

Quality management

INNOVATIVE SOLUTIONS IN MANAGEMENT OF PROCESS AND ACCOUNTING TASKS AT MEAT INDUSTRY ENTERPRISES AS A PRODUCT QUALITY FACTOR

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Abstract

The article is devoted to issues of process management and formation of the set product quality as applied to the activity of meat factories. Topicality of the problem is determined by a complex of factors, including information uncertainty of the raw material base condition in the field and individual companies. The authors proposed to apply MultiMeat Expert software complex (certificate of PC software registration # 2013616949) consisting of five modules – "Basic", "Formula optimization", "Expert system", "Production task", "Meat boning and trimming", each of which is meant to solve individual tasks.

The long-term objective of any meat factory operating in market economy conditions is maximization of profit. This objective can be reached by different ways, including ensuring of financial stability of the company's operation on account of stable obtaining of profit, as well as continuous sweeping and maintaining the market.

In order to achieve the specified objectives in conditions of severe competition meat factories have to widen the product range in the price segment from economy to business class, which allows to retain consumers of their products. In this connection, the company's product range can reach

Key words

Quality	Meat product technology
Software complex	System approach
Information uncertainty	

several hundreds of names, where as least one formula corresponds to each product.

Information uncertainty of the Russian meat and meat food market caused by fluctuation of raw material prices, instability of meat by-product quality, constant appearance of new ingredients and food additives leads the manufacturer willing to produce competitive products to work with the product formula with several alternative variants. As a result, the technologist of the meat factory has a huge range of formulas, which at formation of the process task provokes a problem of operative search of an optimal alternative product formula in view of the stock balance, its prices and economic efficiency.

It should be also noted that currently there are a lot of small and medium companies, where production tasks are performed by the technologist with huge time expenditures. Such organizational approach within the framework of a large product range does not allow to clearly organize ingredient delivery and record from the warehouse for production subject to the production task. There often appear problems with recording of ingredient stock balance and failures in fulfillment of the customers' orders of finished products. As a result, the company's management cannot operatively receive accurate information on the company's economic activity analysis by the following reasons: detection of profitable and loss-making products; ratio of high- and low-profitable products in the total volume of produced and sold products; differentiate raw materials from suppliers and determine optimal lines of its usage at the company. etc. Absence of a detailed analysis in the company generally leads to reduction of profitability and worsening of the company's image. One of the ways out of this situation can be advanced information technologies in the form of specialized computer programs meant for upgrading of process management and simplification of technologists' work.

However, it is known that widening of the product range in different price categories is not enough for successful activity of the meat factory. It is necessary to ensure stable product quality, which is rather complicated in conditions of information uncertainty. The consumer generally refuses from products if they were at least once of bad quality.

In this connection it should be noted that the product demand does not only depend on the price but also on its quality, which is laid at the process stages, in particular at composition of the minced

meat. It should be noted that minced mixture indices but not finished product indices constitute controlled parameters. Therefore, product profitability in many respects depends on the formula optimization level. In order to obtain it the technologist must solve a dual problem – the final product must have a minimum cost but at the same time it must comply with the set quality parameters.

Currently there are expressly regulated rules of making formulas, generally they are created experimentally, based on experience, knowledge and intuition of technologists. It is surely easy to make a formula if you have the entire ingredient range, its good quality and price of ingredients, which is not less that the competitors' one. However, such situation is rather an exception than a rule. In such conditions it is hard for a technologist to ensure stable product quality, therefore, application of special software programs for optimization of technologist's work is deemed expedient.

Nowadays, on the IT market in the meat factory sector many software products are offered, which basically solve only problems of accounting automation at the place of production but are not absolutely focused on solution of the above-mentioned problems critical for the meat factory's profitability and image.

