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TECHNOLOGICAL DEVELOPMENT OF THE MEAT PROCESSING INDUSTRY,

DP/MON/72/005

MONGOLIA,

Technical report:
ASSISTANCE IN TECHNICAL MICROBIOLOGY AND HYGIENE, MEAT AND MILK INDUSTRIES,

Prepared for the Government of Mongolia by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

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Technioal report: Assistance in technioal microbiology and hygiene, meat and milk industries

Prepared for the Government of Mongolia
by the United Nations Industrial Development Organization,
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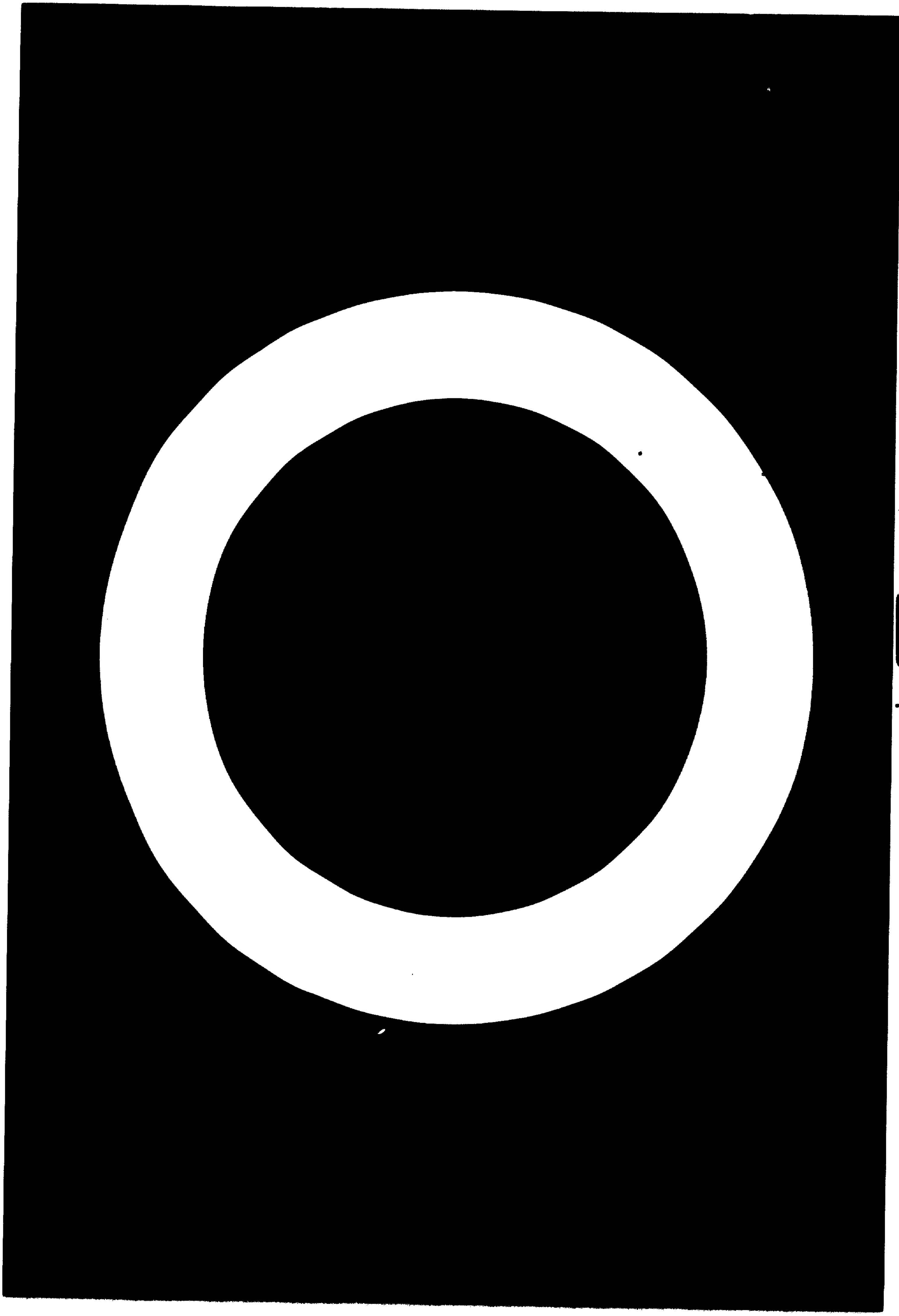
Based on the work of S.W. Szozepula, meat industry miorobiologist

United Nations Industrial Development Organization
Vienna, 1976



ABSTRACT

This report was prepared by the expert on meat industry microbiology assigned to the project "Technological Development of the Meat Processing Industry" (DP/MON/72/005) in Mongolia.

