IMPROVEMENT OF TECHNOLOGY FOR CREATION OF HIGH-AUTOMATED PROCESS OF FRANKFURTERS MANUFACTURE

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INTRODUCTION

Creation of the heavy-duty equipment for by the piece frankfurters manufacture is an important scientific problem including many aspects. To solve it the main statements of the theory of technological subsystems mathematical modelling may be employed, these subsystems being constructed in the form of formalized systems. Assuming that any formal system includes an abstract and a practical part while solving theoretical aspects of the problem we have made an attempt to offer simple engineering methods for quantitative analysis of the main technological processes in the meat inductry.

Firstly it was necessary to evaluate the composition of the raw material delivered for processing. Results of the measurements taken are listed in the Table.

The driven data show that means of the main values vary greatly. Thus, pork of region 3 has lower moisture content and higher fat content as compared with raw material from regions 1 and 2.

On the basis of the above-mentioned the process of by-fat standartization of comminuted meat with the automated recalculation of composition expressed as protein and moisture is included into technological shedule of frankfurters production.

For the machine standartization process an empirical formule for calculation of the necessary amount of fat is suggested:

$$W_{fat} = \frac{W_r \times (F_p \times Y - 100F_r)}{10.000 - F_p \times Y},$$

where W_r - total weight of the raw material in a tank, kg;

$$W_r = (W_{beef} + W_{pork}) \times (1 + \frac{P_a}{P_r})$$

P_a - percent of additives in the content according to the formule;

P_r - percent of meat raw material according to the formule;

F_p - percent of fat in a finished product;

F_r - percent of fat in the initial raw material;

Y - yield of the finished product,%.

The outcome data for calculation are introduced by the ASTPC-operator (Automated System for Technological Processes Control) from the microcomputer keyboard in a dialogical regieme and the calculation results are inducted on a display.

It is common knowledge that in the practice of frankfurters manufacture many operations bound with raw material preparation, processing, cooking, packaging and transportation of the finished items are very labour-consuming. They are done on the equipment of periodic function or on the mechanized production lines including various units, trasportation facilities and very often - special intermediate storage means.

The listed shortcoming made it necessary to develop a new process and the equipment for frankfurters manufacture on the mechanized in-line units of original design. In diffe-

Table

	Region and type of raw material	Content, %		
		moisture	protein	fat
1	Beef	70.0 - 72.7	18.5 - 21.2	7.0 - 8.8
	Pork	48.3 - 51.4	10.1 - 11.9	30.2 - 38.5
2	Beef	69.2 - 72.5	16.3 - 19.5	2.1 - 3.4
	Pork	49.4 - 60.1	12.3 - 18.1	22.8 - 39.1
3	Beef	66.9 - 72.6	17.8 - 19.0	7.1 - 12.1
	Pork	40.5 - 41.0	10.9 - 11.2	43.9 - 44.8

rent countries (Canada, USA, France) some research work has been already conducted to create mechanized production lines for frankfurters manufacture on the equipment of a new type. The same work is under way in the USSR (the joint development of Kharkov meat-packing plant and the All-Union Meat Research and Designing Institute) where experimental manufacture of frankfurters on the basis of rational formules is being organized with the use of new-type equipment ensuring continuous hot meat processing.

MATERIALS AND METHODS

Great variability in raw materials composition created the necessity of using a new scheme for halves dressing on the vertical boning units capable of deriving the main components of raw material: backfat, first grade muscle tissue and sausage meat.

While developing a new type of production some initial data were determined to choose a technological scheme of the process and its capacity taking into account the demand for these products, optimization of the equipment capacity in this country and abroad, as well as the research results and commercial experience of the operation of systems of units and various types of equipment.

The aim of the development was to create a production floor equipped with large units and not with machines meant for separate operations.

The developed equipment is intended for manufacturing of definite types of frankfurters as well as for mass production of different products which makes it possible to implement continuous comminuted meat manufacture, frankfurters forming, cooking and their group packing, i.e. to create a stable in-line process, a complex mechanization of all manufacturing operations and to facilitate control of all units and parametres of technological operations.

At present in mass-type sausage production a progressive scheme of comminuted meat manufacture from hot meat is used involving levelling and normalization of its composition in mixers with the capacity of 2-3 m^3.

The research done by some soviet and foreign scientists has determined significant benefits of a "fast" production scheme for frankfurters including intensive mechanical treatment at the stage of mixing and

bringing up of the total specific work expenditure per batch up to 24-25 J / 1 g of comminuted meat.

The continuous process of sausage manufacture under creation has some specific peculiarities effecting quality of the finished products. First of all it concerns a strictly established sequence of technological operations, excluding any possibility of their repeating with the aim of improving defects of the semi-prepared items and finished products.

At the same time the demand for raw materials normalization and for obtaining frankfurters of definite composition makes it necessary to introduce into the process a batchwise mince manufacture in mixers of periodic operation. It will render possibility to improve composition of a mix by adding definite proportions of components in need.

For instance after mixing beef with pork the resulting mixture may be normalized by fat, protein and moisture. With a continuous mixing process it is impossible.

The problem of ensuring the desired quality characteristics of comminuted meat in the continuous manufacturing process in principle may be solved in two ways: by systematic interference of personnel into the process carried out on the equipment of low technical characteristics or by improving both technical characteristics and operational stability of the equipment developed with the account of scientifically based calculation methods.

Our creation of the manufacturing process is based on the first way excluding influence of subjective factors and ensuring quality control by means of heavy-duty mechanization.