Currently the only system, which allows simultaneously to solve a wide range of process and accounting tasks at enterprises of meat and fish industry is MultiMeat Expert software complex (certificate of PC software registration # 2013616949). The program consists of five modules – “Basic”, “Formula optimization”, “Expert system”, “Production task”, “Meat boning and trimming”, each of which is meant to solve individual tasks.

Main program functions include:

- formation of the meat cutting task;
- meat boning and trimming subject to the actual standards based on the type of animal and its fatness;
- calculation of the cost of raw materials received from meat cutting;
- automatic formation of meat boning and trimming log books;
- analysis of standard and actual indices of meat boning and trimming results;
- maintaining of the register of standard formulas of meat, fish and sausage goods;
- creation of operative (working) formulas based on standards and adjustment thereof;

Журнал обвалки

Журнал обвалки

Осн. Вып. № задания

Дата

Наименование

Дефр., %

Кол-во, кг.

Цена 1 кг., руб.

Сумма, руб.

Обвальщик

Ответственный

Обоснование

Склад

Код партии

Получатель

Ко

Удалить

Найти

Печать

Фильтр

Сохранить

Отменить

Обновить

Искать:

Страницы журнала

Страницы

Страница 1

Опн.	Вып.	№ задания	Дата	Наименование	Дефр., %	Кол-во, кг.	Цена 1 кг., руб.	Сумма, руб.	Обвальщик	Ответственный	Обоснование	Склад	Код партии	Получатель	Ко
			2 16.08.2013	Говядина 1 кат.	2	392	117,35	46 001,20	Новиков Л.П.	Иванова А.М.	На обвалку со склада	Склад "Демо"	3326	Цех обвалки	Ко
			2 16.08.2013	Свинина 2 кат. мясная	0	300	90,00	27 000,00	Ключников А.С.	Иванова А.М.	На обвалку со склада	Склад "Демо"	3327	Цех обвалки	Ко
			1 15.08.2013	Говядина 1 кат.	1	297	116,16	34 499,52	Новиков Л.П.	Иванова А.М.	На обвалку со склада	Склад "Демо"	3314	Цех обвалки	Ко
			1 15.08.2013	Свинина 2 кат. мясная	0	250	90,00	22 500,00	Ключников А.С.	Иванова А.М.	На обвалку со склада	Склад "Демо"	3315	Цех обвалки	Ко
				Итого:	4	1 239		130 000,72							

Результат обвалки

Опн.	Наименование	Оприходовано, кг	Количество, кг.			Выход, %			Цена 1 кг., руб.			% в цене			Сумма, руб.
			Факт	Норма	Откл.	Факт	Норма	Откл.	Факт	Норма	Откл.	Факт	Норма	Откл.	
	Жил. говядина 1 кат.	282,1	282,1	286,2	-4	72,0	73,0	-1,0	155,76	153,84	1,92			0	43 939,90
	Жир-сырец говяжий	17	17	15,7	1,3	4,3	4,0	0,3	31,68	31,68	0,00	27	27	0	538,56
	Соединительная ткань, хрс	10,2	10,2	9,4	0,8	2,6	2,4	0,2	11,73	11,73	0,00	10	10	0	119,65
	Кость	78,8	78,8	77,2	1,6	20,1	19,7	0,4	17,60	17,60	0,00	15	15	0	1 386,88
	Технические зачистки	3,4	3,4	3,1	0,2	0,9	0,8	0,1	3,52	3,52	0,00	3	3	0	11,97
	Потери	0,5	0,5	0,4	0,1	0,1	0,1	0,0	0,00	0,00	0,00	0	0	0	0,00
	Итого:	392	392	392	0	100,0	100,0	0,0	-	-	-	55,00	55,00	0	45 996,95

Оприходовано

Опн.	Обоснование	Кол-во, кг
	На склад с обвалки	132,1
	На жилую с обвалки	150
	Всего:	282,1

Текущая БД: 'D:\Program Files (x86)\MultiMeat\mme.gdb'

Записей: 4

Группа: Страница №1 (2) Обвалка: Говядина 1 кат. (731)

Закрыть

Помощь

Pic. 1. Fragment of MultiMeat Expert software complex. Meat trimming log book.