The expert began her 18-month assignment with a review of existing conditions in the meat and milk industries and of present needs in technical microbiology and hygiene at Ulan Bator, Darkhan and Choibalsan. Hygienic standards were found to be unsatisfactory and microbiological control almost non-existent. Lists of the literature, reagents and equipment needed to improve the situation were drawn up, and the reagents and equipment were subsequently ordered and delivered to the project site.

Part of the expert's work involved training in industrial microbiology and in procedures for the protection of products, especially:

(a) Cleaning, washing and desinfecting of accommodations, equipment and small utensils;

(b) Processing raw materials (meat and milk);

(c) Transport facilities to the factory lines;

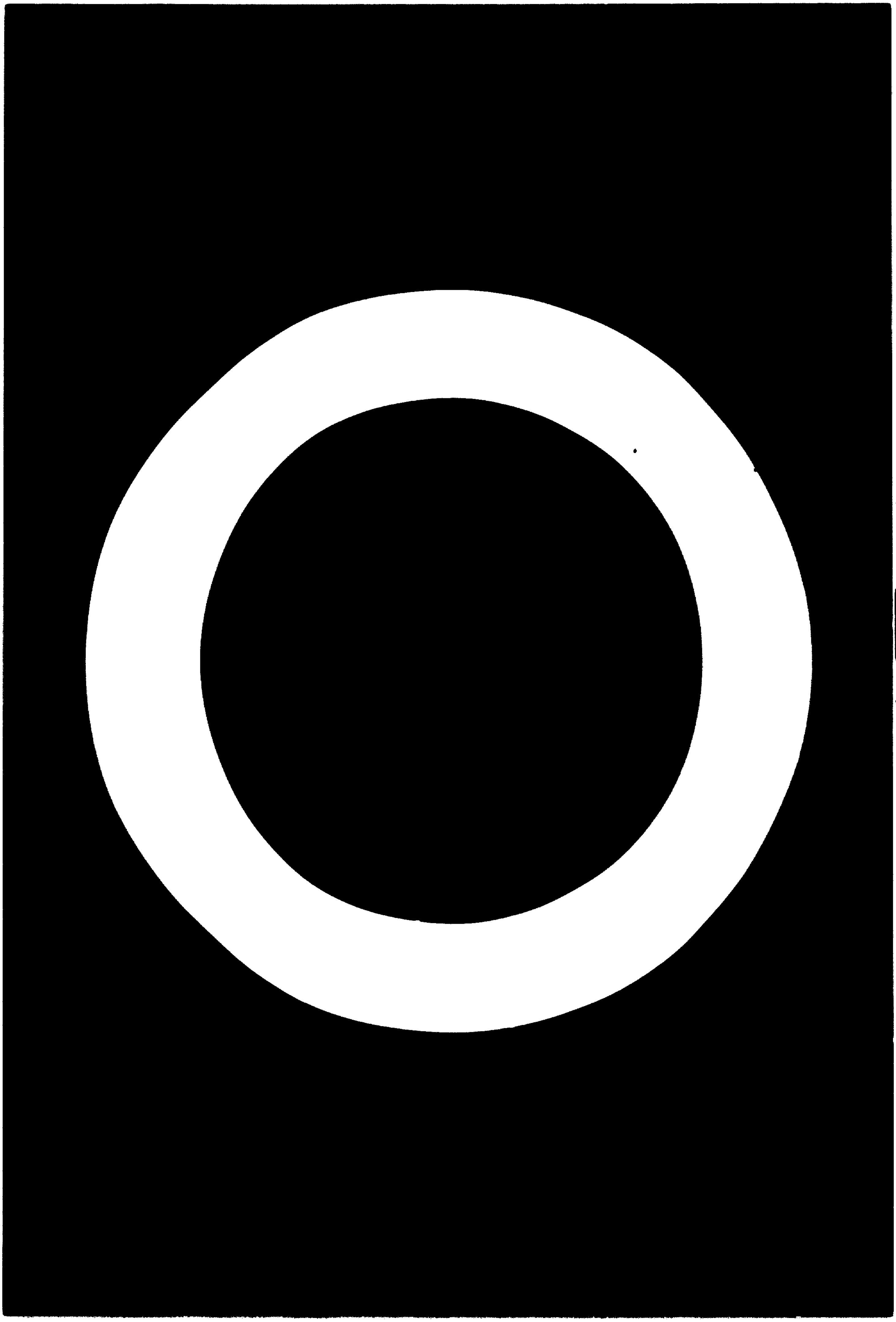
(d) Microbiological checking of products;

(e) Microbiological analyses of raw materials and final products.