RESULTS

Summing up the above-mentioned, the objective was defined - to develop a technological production scheme aiming at 25 tons of frankfurters per shift.

The technological scheme involving dressing (boning) of hot halves on the units of vertical displacement allows to obtain backfat, raw material for half-finished products and sausage meat with the obligotory fat deficiency.

To create fat deficiency in meat the project specifies separate backfat and side fat separation from pork halves and then after grinding conveying it into storage tank.

Meat is conveyed on a metallic belt for grading where it is separated into meat for half-finished products and into sausage meat which is in turn conveyed into grinders.

Ground meat is conveyed into tanks being intermediate storage means for different types of raw material. Their measurements correlate with the floor capacity and the amount of raw material delivered. Aiming at unification and possibility to vary the types of manufactured product it is necessary to use storage tanks of common modification - with the bowl capacity $3m^3$. It creates some stock of each type of raw material and ensures continuous floor functioning during 2.5-3.0 hours. Storage tanks are compound in such a way that from each tack raw material is conveyed by ASTPC to a batcher in a strict sequence.

Weighing is done with the help of strain gauges with signal generation. All operations including batching of mince components are passive as they do not form the products structure, they only predetermine its basic composition.

The main operations are as follows:

The batched raw material is de-

livered into mixers. These machines affect greatly quality of the raw material, its consistency and uniformity of the components distribution.
The study into technological effectiveness of intensive processing of the raw material with components in the mixers (additives according to the recipe) has shown that processing time should vary in a significant range according to quantitative and qualitative characteristics of the raw material. It was established that for a more viscous composition the level of optimum energy costs is approximately 2.2-2.5 times higher than for a composition of a lower viscosity. Thus the statement is affirmed that insufficient as well as excessive mechanical processing deteriorate quality of the batch.
To improve mass transfer it is recommended to use screw conveyors in mixers; screw spacing, spiral width and rotational spped being sufficient for a mixer's capacity of $2m^3$, so volumetrical screws feed inside a bowl should 3-4 times exceed the maximum capacity of the machine. This causes part of the conveyed mix to return through the middle cross-section, creating its forced circulation.
Owing to the two operational members, rotating in the opposite directions without overlapping each other mass transfer in the cross direction is improved.
The aim of developing machines for intensive mechanical treatment of comminuted meat structures depends on some aspects connected with the choice of optimum values of the main technological parameters, measurements of the working members, rotational speed, drive capacity. The shorter processing time is, the more compact and less metal-intensive the machine may be. However processing time being lower than the determined level may affect adversely the products quality.
To determine the processing time exactly an empirical formula may be recommended:

$$T = \frac{V}{G} \times \rho \times \varphi ,$$

where V - volume of the mixers bowl, m^3;
G - capacity of the machine, kg/hr;
ρ - density of a mix, kg/m^3;
φ - filling coefficient of the bowl operational volume.

For the mixing device chosen for the design it was established that at the capacity of 2500 kg/hr, mix density of 1020 kg/m^3, filling coefficient of a bowl equals to 0.7, processing time will by 36 minutes.
This value is in a good accordance with practice. With the shorter period of mechanical treatment the processes of proteins swelling, enzymatic effect and pure solving lack time for development as the process of discrete cutting is substituted for the high-speed comminuting of mixture in a continuous machine. Mechanical processing of a long duration stimulates proteins denaturation in the main meaty components.
Precision of components measuring effects dramatically quality of the finished products. In practice, screw, drum and belt dosers (measuring devices) may be used for coarsely cut meat.
Screw dosers are very simple by their design but they lack accuracy of measuring ($\pm$ 7 kg and more). Besides, during a working shift they obtain significant time variations reaching $\pm$ 10% and even more.
Drum dosers are more compli-

cated, however, they provide measuring accuracy not more than K ± 3% with the shift variations of 8-10%.
Belt dosers have the most complicated design providing the highest measuring accuracy K ± 0.5%.
A combination of a screw doser with a weighing platform seems interesting. The system is connected with automatic feed control; it allows to normalize composition according to actual batch ensuring final products with insignificant variation in quality parameters.
Taking into consideration benefits of tucker measuring pumps for liquid components and trying to get rid of the shortcomings of the existing devices tucker measuring pumps with forced mechanical valve control may be recommended.
After mixing comminuted meat is conveyed by a pressure pump into a continuous finely mincing unit for obtaining meat emulsion. Mincing is performed under vacuum. The power consumed equals to 92 kVhr.
The unit consists of two storage tanks (to accept comminuted meat and final emulsions) and a machine for fine mincing. The final emulsion is conveyed to molding devices. The ready link of frankfurters is passed by a manipulator to the frame where it is arranged in two rows providing specific load and mechanization. Frames with frankfurters are grouped and carried by means of spatial conveyors to the cooking tunnels, then to the unloading unit for removing frankfurters from the frames and after that to the cutting device to separate links into single frankfurters. High-quality frankfurters by means of orientation are collected and packed into boxes containing 10-12kg.
The process of frankfurters manufacture is pursued by ASTPC and automation system.

CONCLUSIONS

Thus, the developed continuous frankfurter manufacturing process includes: vertical boning of halves, the use of the prerigor raw material, elimination of meat ageing in cure; raw material normalization by fat.
All this becomes possible only if non-standard equipment is designed and ASTPC is applied.
The process will allow to manufacture both traditional and new types of products.

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