- minimization of the prime cost of the final product with preservation of its consumer properties;
- determination of optimal formula replacements in view of the current raw material prices;
- ensuring of meat emulsion stability on account of calculation and adjustment of optimal physical-chemical and functional-technological characteristics;
- creation of new products with the set consumer characteristics and an optimal prime cost within minimum time periods, including for infant food;
- formula analysis by the expert quality system, outlining of process problems and ways to solve them;
- calculation of the finished product output;
- calculation of quality indices (protein, fat, moisture, caloric value, hydration factor, pH, etc.) of the finished product;
- calculation of the water amount needed for hydration of the formula ingredients;
- calculation of the minced meat's hydration level;
- graphical analytics of formulas by different criteria;
- rheological analysis of summer sausage;
- formation of blends (ingredient mixture, whole minced meat, emulsions) making up the finished product;
- formation of alternative formulas;
- formation of the production task;

- search of the optimal alternative formula for each product of the production task in view of the stock balance and product profitability;
 - calculation of the formula in view of the laying weight and the number of batches;
 - calculation of the product economic indices, including in view of the actual output;
 - planning of raw material purchase;
 - automatic formation of the task to the minced meat maker based on the production task;
 - automatic formation of the formula log book;
 - adjustment of the production task in view of the previously unscheduled changes of the product order;
 - cancellation of product output with recovery of the stock balance;
 - carrying out of the scheduled /actual analysis of the work production;
 - integration with management and accounting programs (1C: Enterprise, Galaxy, Sprut software program, etc.);
 - online formula exchange via XNL files;
 - differentiation of access rights – formation of users and management of their access rights to individual program modules and functions;
 - formation and print-out of reports.
- Functions for accounting of warehousing activities implemented in the program allow to:
- maintain accounting of receipts, expenditure and balance of raw materials by batches;
 - specify justification of raw material receipts and expenditure;

- use several price groups (actual, scheduled, prices for different regions, etc.);
- set the actual quality of raw materials;
- track any raw material movement, which is automatically recorded in the warehouse;
- maintain accounting of raw materials in different units of measurement and currency;
- maintain accounting of raw materials below the set minimum for stock level control and timely orders;
- maintain accounting of distribution of raw material expenses subject to the production plan;
- keep records of raw material suppliers.

The program data base consists of the applicable regulatory documentation and reference materials.

“Meat Boning and Trimming” module will be primarily interesting to companies, which have a butchering shop. The type of the screen window of the trimming log book is shown in pic. 1. Let us consider some of its capabilities.

If necessary, the company’s expert forms meat cutting tasks in the program. This document can be compiled both manually and automatically based on the demand for raw materials of a specific production task and stock balance.

Then the task is set for fulfillment. Subject to the standards of raw material output (specified in the settings) the program calculates the amount of raw materials depending on the cutting scheme and the price. These data are fixed in meat boning and trimming log books used for daily maintaining of the entire meat cutting history at the place of production. The operator adjusts these log books if the actual raw material weight received from meat boning or trimming does not correspond to the weight subject to standard indices.

Ultimately, the program provides for the fact that the raw material from meat cutting is recognized in the stock balance or directed for utilization or to the trimming department. All types of raw material movement from cutting are automatically recorded in the programs’ warehouse. MultiMeat Expert allows to form and print-out different types of meat cutting reports.

At development of the “Formula Optimization” module we used experience and knowledge of experts in the sphere of modeling food mixture formulas, who took part in development of the known OPTIMEAT program (meat food formula optimizer). Due to their work we managed to significantly improve optimization algorithms, which allowed to achieve higher results at formula optimization in MultiMeat Expert software complex. Mathematical apparatus and expert system of this program ensure high efficiency of the modeling process and guarantee obtaining of an optimal ingredient composition of meat, sausage and fish goods formulas.