Teaching was carried on by lectures, seminars, practical demonstrations and on-the-job training at the meat and milk plants. In the final stages there were examinations.

Efforts were made to improve the existing sanitary conditions in the plants at Ulan Bator, Darkhan and Choibalsan. A microbiological laboratory in the Darkhan meat plant and three microbiological laboratories in milk plants were organized. In addition, a plan for installing a microbiologioal laboratory at the Choibalsan meat plant was worked out. The meat industry microbiologist worked closely with the other experts on the same project, and with experts of the World Health Organization (WHO) concerned with fighting Brucella sp.

An outline for a second phase of the project involving six months of expert services was prepared and has been accepted in principle by the Experimental and Research Institute and by the Ministry of Light and Food Industries. The expert's recommendations on hygienic control of meat and milk plants and on microbiological analyses have also been accepted for implementation.



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INTRODUCTION

Project background

A project to develop the meat processing industry was requested by the Government of Mongolia and approved by the United Nations Development Programme (UNDP), with the United Nations Industrial Development Organization (UNIDO) acting as executing agency. The government co-operating agency was the Ministry of Light and Food Industries. The principal location of the project was at Ulan Bator at the Experimental and Research Institute of the above Ministry and at the meat processing plant, with periodic visits to the meat and milk plants at Choibalsan and Darkhan.

The meat industry microbiologist began the assignment in Mongolia on 19 May 1974 and finished on 21 February 1976, with a break in work necessary for the purchase of the required equipment and reagents and for co-ordination of the activities of the other experts working on the project. In September 1974, F. Vinokurov joined the project and in July 1975 K. Szerdakholyi. Both were experts assigned by UNIDO.

Work programme

The purpose of the meat industry microbiologist's work was to provide the latest experience in the safe processing of meat and milk from producers to consumers. The primary purpose of good meat and milk hygiene practice is, of course, to prevent transmission of diseases to people and to provide a safe, wholesome product for consumption. The secondary aim lies in the reduction of losses in milk, meat and their by-products.

According to her job description, the expert was to:

(a) Elaborate a programme for process, quality and microbiological control in the meat and milk processing industry;

(b) Elaborate a programme for scientific and practical experimental work;

(c) Assist in improving the organization and technical operation of laboratories in order to improve quality control of raw materials, semi-finished and finished products;

(d) To accomplish (c), prepare specifications for the required equipment;

(e) Train counterpart personnel in laboratory techniques and prepare a further training programme as required.

In conjunction with the Experimental and Research Institute, the expert prepared a detailed programme of work encompassing scientific and practical experiments and training of laboratory staff in microbiological methods. The training was to be carried out by means of seminars and lectures emphasizing the need for improved hygiene during processing and for continual microbiological control.

The work programme was subsequently confirmed by the Ministry of Light and Food Industries.

The first part of the expert's programme entailed becoming familiar with the livestock situation in Mongolia, visiting the existing meat and milk plants and learning about the microbiological analyses being made at the operational laboratories.

Animal husbandry in Mongolia

In the development of industry and agriculture in Mongolia, animal husbandry plays a major role in agricultural output. Mongolia leads the world in the amount of agricultural land taken up with pasturage: 83.5 per cent consists of pasturage, 0.8 per cent is meadows and 0.5 per cent is cultivable. The number of animals (cows, yaks, horses, camels, sheep and goats) per person is also one of the highest in the world.

The animals are used mainly for meat or milk or for both. Throughout many centuries of free breeding, they have become habituated to specific conditions. They stay in the open all year round, enduring heavy winters and dry seasons when food and water are scarce. All these factors have influenced the seasonability of slaughtering and milk supply.

The average weight of Mongolian cows is 250-300 kg. Their milk yield is extremely low (600-1,000 litres yearly) but has a very high fat content (4-5 per cent).

