MANAGEMENT OF PLANT FOR ANIMAL RAW MATERIAL PROCESSING AT STOCHASTIC CHARACTER OF MATERIALS FLOWS

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SUMMARY: Based on statistic data a stochastic immitation model has been developed. It allows to take into account periodic and stochastic changes characterizing quantitative and qualitative parameters of biological raw material intended for further processing.

Raw material distribution according to assortment of guaranted quality products is mode by traditional methods of linear programming. For the same task solution by non-linear criterion of a minimum deviation from structure and assortment a step-by-step interaction method should be used at solution linealization at each step.

Optimal production control based on combination products study allows to regulate biological material receipt and spread of its quality parameters by 30%.

Maximum efficiency of biological material processing, the latter being characterized by a great spread of quality parameters, is achieved by solving the tasks of assrotment and recipe optimization at a given system of limits.

INTRODUCTION: Products manufacturing from animal raw materials is stipulated by a routine program developed in advance. Program of products manufacturing at the given assortment determines all types of necessary raw materials received from suppliers: production refrigerator, other shops, storehouse and other organizations. Besides, there are used raw materials kept in sausage line chiller as non-used residual material of the previous day. However, suppliers not always satisfy production orders at 100% guarantee. Actually there are deviations in supplies volume and partial replacement of one type raw material by another. Based on supplies deviation there are gathered statistic data characterizing a supplier's reliability. Under such conditions it is difficult to fulfile a program developed in advance. A routine program can be corrected due to slight changes of recipe in the range of a standard and due to assortment change according to agreement with shops.

METHODS: Under stochastic character of raw material receipt a producer should solve two tasks. The first one, a long-term, is to determine reliability of guaranteed profit at a known spread of material receipt volumes and limits for recipe and assortment change. The second one, operative, is to determine an actual subprogram of sausage production from existing material by the criterion of profit maximum or minimum deviations from a given recipe and assortment.

For the task of a guaranteed profit it is necessary to get a function of profit probability F(P) distribution for a concrete plan of production $X=\{x_{ij}\}$ assumed by distribution of i-st material(i=1,n) for production of j-th product(j = 1,m). And profit P=L(X) is determined at solving optimization task of its maximization.

$$L(X) \rightarrow \min \tag{1}$$

by a purpose function

$$L(X)=\sum_{j=1}^{m}\sum_{i=1}^{n}(C_j - q_j - g_i)\,x_{ij} \tag{2}$$

where Cj is a wholesale price of j-th product;
q_j is given costs for j-th product manufacture;
g_i is a buying price of i-st meat.

Assumed maximum deviations from recipe structure are used as optimization task limits

$$\lambda_{ij} \le \frac{x_{ij}}{\sum_{k=1}^{n} x_{kj}} \le \bar{\lambda}_{ij},\ (i=\overline{1,n}),\ (j=\overline{1,m}) \tag{3}$$

allowed deviations from the given assortment

$$R_j \le \sum_{i=1}^{n} x_{ij} \le \bar{R}_j,\ (j=\overline{1,m}) \tag{4}$$

and meat materials supplies

$$y_i \ge \sum_{j=1}^{m} x_{ij},\ (i=\overline{1,n}) \tag{5}$$

of a probability character submitted to a certain law of distribution $f_i(y_i)$.

In relation to season a stochastic character of materials supplies changes. It was found that in autumn, mass cattle slaughter, a chance value characterizing materials resources amount has a logarythmic normal distribution at (m_i, σ_i^2) parameters

$$f_i^{I}(y_i)=\begin{cases}\dfrac{1}{y_i\sigma_i\sqrt{2\pi}}\exp\left\{-\dfrac{\ln(y_i-m_i)^2}{2\sigma_i^2}\right\}, & x>0\\ 0, & x\le 0\end{cases} \tag{6}$$

where m_i is expectation of a chance value corresponding to planned supply of i-st material;
σ_i is dispersion determined on the basis of statistic data on raw materials supply.