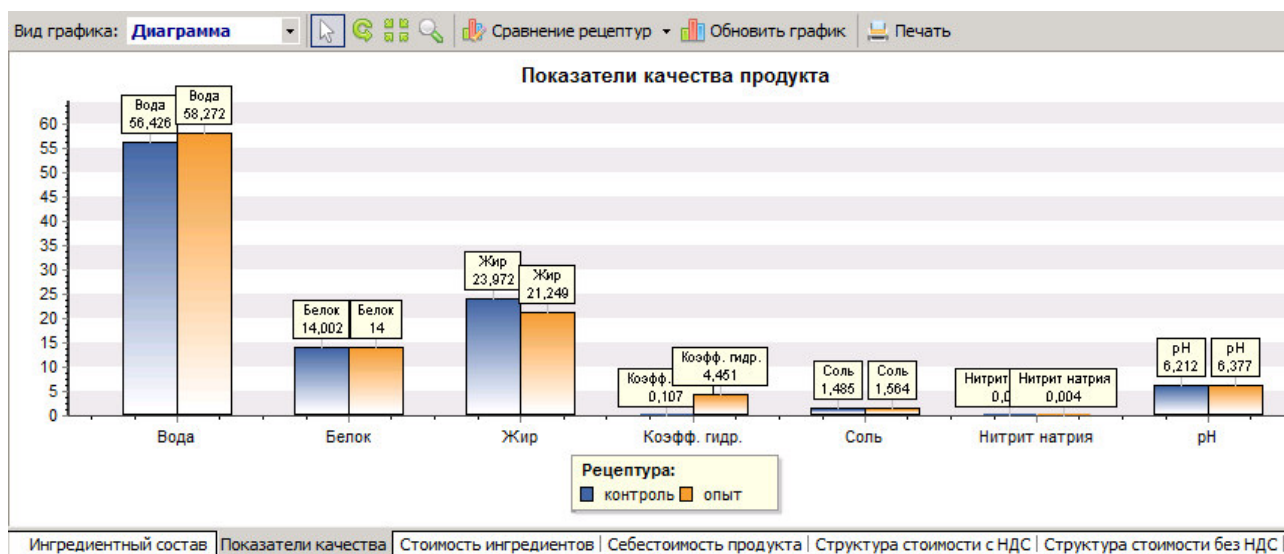
Main current task – minimization of the final product’s prime cost provided that its consumer properties are preserved.

The task of the program lied in determination of the composition and the amount of the formula raw ingredients on account of partial replacement of the main raw material, current raw material prices and fulfillment of the set requirements.

Let us demonstrate operation of MultiMeat Expert software complex by the example of searching for an optimal alternative to “Vienna sausages with cheese” basic formula TU 9213-010-40155161-2002, which composition is specified in table 1

Table 1 – Composition of basic and alternative formulas

Ingredients	Price rub/kg	Basic formula	Alternative formula
Unsalted ingredients, kg per 100 kg			
Beef category 1	180,00	30,0	23,6
Beef category 2	140,00	14,0	4,7
Mid-back fat	75,00	20,0	19,2
Hydrated soya protein	18,00	10	11,1
Milk powder	51,00	2	2,1
Mélange	30,00	2	–
Wheat flour	15,50	2	2,1
Cheese	140,00	20	21,3
Broiler breast	120,00	–	5,5
Pork skin emulsion	9,48	–	6,9
Animal protein (Tipro 600–25)	270,00	–	1,0
Egg powder	80,00	–	0,5
Vitacell	110,00	–	1,8
Spices and materials, kg per 100 kg of unsalted ingredients			
Salt	4,00	1,8	1,91
Sodium nitrite	50,00	0,007	0,007
Complex multi-purpose additive art. 42- 44Z	250,00	0,5	0,624
Fermented rice	85,00	–	0,011
Ice (water)	0	28,0	36,2
Cost of minced meat, rub/kg	–	93,36	79,78



Pic. 2. Fragment of MultiMeat Expert software complex. Comparison of qualitative characteristics of basic (control) and alternative formulas.