Calf-raising uses up 50 per cent of the milk supply. Cows usually calve in April or May and the period of lactation comes to an end in November-December. The slaughter of livestock usually lasts from June to December.

It is worth pointing out that methods of breeding and reproduction are gradually changing. It is now recognized that building warm quarters for livestock is essential for increasing the cattle population. Moreover, water-supply is of national importance because of sparse rainfall (mainly in June and July). Over the last four years 17,000,000 hectares of pasture have been irrigated, which could increase the production of hay for supplementary feed during wintertime.

One of the most important aims of the Mongolian authorities is to increase the live-stock population to bring about expansion of the meat and milk industry.

The Government is also concerned with the production of new hybrids to provide more milk and meat. In recent years large breeding farms have been organized, where livestock is raised in confined areas rather than in pastures. Hybrids of imported cows with Mongolian breeds are giving an increase in weight of 320-400 kg and an increase in milk of up to 1,800-2,400 litres per cow yearly, with an average fat content of 4.26 per cent.

In some districts a large percentage of milk (up to 75 per cent) comes from yaks. Yaks are used for many products and purposes: work, milk, meat, wool, hair and leather. While yak-cows are poor milkers, the fat content of the milk reaches 6-8.6 per cent. Butter made of yak's milk has an agreeable aromatic flavour and does not easily turn rancid.

In Mongolia there are about 850 points where milk is collected and 280 small points where butter is produced. Milk is processed mainly in large centres at Ulan Bator, Barkhan and Choibalsan. The same centres have slaughter-houses.

Three meat processing plants have been built in Mongolia. These plants are not in full operation yet, and assistance was required in:

(a) Products development;

(b) Instruction in adequate processing technology;

(c) Quality control and microbiological control in all phases of production;

(d) Utilization of the existing laboratory equipment;

(e) Training of personnel.

Situation in meat and milk plants when the project began

Ulan Bator

The meat industry section of the plant had an equipped laboratory with a chemical and a microbiological department. The microbiological laboratory was sufficiently equipped to provide routine analyses of meat and meat products. The laboratory staff consisted of one microbiologist, two laboratory workers and one technician from the German Democratic Republic. The analyses made were not thorough and the methods used were in need of improvement.

The milk plant had neither laboratory facilities for microbiological investigations nor personnel trained to undertake suoh investigations.

Darkhan

Although the meat plant started operations in 1974, the rooms designed for the laboratories were left unorganized, with new equipment still unpacked. According to the work programme, the expert was to have trained a microbiologist and two laboratory workers in this plant.

The milk plant had a small laboratory, whioh was not making microbiological examinations.

Choibalsan

The meat plant had no miorobiological laboratory and personnel trained to organize and oonduot laboratory work.

The milk plant had a small laboratory whioh was not yet in operation.

This review of the situation clearly indioated that the danger of distributing infected products was very high owing to lack of miorobiological oontrol of meat and milk products.

I. FINDINGS

The project "Technological Development of the Meat Processing Industry" covers meat processing technology together with microbiology of meat and meat products and milk and milk products. Implementation of the plan of work in microbiology proceeded as follows:

(a) Training in microbiology on two levels: for persons with university education and for technicians;

(b) Discussions with plant authorities, with explanations of the danger of distributing food products without continued microbiological examination;

(c) Gradual introduction of microbiological analyses and participation in the work of the laboratories;

(d) Organization of microbiological laboratories in all plants except Choibalsan and introduction of methods of laboratory investigations;

(e) Preparation of specifications for the necessary equipment, reagents, media and books (see annexes IV-VI)

Of the equipment needed, the items ordered during the project are now in Ulan Bator. A list of required microbiological books in Russian has been given to the management of the Experimental and Research Institute.

Training began with microbiological analyses in all centres of the meat and milk industries, except the meat plant at Choibalsan. There, space for laboratories has not yet been designated by the authorities, so that equipment and nutrient media could not be sent because of the danger that the media could be damaged in improper storage conditions. It is of urgent importance that the authorities be impressed with the need to intervene quickly and effectively to change this stituation.

Since the Experimental and Research Institute is still being organized and built up, scientific staff is conducting research work in the milk and meat plants. Microbiological research is not conducted because the scientific staff, although highly educated and experienced, has insufficient knowledge of microbiology and biochemistry. Lack of knowledge of these disciplines could interfere with proper understanding of technical processes, the parameters used and the satisfactory interpretation of experimental results.

