The mechanized line for the production of livexes.

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The liquid form of the full animal blood and its fractions is a basic obstacle in the economic utilization of blood on a wider scale. As fluids, these media have no mechanisms protecting against the invasion and proliferation of microorganisms, whereas the chemical composition of these media provides optimal conditions for the growth of bacteria. Therefore, by the application of traditional methods in the food industry, the full blood or blood plasma used for further processing contains a high number of bacteria. This has a negative influence on the quality and durability of those food products which are produced with the addition of blood or its plasma.
The use of raw, liquid animal blood for feeding of animals is not possible for epizootiological reasons. Thus, in order to be used for feeding, the blood is being per-processed by means of mechanical, physical, or chemical methods, or a combination of them. However, none of these methods can ensure a proper quality of products, although the methods used are both energy- and finance-consuming. The lack of simple and cheap methods of blood processing which would help in producing fodder components of high quality, is the reason that too often the blood is being disposed of into the sewage system as a useless waste liquid,or poured over the fields. Such practice must be evaluated as disadvantageous from the viewpoint of environmental protection, and as a waste of valuable animal proteins, too.
The proceedings of the XXX. Meeting of Meat Research Workers (1) give the first information about the elaboration of a new technology of processing the animal blood and its fractions for the purpose of alimentary, fodder, and pharmaceutical industry. Unlike the techniques known hitherto, this one should be regardes as a biotechnological method, since it makes use of the enzymes, which are natural components of blood and its fractions, and cause a natural clotting process. In this process of natural blood clotting, in the last phase of clot forming, a retraction of the clot takes place, during which a fibrin reticule shrinks, thus pressing out the serum enclosed in the clot. This feature has a positive effect in case of wound healing, but as far as the industrial blood processing is concerned, such process is regarded as negative. In result of disturbing the ionic balance in the still liquid blood, a modified natural clot is created which shows no retraction ability.
The clot created with the use of a new technology has a solid form, and all liquid substances and morphotic elements of blood are enclosed within the fibrin reticule. The capacity of the fibrin reticule is greater than the amount of the components of the blood alone or its fractions, and therefore it is possible for the fibrin reticule being formed at that moment to enclose additionally other liquids or small morphotic elements, artificially introduced into the blood or its fractions. Taking advantage of this feature, any modified livex can be produced by the addition of e.g. meat decoction, milk, bran or pea pure, into the still liquid blood, The introduction of various components can have various purposes, for instance to improve the balance between the exogenic aminoacids in a ready product, or to improve its taste by the use of by-products of alimentary industry.
A raw livex does not change its form during several hours and within that time no liquid fraction occur. However, the durability of the raw livex is limited to several hours, since the bacteria present in it continue the process of spoiling. Technological usefulness of the raw livex should also be regarded as limited, since during comminution the fibrin reticule breaks up, and the liquid fractions enclosed inside are liberated. This disadvantageous feature can be fully eliminated by a thermal processing of the raw livex. Before the processing the livex is being cut into small pieces, e.g. 5x5 cm size, which are then thrown into water, heated up to 80^oC. At the last phase, single pieces of livex of the required size undergo the process of scalding in a scalding water, during which all walls in each piece of the modified clot have a direct contact with the water on the whole their surface.