(basic formula).

The following requirements were posed to the alternative formula:

The cost of minced meat shall not exceed 80 rubles for 1 kg;

As a permissible replacement of beef, category 1, beef, category 2, and mélange the following ingredients were offered: animal protein, semi-fat pork, broiler breast, pork skin emulsion, vitacell, egg powder;

Calculation of the amount of ingredients is included in the program's functional;

By organoleptic and physical-chemical indices the finished product shall comply with regulatory requirements "Vienna sausages with cheese" TU 9213-010-40155161-2002;

pH factor of the minced meat of the estimated formula shall be within the range of 6.0–6.4.

Ingredient composition of minced meat (in terms of 100 %) shall comply with the requirements set out in table 2.

Table 2 – Requirements to ingredient composition of minced meat (in terms of 100 %)

Ingredients	No less than, %	No more than, %
Beef, category 1	15	
Semi-fat pork		10
Mid-back fat	13	
Broiler breast		4
Pork skin emulsion		5
Animal protein		0,7
Vitacell		1

Apart from optimization of formulas, the program allows to perform graphical analytics of formulas by different criteria. Pic. 2 shows a graphical comparison of qualitative characteristics of basic and alternative formulas.

Expert system is the program module able to partially replace the specialist in solution of a problem situation. Such module is implemented in MultiMeat Expert program. It analyzes the formula quality, detects technological problems and offers ways of their solution to the technologist. Physical-chemical and functional-technological properties of ingredients are considered at the analysis.

Let us demonstrate operation of the expert system by the example of analyzing classical formula (basic) of cooked sausage consisting of PSE pork (table 3).

Complex food additives sold on the Russian market basically consist of the following ingredients: natural spices, essential oil and oleoresins; taste boosters; colors; dye fixatives; water-holding agents, etc.

The functional part of such additives generally remains constant irrespective of the raw material quality and production conditions. Therefore, without consideration of peculiar features of raw ingredients their application turns to be low-efficient both in technological and economical respects.

In the considered example the used raw ingredient is PSE pork. It has a low water-binding and water-holding capacity. In order to hold moisture in the minced meat and not to let it escape at heat

Table 3 – Cooked sausage formula consisting of PSE pork

Ingredients	Price, rub/kg	kg	%
PSE pork	180	70	50,94
1c beef	180	25	18,19
Egg	120	3	2,18
Milk powder	40	2	1,46
Total of basic ingredients		100	72,77
Salt	5	2,3	1,67
Sodium nitrite	40	0,01	0,007
Ice (water)		34	24,74
Rosmix Doktorskaya	256	1,1	0,8
Total amount		137,41	100,00
Business calculation			rub/kg
Cost of minced meat			129,78
Losses			3,0
Output			133,29

treatment, i.e. to minimize the risk of the broth-fat pocket formation, it is necessary to use additives in the formula, which obligatorily consist of adapted ingredients allowing to minimize the occurring risks. Therefore, mere usage of complex food additives in the specified formula, for example “Rosmix Doktorskaya”, is not enough to ensure stable quality of the finished product.

As a result of analysis of the considered formula the expert system outlined several problems: it detected PSE raw material; pH is shifted to acidity; possible surplus of residual sodium nitrite; low hydration factor.

In respect of each outlined problem the program determines a negative impact and gives its recommendations on elimination thereof. In particular, in order to prevent formation of the broth-fat pocket due to presence of a big amount of PSE raw materials the program proposed

to solve this problem as follows based on the current availability of stock: use the following ingredients instead of “Rosmix Doktorskaya” ingredient: “Rosmix PSE System” (input percentage from 1 % to 1,5 %) and “Rosmix Aroma Doktorskaya” (input percentage from 0,6 % to 0,7 %).