The danger of distributing unpasteurized milk and milk products is great. Widespread Brucella sp. as well as common pasturage of cows and sheep create a danger of Brucella in milk and milk products. This situation calls for immediate, continued and effective intervention. The work demands wide knowledge of both microbiology and milk technology. Establishing the exact parameters of pasteurization is a matter of top priority.

Moreover, faulty handling of meat and milk in unsanitary conditions not only causes contamination and rapid growth of bacteria but also adversely affects the quality of the products.

The most effective step that could be taken would be to obtain help in the technical training of staff at all levels and, in particular, in the training of practical, production-oriented technical management. Although many of the technicians have been trained abroad, they have come to occupy positions entirely unrelated to the training received. It can be expected that the more well trained people there are, the greater the possibility of changing a static and inadequate situation.

Raw materials

The meat industry in Mongolia is generally based on the manufacture of beef and mutton, with products consisting of beef meat and mutton fat. Horse meat is also used, and much of the Experimental and Research Institute's work is devoted to the technology of processing horse meat.

In addition, a significant percentage of yaks and yak-hybrids as well as ordinary cattle whose meat is different from regular beef influences the value of raw materials and final products. Because yaks live exclusively in Asia, it seems necessary to add a few words about them.

Yaks attain their full body weight at six to seven years of age. Mature bulls weigh 380-400 kg and cows 260-270 kg. Owing to its high haemoglobin and low fat content, yak meat is characterized by an intense dark-red colour. The meat, which is unmarbled and coarse-fibred, is very suitable for sausages (an important fact since there is not enough pork for sausages). Yak fat, owing to its high carotene content (19 mg per 1 kg of fat), is dark yellow.

A certain difficulty arises because of the very specific technologies required for processing the milk and meat of such local animals as yaks and koumi, in that a limitation is placed on the possibility of direct transfer of technology from institutions in advanced countries with greatly differing conditions.

Introduction of new products

The experts working on the project were entrusted with introducing new products, especially techniques of sausage fermentation, as in salami. Prescriptions were worked out for the new products along with heat processing parameters, depending upon the microbiological picture of the raw materials. Instructions were given to the local staff dealing with: new working methods; washing and cleaning; disinfection; cleaning and wiping of carcasses; proper timing of preparation of materials; and interpretation of microbiological results.

The finished products were organoleptically and bacteriologically checked by the experts, and after receiving a proper microbiological picture, pasteurization parameters were passed on as instructions for industry.

Particular attention was paid to salami production. Various kinds of meat were evaluated as to their tendency to infection. It was proved that mutton could not be used for production of fermented sausage because of the high level of Brucella melitensis infection.

Fermented sausage already made from mutton must be treated with high temperatures and then organoleptically checked.

Salami-type sausage is fermented in lactic acid to produce the desired tangy flavour. The success of this procedure depends on developing the lactic acid bacteria that normally contaminates the sausage mixture or on adding a starter culture to induce controlled fermentation. Meat used for the production of these sausages has to meet high microbiological standards, while the production process itself has to be carried out under sanitary conditions that eliminate the possibility of secondary infection. If both these requisites are fulfilled, an acceptable end-product is guaranteed.

Hygiene

Currently, the hygienic standards of Mongolia's food industry, particularly the meat industry, are unsatisfactory. This is caused by lack of knowledge of microbiology and by not appreciating the adverse effects of poor hygiene on consumer health and financial prospects.

The meat industry

Meat handled in production lines has usually not been washed, a primary reason for the high incidence of infections. In spite of constant urging from the expert, this situation has not yet improved.

The highest standard of hygiene has been reached in a sausage production department in the Ulan Bator meat plant. This is the result of good understanding by the authorities and technical staff of the problems caused by inadequate hygiene.

The expert gave a lot of attention to hygiene in cold storage plants. Consequently, sanitary conditions in cold storage and deep freezing compartments have improved considerably.

Technical staff was instructed in meat processing plant hygiene according to the plan outlined in annex II. The presence of three experts at the meat plants (the microbiologist and two meat industry technologists) broadened the scope of professional activities possible under the project, permitting sanitary conditions and microbiological interpretations to be considered. Later, the efficiency of using heat was demonstrated by examining samples microbiologically.

Hygiene and sanitary precautions in the technological departments were taught in the following way: at least twice a week hygiene inspections were held in the plants, conducted by the experts together with the heads of departments and technological staff. These inspections were closely related to the professional training in hygienic aspects.

