongly affect development of the finished product's quality.

In accordance with this, selection of "trees of properties" consists of the following (Figure 1):

pH (at initial classification);
structural and mechanical properties (P 0.5 kPa); and
water-holding capacity (%).

pH is chosen as control parameter when raw meat material was selected for experimental investigation and suitability criterion of target model when results of comprehensive assessment are evaluated.

In accordance with the target model, the comprehensive assessment of raw meat material was conducted on the basis of results of selected indices measurements. Beef cuts from the following muscles (groups of muscle) served as objects of the study:

Front (neck, m.infraspinatus, m.supraspinatus, m.triceps brachii);
Middle (m.longissimus dorsi and lumborum);
Hind (adductor muscle, m.semimembranosus, m.pectineus,
m.quadriceps femoris, m.gluteus medius, biceps femoris, m.semitendinosus).

Raw meat material was selected in hot state (45 minutes, post-mortem) by pH, which was measured in three sites of carcass halves (hind, front and middle). The duration of carcass cooling was 24 hours at 2 to 4 °C. After cooling, at the sites, carcass pH was measured and grading into PSE, DFD and NOR was conducted.

After that, each carcass was separated into three cuts, deboned and flesh was separated by muscles.

RESULTS AND DISCUSSION

The investigation of quality of 13 beef muscles shows that substantial qualitative differences are observed between separate muscles as between groups PSE, DFD and NOR (Table 1).

To interpret the significance of quality indices in terms of utilization or desirability, the unimodel function is chosen (Kalinia *et al.*, 1989) which is represented in Figure 2.

The comprehensive criterion of quality is calculated by the equation:

$$D = \sqrt[2]{d1 \times d2}$$

where d1 and d2 are specific functions of desirability for structuro-mechanical properties and for water-holding capacity respectively.

In accordance with comprehensive quality assessment of raw meat material, it was classified into groups (Table 2):

"very good" -- 0.80 to 1.00;
"good" -- 0.63 to 0.80;
"satisfactory" -- 0.37 to 0.63;
"bad" -- 0.20 to 0.37; and
"very bad" -- 0.00 to 0.20.

As is seen in Table 2, PSE meat has low values of comprehensive criterion "D" in comparison with NOR and DFD meat. Therefore, PSE meat is assessed in the framework of the developed model as unsuitable or of little use for this particular case of processing.

The diagrams of beef muscle evaluation are presented in Figure 3. They are constructed taking into account modifications of comprehensive criterion values when PSE and DFD meats are assessed.

The expert assessment of quality was conducted on three muscles (*l.lumborum*, *m.quadriceps femoris* and *m.semitendinosus*). The results of the experts classification and comprehensive criterion classification turned out to be identical.

On the whole, results of comprehensive assessment of beef quality showed that the constructed target model makes it possible to assess PSE and DFD raw meat adequately and can be utilized to solve technological problems.

CONCLUSIONS

On the basis of conducted studies, the target qualimetric model suggested makes it possible to classify raw meat objectively by quality for whole-muscle smoked-baked products. The model permits one to take into account not only the qualitative state of the raw meat (PSE, DFD or NOR) but the anatomical origin of the muscles as well. The limitation of number of control parameters doesn't bring about a substantial reduction in the probability of making right decisions. Such attitudes simplifies qualimetric measurement of product while at the same time reduces the time required for decision-making under production conditions.

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Table 1. Experiment results of raw meat materials quality evaluation (beef).

Cut muscles	NOR raw meat material pH 1	pH 24	SMP* P kPa 0.5	WHC** %
Front				
m.infraspinatus		6.1	273.5	56.5
m.supraspinatus	6.2	6.15	198.3	54.1
m.triceps brachii		6.15	314.2	59.2
neck		6.0	179.4	58.5
Middle longissimus dorsi				
l. lumborum	6.2	6.1	155.7	64.3
		6.0	96.8	63.6
Hind				
adductor m.		6.1	265.0	58.8
semimembranosus		6.0	215.6	61.7
m.pectineus	5.9	5.9	383.7	53.0
m.quadriceps fem.		6.2	212.6	60.9
m.gluteus medius		6.0	133.1	62.6
biceps femoris		5.9	245.0	60.1
m.semitendinosus		6.15	383.2	64.2

Cut muscles	PSE raw meat material pH 1	pH 24	SMP* P kPa 0.5	WHC** %
Front				
m.infraspinatus		5.4	263.0	50.6
m.supraspinatus	5.9	5.3	245.0	49.5
m.triceps brachii		5.2	272.2	46.8
neck		5.7	258.1	50.2
Middle longissimus dorsi				
l. lumborum	5.65	5.5	139.3	58.4
		5.4	267.3	51.6
Hind				
adductor m.		5.3	224.6	51.0
semimembranosus		5.4	351.9	45.5
m.pectineus		5.3	439.7	46.1
m.quadriceps fem.		5.4	207.4	48.9
m.gluteus medius		5.1	152.2	51.1
biceps femoris		5.2	346.3	48.1
m.semitendinosus		5.2	516.5	47.8

Table 1 (cont.). Experiment results of raw meat materials quality evaluation (beef).

Cut muscles	DFD raw meat material pH 1	pH 24	SMP* P kPa 0.5	WHC** %
Front				
m.infraspinatus		5.9	161.8	63.0
m.supraspinatus	7.0	6.8	310.5	67.9
m.triceps brachii		6.8	291.6	66.2
neck		6.7	140.0	66.6
Middle longissimus dorsi				
l. lumborum	6.9	7.0	154.0	66.9
		7.1	176.3	67.1
Hind				
adductor m.		7.2	263.3	68.2
semimembranosus		7.2	335.4	65.6
m.pectineus		7.1	379.4	64.1
m.quadriceps fem.		6.8	139.9	65.8
m.gluteus medius		7.1	148.0	69.7
biceps femoris		6.9	381.4	68.3
m.semitendinosus		7.2	256.7	68.6

* SMP = structuro-mechanical properties
** WHC = water-holding capacity

Table 2. Distribution of muscle by group of quality (for beef).

Quality groups	NOR Muscle
"very good"	longissimus lumborum, 0.87
"good"	longissimus dorsi, 0.78 gluteus medius, 0.77 semimembranosus, 0.69 quadriceps femoris, 0.67 neck, 0.64
"satisfactory"	biceps femoris, 0.62 adductor, 0.57 triceps brachii, 0.51 infraspinatus, 0.49 supraspinatus, 0.47 semitendinosus, 0.43
"bad"	pectineus, 0.24
"very bad"	

Quality groups	PSE Muscle
"very good"	
"good"	longissimus dorsi, 0.67
"satisfactory"	
"bad"	gluteus medius, 0.36 adductor, 0.33 longissimus lumborum, 0.32 neck, 0.27 infraspinatus, 0.27 supraspinatus, 0.24 quadriceps femoris, 0.22
"very bad"	biceps femoris, 0.13 triceps brachii, 0.13 semimembranosus, 0.06 pectineus, 0.04 semitendinosus, 0.03

Table 2 (cont.). Distribution of muscle by group of quality (for beef).

Quality groups	DFD Muscle	
"very good"	gluteus medius, longissimus dorsi, neck, quadriceps femoris, longissimus lumborum,	0.85 0.82 0.82 0.81 0.80
"good"	infraspinatus, semitendinosus, adductor, triceps brachii, supraspinatus,	0.76 0.72 0.71 0.64 0.63
"satisfactory"	semimembranosus, biceps femoris, pectineus,	0.55 0.46 0.44
"bad"		
"very bad"		