In winter raw materials supply has a more uniform character and resources amount submits to a normal distribution

$$f_i^{II}(y_i)=\frac{1}{\sqrt{2\pi}\sigma_i}\exp\left\{-\frac{(y_i-m_i)}{2\sigma_i^2}\right\} \quad (7)$$

During spring-summer period supplies reduction leads to submition of materials daily demands satisfaction to a logic distribution.

$$f_i^{III}(y_i)=\frac{\pi\cdot\exp\left\{\frac{\pi}{\sqrt{3}}\left(\frac{y_i-m_i}{\sigma_i}\right)\right\}}{\sigma_i\sqrt{3}\left(1-\exp\left\{\frac{\pi(y_i-m_i)}{\sigma_i\sqrt{3}}\right\}\right)^2} \quad (8)$$

The second, operative, task is being solved at known daily y_i,(i=1,n) materials supply aimed to determination of X materials distribution by the criterion of profit maximum(1) or criterion of minimum T(X) → min deviations from the given recipe and assrotment structure

$$T(x)=\alpha_1\sum_{j=1}^{m}\beta_j\left|\gamma_j^{(P)}-\frac{\sum_{i=1}^{n}x_{ij}}{\sum_{j=1}^{m}\sum_{i=1}^{n}x_{ij}}\right|\cdot\alpha_2\sum_{j=1}^{m}\sum_{i=1}^{n}\beta_{ij}\left|\lambda_{ij}^{(P)}-\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}}\right| \quad (9)$$

where α_1, α_2 are significance coefficients for deviations from the given assortment and recipe;

β_j, β_{ij} are significance coefficients for assortment types and recipe components;

$\gamma_j^{(P)}$ is a planned fraction of j-th product manufacturing;

$\lambda_{ij}^{(P)}$ is a j-th product recipe,

In both cases limits are presented as the given deviation from recipe structure(3), allowed deviation from the given assortment (4) and materials supplies(5) at Yi=const. Methods of imitation stochastic modelling are used for determination of distribution law.forA chance receipt of materials with the given law of distribution was modelled (6), (7), (8). Obtained chance distribution of raw materials was used at an optimal profit calculation by a criterion(1) and limits (3,4,5) using methods of linear programming. As the result of repeated machine experiment a possibility of the given assortment production is determined and stochastic information on a possible profit is gathered. The obtained data allow to determine value of the most probable guaranteed profit, to evaluate production imperfection by profit dispersion value and guarentee of orders satisfaction as related to the number of mutual decisions and total number of solutions.

Two alternative approaches were used for solving tasks of efficient production control.

Materials distribution according to products assortment at a maximum profit are done using traditional methods of linear programming. The same task being solved by a non-linear criterion of minomal deviation from structure and assortment can be solved using step-by-step interaction method with linealization of solution at each step. An alternative approach allows to control production with more flexibility depending on market sutiation.

RESULTS: Spread of biomaterial parameters stipulates statistic character of optimality of production programes, technologies and regimes of manufacturing at a certain stage. This spread can be compensated by change of assobtment structure and products recipes, redistribution of materials flows, reconstruction of technological schemes and regimes. The abovementioned structural changes constitute the essence of structural optimization of technological system,as combined processes and regimes, flows and products, aimed to production increase and quality improvement taking into account standard parameters. Meanwhile structure and parameters of processes and flows, on the basis of their mathematic and imitation models, are being remade according to an optimal variant as related to raw materials properties and changes in consumption type.

Initial uncertainty of technological situation demands technological system adaptation to a chance deviation of biomaterial properties from average statistic parameters for yield and quality stabilization (or maximization). To be able to make decisions under initial uncertainty it is necessary to find out a compromise between demands (plan of supply and production, request, instructions,etc.) and concrete, often contradictory, conditions of their support(non rythmic supply, deviation of materials properties from standard, non-work of equipment, deficiency in storehouses, chillers etc.).

Optimal solution can be achieved by modelling and structural optimization of plant technological system meaning change of structure of materials flows and technological schemes for a better use of raw material under concrete conditions.

CONCLUSION: A proposed imitation stochastic model of biomaterial flow in conjunction with linear and non-linear programming allowed to solve two pwoblems aimed to the optimal control of biomaterial processing.

The developed soft ware allows to determine the optimal structure of raw materials processing and to provide manufacturing of a product of the given quality. All these can be done under real production conditions as related to volume and quality of materials receipt. Product assortment is being stipulated by market economy limits.

Testing of automized system for quality control and biomaterial processing showed high efficiency of the proposed aproach and flexible reaction to changes in materials supplies and market situation. The task may be introduced at the plants of biomaterial processing for multicomponent products manufacturing.

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