The milk industry

In the milk industry, the expert's efforts were concentrated on organizing the laboratories and training laboratory staff in the required bacteriological analyses of milk and milk products, as well as in improving standards of hygiene in milk processing. Hygiene in the milk plants has now been raised to a satisfactory level. However, for continued effectiveness, these efforts have to be translated into a daily routine incorporating the basic principles of washing and disinfection.

Brucella sp. in milk

During the project a problem unforeseen in the work programme arose that required rapid action. The presence of Brucella sp. was detected in milk coming from the biggest farms. Analyses were made of hundreds of milk and cream samples to test for Brucella sp. These examinations were conducted in the Darkhan plant and in pastures and farms near Darkhan during milking. More than 90 per cent of the milk samples proved to have been infected with Brucella sp.

To remedy this dangerous situation, special parameters for pasteurization (time and temperature) were worked out after the bacteriological picture following pasteurization proved that the milk and cream could be distributed. The pasteurization process was fully effective in killing the Brucella sp.

Similar actions were taken at Choibalsan and Ulan Bator.

Co-operation with the World Health Organization (WHO)

Close co-operation has been established with a project organized by WHO to combat more effectively Brucella in Mongolian live-stock. It was suggested that the WHO project confront not only the problem of infection in live animals but also in animal products. Particularly dangerous are infectious contacts among people working in slaughter-houses, especially those where sheep are killed. It was agreed that the WHO project would organize a permanent sanitation and health programme for meat industry employees. This programme was subsequently fully implemented. All laboratory staff and technologists, including those in the country, were trained in using the simple and fast red ring test for detecting Brucella sp. in milk.

Training

The training programme covered the microbiological analyses necessary in particular industries and the preparation of basic media. A detailed account of the subjects taught during the project is given in annex III.

Training was carried out by means of lectures, seminars, on-the-job training, consultations, discussions and written instructions. It took place in six centres in the Ulan Bator, Darkhan and Choibalsan meat and milk procesing plants. The courses were conducted under difficult circumstances in that the expert had to do all the preparations unassisted.

The counterparts showed a genuine interest in theoretical and practical training, but uneven attendance detracted from the success of the courses. Of the 19 persons who started training, 14 remained until the end of the project. Training proceeded systematically with the use of the available equipment. All laboratories were sufficiently equipped for conducting microbiological examinations of plant facilities and products, except the one in the Choibalsan meat plant.

Two counterparts completed the training programme with an examination before a commission composed of the Institute manager, the meat plant manager and the expert. The examination covered the whole training programme on technical microbiology.

Other counterparts who received training passed more limited, informal examinations. These informal examinations were based on the kind of professional activity to be performed later, e.g., milk examination, bacteriological meat examination etc.

In general, the project's training objectives were fulfilled, with the co-operation of the Mongolian authorities.

<u>Achievements of the project</u>

During the course of the expert's assignment, the best results were observed in the following areas:

1. Management personnel in the milk plants came to understand the necessity of conducting microbiological analyses and of subjecting milk and milk products to high temperature pasteurization.

2. Following the testing of milk samples for <u>Brucella</u> sp. under the expert's supervision, all three milk plants have continued to administer this test routinely.

3. The authorities of the meat plant at Ulan Bator now realise the importance of improved hygiene during production and of constant microbiological control.

4. Examination of meat products during processing at the Darkhan meat plant has begun.

5. The organization of courses on microbiology with final examinations is proceeding.

II. RECOMMENDATIONS

Based on her experience in Mongolia, the expert recommended that the following steps be taken to supplement activities begun during the project:

1. The project should continue for several years, through the provision of short-term consultants corresponding to seasonal needs.

2. The skills and knowledge of laboratory workers should be systematically improved by means of training courses. In particular, further education in microbiology is necessary. Some courses should concentrate on staff who have already done microbiological examinations, to improve their ability to identify micro-organisms. Other courses should be introductory. Outside help in microbiological training will be necessary, preferably by three or four experts working together. Since microbiological training is a complex subject requiring extensive secondary activity, one expert alone cannot be fully effective. Specialists in technical as well as in veterinary microbiology will be required.

3. The training should be extended to the staff of the Experimental and Research Institute and should cover microbiology, laboratory sciences and research methodology.

4. The training programme outlined in annex III should be repeated until local specialists in microbiology are able to assume responsibility for conducting further courses in all local centres. Refresher courses should be given yearly. These would be of great importance in improving food technology and hygiene, protecting consumer health and decreasing raw materials losses.