The scalding process properly carried out finally hardens the product, and the raw livex becomes a fresh one. The final hardening is the result of a coagulation of proteins in the pieces of raw livex, and those pieces preserve their original shape. The scalding process properly carried out plays the role of a pasteurization process. Microbiological condition of the fresh livex is very good, and depending on the kind of the additional component introduced into the blood or its fraction, 1 g of the fresh livex can contain from several to several thousand of bacteria. The keeping quality of the fresh livex kept in refrigerator also depends on the kind of the additional component introduced into the blood or its fraction, and amounts from 10 to 28 days.
Depending on whether the full blood or its fraction was used for the production of livex, a respective type of product is obtained - brown livex from the full blood, white livex from the blood plasma, and black livex from the condensed blood cells. If in the process of livex production only hardening media are added, basal livexes are obtained, the addition of other components, such as meat decoction for instance, to the blood plasma gives in result a modified livex, in this case a meat-type white livex.
For the production of any livex, no chemical compounds are used, except for those which are generally permitted for use in the food and fodder industry, and hence are regarded in all countries as harmless for human and animal consumption.
As it can be seen from this short presentation, the technology of fresh livex production is rather simple. When the output of fresh livex production per day is not great, up to 1,5 tons, the production does not require any special equipment or mechanization. The production line in such case can be composed of such devices as barrels or other containers, a scalding trough (tub), and a dripping table. On such basis, 8 processing plants are producing fodder livex in Poland, and 2 in Hungary. Their common output amounts to 2 tons per day. In order to increase this output it would be necessary to mechanize the production line. The project of a mechanized line for the production of any kind of livex has been elaborated in Poland and the industrial production of such lines will start by the end of 1986.
As a starting point for the elaboration of the production line it was assumed that the blood must be stabilized during gaining, before it can be used for the production of any livex. The blood for consumption purposes must be collected according to the existing sanitary requirements, i.e. using a cannular knife, or a vacuum cannular knife, and its fractionation is performed with the use of traditional methods. The blood for fodder purposes can be collected by any method. For instance, it can be the blood from the slaughter gutter, provided that the stabilization has been done.
The elaboration of assumptions for the construction of machines and devices was done according to generally accepted rules, such as: accessibility to assemblies, subassemblies, and other parts during mounting, exploitation and renovation works; easy exchange of assemblies and parts, safety of maintenance personnel, easy cleaning and disinfection; easy filling and emptying of containers with raw material or livex; efficiency of automatic control

and temperature regulation, as well as of the control of duration of particular phases of processing. The noise during the line functioning should not exceed 85 dB/A, and the degree of electrical equipment protection should not be lower than JP-55 mg ST SEV 778-77, and the insulation strength of the wiring system should not be lower than 1M. All devices will be equipped with motor overload preventive media.

Taking all these assumption into account, a completely mechanized technological line for the production of any livex, for food, fodder or pharmaceutical purposes, has been worked out, and the solution is presented in the scheme 1.

For the sake of simplicity, the scheme does not include that part of the line which takes care of blood collection and fractionation. The omitting of this part can also be explained by the fact that the blood for fodder can be gained from the adapted slaughter gutter and then pumped out or poured out into the transporting containers. Thus, the scheme 1 presents particular devices according to the phases of livex production, with a short description of each production phase. And so:

1) Preparation stand for blood stabilization. Here, a proper stabilizing solution is prepared, which is then introduced into the blood. A precise standardization of the solution is an essential operation in view of further destabilization of the blood. This stand can be modified so as to serve as a stand for the proportioning of a dry natrium citrate onto the bottom of the slaughter gutter. Before such modification, the slaughter gutter should be respectively adapted, since the citrate must be dissolved by the first portion of the falling blood, and then it should be uniformly distributed over the whole mass of the subsequently collected blood.

2) Container for blood storage. Only short-term storage of blood is planed. In principle, this container should serve as a device at hand, from which the collected blood will be transported in portions to further processing stands.

3) Container for components. One container for components is shown in the scheme. Depending on the kind or kinds of livexes to be produced in a given department, two or three such containers may be necessary. For the production of a basal livex only one container is required, in which the solution of hardeners in proper concentration will be kept. For the production of livexes modified with a given component, for each component a separate container will be necessary, unless it is assumed that several components will be used together for the production of one given modified livex. In such case the components can be mixed together in one container. The container for the solution of hardeners will be provided with a mixing arm, which should enable the preparation of the solution, composed of water and various chemical compounds poured into it.

4) Containers for the production of raw livex. These containers will have small capacity, between 40 and 50 kg each. Into each container the blood or its fraction, hardeners, and possible modifiyng media will be put separately. The mixing of all components will be done by means of the pouring, manual stirring can be limited to a single one-second stirring of the mixture. It is assumed that the time of raw livex formation, depending on the kind of the livex to be obtained, will not exceed 60 minutes, and hence the respective number of containers should be chosen to ensure the continuance of production.

5) Conveyor for the containers with raw livex. This conveyor will be in constant motion, so that empty containers will be transported to the feeder of components. The raw livex will be formed on this moving conveyor and the containers with the ready raw livex will be taken to the scalding unit.

6) Jack for lifitng of containers with raw livex. A container will be lifted with this jack to the level of the scalder, and then it will be tilted so that the livex inside the container drops out into the scalder.