Subject to the expert system’s recommendations changes were made to the basic formula with a repeated computer analysis. As a result of such analysis in the adjusted (alternative) formula the expert system specified in the recommendations that the formula contained all necessary components to eliminate the defected defect.

Results of comparison of economic efficiency of basic and alternative formulas are presented in table 4. It is clear that the expert system of MultiMeat Expert program allows to reduce the prime cost of the finished product.

Results of comparison of quality characteristics of these formulas are presented in table 5.

Thus, the above example visually illustrates that the recommendations of the intellectual expert system allow to avoid process scrap in the final product, in particular, application of “Rosmix PSE System” additive in the considered formula allows to reduce the content of salt, sodium nitrite and to reach an optimal pH value of the minced meat, water-binding and water-holding capacity (which are characterized by the complex hydration factor).

Table 4 – Comparison of economic efficiency of basic and alternative formulas

Components	Price rub/kg	Alternative formula		Basic formula	
		kg	%	kg	%
PSE pork	180	70	48,64	70	50,94
Beef 1c	180	25	17,37	25	18,19
Egg	120	3	2,08	3	2,18
Milk powder	40	2	1,39	2	1,46
Total of basic ingredients				100	72,77
Salt	5	2,3	1,6	2,3	1,67
Sodium nitrite	40	0,008	0,006	0,01	0,007
Rosmix Aroma Doktorskaya	376	0,6	0,42		
Water/Ice		40	27,8	34	24,74
Rosmix PSE System	322	1	0,69		
Rosmix Doktorskaya	256			1,1	0,8
Total amount		143,91	100	137,41	100,00
Business calculation					rub/kg
Cost of minced meat					125,77
Losses					3,0
Output					139,59

Table 5 – Comparison of qualitative characteristics

Quality factors in finished product	Formula	
	alternative	basic
Water, %	65,23	63,93
Protein, %	13,05	13,55
Fat, %	17,80	18,64
Sodium nitrite, %	0,004	0,005
Salt, %	1,65	1,72
pH	6,05	5,90
Hydration factor	1,30	-0,11

Apart from the above capabilities, the program exercises one more important function – formation of production tasks and search of an optimal alternative formula for each product. This functional is implemented in “Production task” program module.

Alternative formulas allow the company to profitably fulfill the customers’ orders of finished products in conditions of changes in raw material prices or breaks in its availability. For example, there are failures in deliveries of any raw material or any ingredient is absent in the warehouse. Fulfillment of the production task is doubtful. In this case the program’s help can be priceless: the technologist can quickly choose an alternative variant without violation of the product’s consumer properties.

Capabilities of this module:

If necessary, the company’s specialist forms production tasks in the program, i.e. specifies what products and in what amount should be manufactured. Then, the program analyzes the task for availability of stock in the warehouse ensuring its fulfillment.

In case lack of raw materials is detected, the screen displays what raw material, in what amount and for what products is insufficient. This function also allows to plan purchase of raw materials. In case there are no problems with availability of raw materials, the program determines an optimal alternative formula, by which the product must be produced, in view of the stock balance, its price and economic efficiency of the product. Then the task is sent for development, at the same time raw materials are automatically written off from respective batches of raw materials.

In the formula log book the program automatically daily forms the bank (archive) of formulas, subject to which the products were developed. It also contains all information on the manufactured products, including on deviations of the actual val-

ues from the planned ones. Production work analysis functions allow to detect failures and to take operative measures, as well as help the company’s management to determine ways to increase the volume of profit.

Working out of the company’s long-term development strategy is a pledge of successful management. Usage of MultiMeat Expert software complex allows not only to optimize the planning and management process but also to reduce the prime cost of produced meat foods and to cut investments in development of a new product range.

Thus, MultiMeat Expert is a modern tool both for scheduled work and for solution of different critical situations at enterprises of meat and fish industry.

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