5. Courses should be started at Darkhan and Choibalsan as soon as possible. The existing reagents and equipment, including apparatuses and media, are sufficient for the training.

6. An effort should be made to provide fellowships enabling laboratory workers to study abroad modern laboratory techniques that would benefit the establishments to which they would return.

7. The microbiological laboratory at the Choibalsan meat plant should be activated as soon as possible, in accordance with the suggestions and instructions left by the expert with the relevant authorities. The equipment and reagents provided by the project are adequate for instituting full microbiological control.

8. The post of Chief Laboratory Specialist at all laboratories should be occupied by a highly qualified laboratory specialist.

9. The Experimental and Research Institute should provide information and guidance to all the laboratories of the food industry. It should maintain close ties with these laboratories and oversee their activities.

10. In addition, co-ordination should be set up with other institutions at Ulan Bator, Darkhan and Choibalsan involved in microbiology, e.g., the Sanitary and Epidemiological Station, Institute of Epidemiology and Microbiology, Anti-Brucellosis Dispensary, Veterinary Institute, etc.

11. The food industry laboratories should be regularly provided with equipment, reagents and media, and attention should be paid to maintaining and repairing the equipment on hand. The current supply is sufficient for routine analyses.

12. A permanent, systematic check is needed of all meat industry employees in order to control Brucella sp.

13. Microbiological control of food should be done in an international context, by establishing international standards for food. In Mongolia, standards should be established for:

(a) Raw products and ingredients;

(b) Plant sanitation and methods of packing, storing and handling;

(c) Finished products for marketing.

Meat and milk products should be distributed only after receiving a miorobiological control certificate.

14. Progress in food processing must be backed up by technical research. Research in microbiology is urgently needed and should involve both short- and long-term programmes. Additionally, the exohange of scientific knowledge should be promoted.

15. When the Institute has been completed, assistance will be needed to organize research activities in microbiology. Fortunately, the necessary expenditures on microbiological analyses are relatively low.

16. Much applied research needs to be undertaken by the Mongolians, to which international experts can contribute by selected training of staff. However, lack of technology is only one of the factors impeding development in Mongolia. The successful application of new technology depends not only on increasing the number of trained personnel but also on alleviating other limiting factors such as inadequate sanitary conditions and lack of microbiological control.

17. Since microbiological methods are basic to most of the technological operations in the food industry, e.g., heat processing, fermentation, cooling and freezing, drying and smoking, a good understanding of the dependence of technology on microbiology must be gained. Thus, it is important to stress the relation of microbiological and biochemical studies to food technology in creating comprehensive research facilities.

18. Microbiologists should be consulted and their approval obtained before new technologies and prescriptions are applied in food production.

19. It is also suggested that the quality of meat and milk products be improved, particularly through microbiological control, with a view to increasing food exports.

The expert also defined the following long-term objectives as follow-up of current activities:

1. The regulations governing hygiene in the food industry should gradually be tightened, so that the quality of prepared foodstuffs, judged by microbiological standards, constantly improves.

2. Preparation of foodstuffs in the factory should yield products ready for consumption or needing only a small amount of additional work.

3. A primary goal should be the complete elimination of illnesses that cause animal mortality and decrease their procreation rate (Brucella), while lowering food value and worsening organoleptic factors.

4. Microbiological studies should cover:

Enzymatic preparations

Chemical reagents for testing

Amino acids

Inoreased use of enzymes in the teohnclogy of meat transformation

5. Only healthy and medically certified animals should be supplied to slaughter-houses, and all slaughter-houses should have their own laboratory.

6. The analyses, especially microbiological, carried out on raw material before and during processing should be systematic rather than haphazard. Facilities should eventually be provided that shorten the examination procedures so as not to add to production time. New, simple and quick test methods of microbiological and chemical examination have to be developed and put into effect.