7) Machine for cutting of raw livex. The livex falling out of the container into the scalder must go through a cutting machine, mounted at one end of the scalder. The cutting machine will be composed of a metal truss with optimized mesh size, e.g. 5x5 cm. The cutting of livex will be done gravitationally.

8) Scalder. The scalder will work in a continuous mode of operation, based on a worm-wheel effect. Thanks to that effect, a continuous movement of all livex cubes is obtained, and thus each livex cube has a constant contact with the scalding water of an equalized temperature. In result of this procedure each cube will receive the same amount of heat, and the scalding effect, and hence the pasteurization, will be the same for all cubes. The temperature of water in the scalder will be kept at a constant level of 80°C $\pm$2°C, with the use of steam heating at a pressure of 5-6 atm. The steam consumption during the scalding of livex, depending on the input amount of livex and scalder size, can reach up to 350-750 kg/h. Water temperature is controlled by means of a thermo-pressure valve, and a worm-wheel speed governor installed in the scalder will permit the setting of the scalding time so that the scalding effect, i.e. the protein coagulation and pasteurization, would be in conformity with the requirements.

9) Taking out the fresh livex of the scalder. As soon as the process of scalding and pasteurization is completed, the livex, being lighter than water, floats up to the surface and can be collected from it mechanically, and put onto perforated trays or thrown into another worm-wheel device with cold water.

10) Warm-wheel device with cold water. The time in which the fresh livex is passing through this device must correspond to the time required to cool down the livex to ambient temperature in case of using pure water, or to refrigeration temperature in case the ice is added to the water.

11) Trays with fresh livex. The tray surface is big enough to bear 15 kg of the fresh livex, and each tray is provided with a draining pan for effusion.

12) Conveyer for initial draining of livex. The conveyer works as a moving belt which transports each tray to carriages where the trays are gathered together.

13) Carriages with shelves. The carriages for collecting of trays are provided with shelves mounted on several levels. The carriages filled with trays are transported to refrigerating room.

A productivity of the constructed line can reach any amount, respective to the production output at one shift. It is assumed that lines with productivity of 0.5, 1.0 and 2.0 tons/h will be built. When choosing a line with the optimal productivity, the technological efficiency of a given livex must be taken into account, since it is different for various kinds of livexes. And so, for instance, the productivity of the white livex fresh and basal is ca.80% in relation to the amount of the processed blood plasma, for the brown basal livex it is ca.99% in relation to the blood used,and for the brown livex modified with whey in the ratio 1:1 it is ca.130% in relation to the mass of the blood used, or ca. 65% in relation to the mass of the bllod-whey mixture.

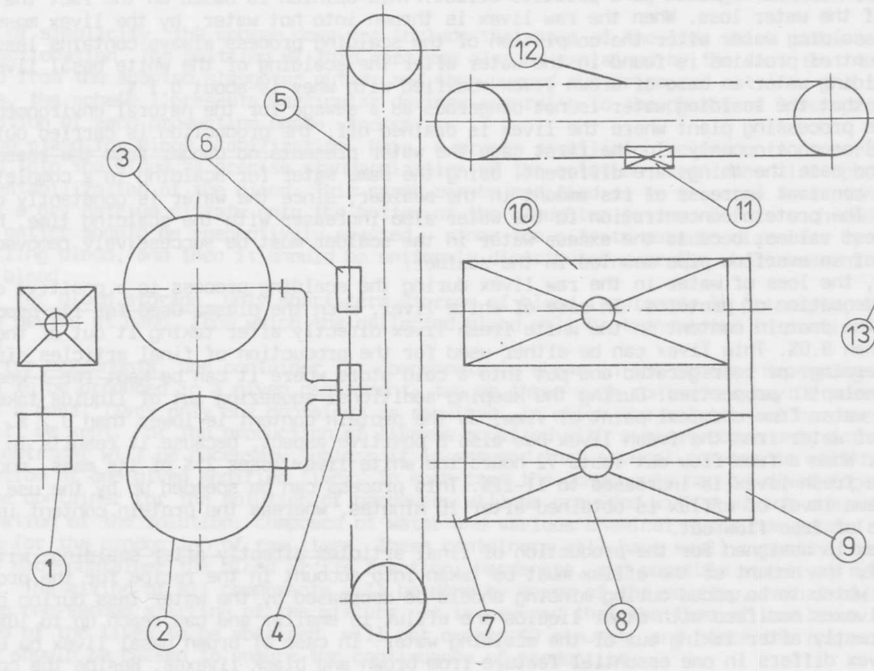
The said production output is obtained when the whole amount of the fresh livex will be collected after the scalding process is completed. During the scalding the pieces of livex are in constant motion, in result of which certain amount of the livex is being crushed into small particles. The crushed livex has different properties from the livex in pieces, and does not float up to the water surface but sinks to the bottom of the scalder. This settled livex preserves its shape and can be fully retrieved by draining off the scalding water through a dense

cloth, e.g. a cloth for cheese-making. The mass of that livex amounts ca. 10 percent of the whole fresh livex. The draining off of scalding water through the cloth for cheese-making is not necessary by the assumption that the whole amount of this water will be gathered and sold as fodder. Particularly, duck breeders are very interested in buying it.
A real mass decrement of white basal livex and brown modified livex during the scalding is of essential importance, but this decrement should be regarded as a positive effect. This opinion is based on the fact that the mass decrement is a result of the water loss. When the raw livex is thrown into hot water, by the livex mass to water mass ratio as 1:1, the scalding water after the completion of the scalding process always contains less than 0.3 % of proteins. Such amount of proteins is found in the water after the scalding of the white basal livex, the protein content in the scalding water in case of brown livex modified with whey is about 0.1 %.
This results prove that the scalding water is not dangerous as a sewage for the natural environment.So, it can be assumed that in the processing plant where the livex is drained off, the production is carried out either in one cycle (small plant) or cnotinuously. In the first case the water presents no danger from the reasons mentioned above, in the second case the things are different. Using the same water for scalding in a complete production shift results in a constant increase of its amount in the scalder, since the water is constantly drained off from the scalded livex. The protein concentration in the water also increases with the scalding time, however it does not reach the highest values, because the excess water in the scalder must be successively removed. This is achieved by means of an overflow pipe mounted in the scalder.
As mentioned above, the loss of water in the raw livex during the scalding process is a positive effect, as it brings about a condensation of proteins. In case of white livex, when the plasma used for its production contains 6.3% of proteins, the protein content in the white fresh livex directly after taking it out of the scalding water is somewhat less than 8.0%. This livex can be either used for the production of final articles directly after the completion of processing, or refrigerated and put into a cold store where it can be kept for 3 weeks without worsening its organoleptic properties. During the keeping additional squeezing out of liquids takes place, these liquids being pure water from chemical point of view, as the protein content is lower than 0.2 %.
The squeezing out of water from the fresh livex has also a positive aspect, because it results in further condensation of proteins. When a free flow out lasts 72 hours the white livex loses 25% of its mass, and hence the protein content in the fresh livex is increased to 11-12%. This process can be speeded up by the use of a press, and in that case the same level of efflux is obtained after 10 minutes, whereas the protein content in the efflux is the same as in case of free flow out.
When the white livex is assigned for the production of final articles directly after scalding, without free or forced draining off, the amount of the efflux must be taken into account in the recipe for the product. It means that the amount of water to be added during mincing should be decreased by the water loss during draining off.
In case of brown livexes modified with other liquids the efflux is smaller and can reach up to 10% of the livex mass determined directly after taking out of the scalding water. In case of brown basal livex no efflux takes place.
The fresh white livex differs in one essential feature from brown and black livexes. Beside the coagulation of proteins during the scalding of white raw livex, a secondary coagulation during the subsequent thermal processing takes place, when this processing is carried out at a higher temperature than that during scalding. This phenomenon is particularly visible when the livex is being put into sterilized cans in form of a minced mass. After the substitution of 10 percent of meat mass with a minced livex, the consistence of products is much better than that in control samples.
The possibility of drying was not taken into consideration while elaborating the construction of the mechanized line for the production of livexes. The omitting of this production phase, however important from a technological point of view, was based on the assumption that each livex can be dried without problems in any drying chamber used in alimentary or fodder industry for drying of solid products.

REFERENCES:

1) Zaleski S.J. et al.: Livexes - the products of biotechnological processing of animal blood for consumption, fodder, pharmaceutic and cosmetic purposes. Proceedings of the XXX Meeting of Europ. Meat Res. Workers, Bristol, 1984, 7.3.

SCHEME 1. A PROJECT OF THE MECHANIZED LINE FOR THE PRODUCTION OF LIVEXES



* explanations of the number can be found in the text of the paper