7. The quality of meat and meat by-products should be improved by using substances that:

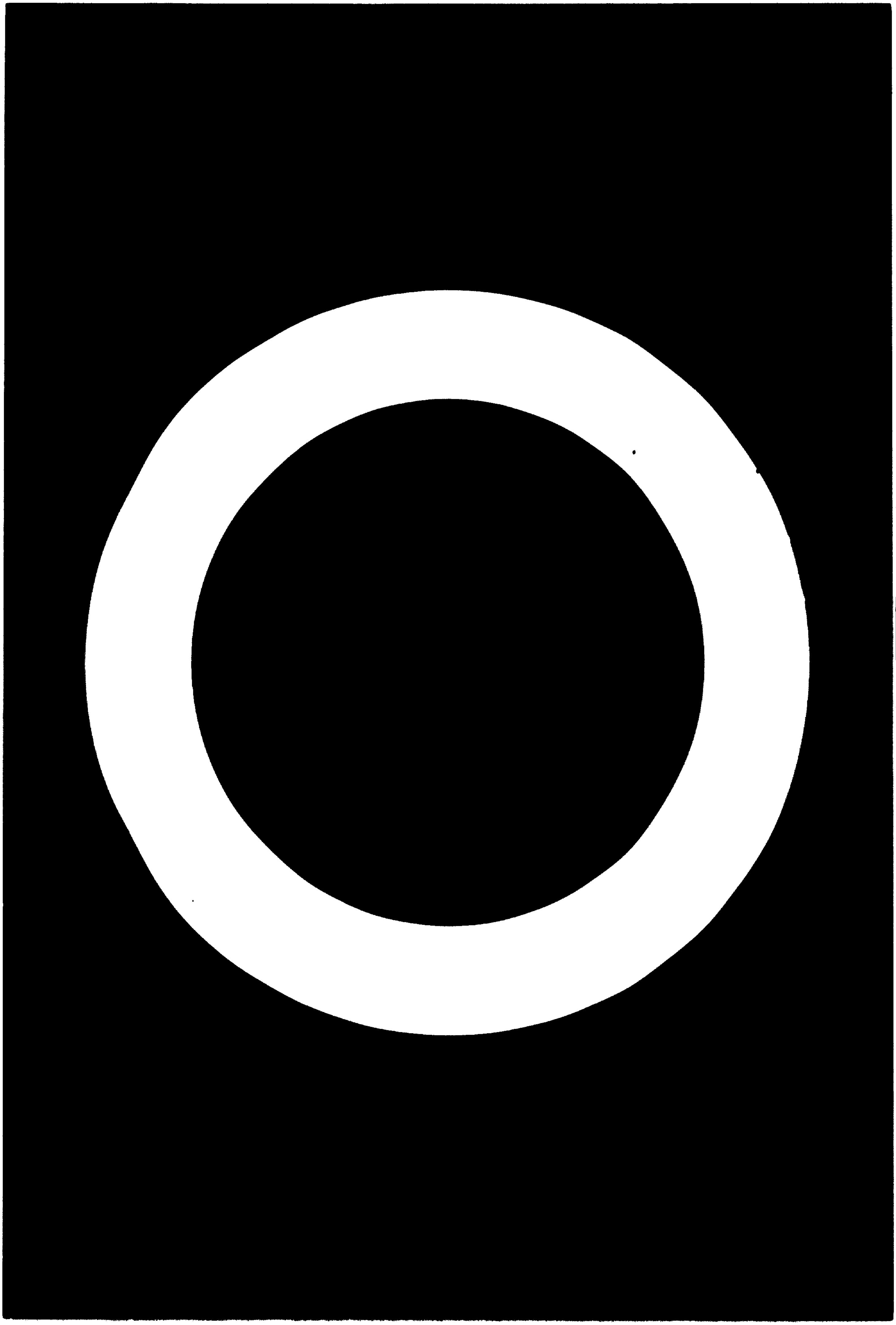
Control meat odour

Increase the capacity of meat to absorb water

Improve taste (especially proteolitio enzymes)

Promote preservation of products (antioxidants)

8. As a further hygienio measure, the containers in whioh produots are stored should also be used for transporting them.



Annex I

COUNTERPART PERSONNEL

Following is a list of the 19 counterparts trained during the project.

Experimental and Research Institute, Ulan Bator

Manager Lhagvazaw
Manager Damdin
Technologist Dulamzaw
Technologist Szara

Meat plant, Ulan Bator

Microbiologist Isz
Head of laboratory Sobiechan
Head of laboratory Darima

Milk plant, Ulan Bator

Three laboratory workers with Masters degrees
One laboratory technician

Meat plant, Darkhan

Two veterinarians
Two laboratory technicians

Milk plant, Darkhan

Head of laboratory Partay
Microbiologist Czintochtoch
Two laboratory technicians

Annex II

HYGIENE IN MEAT PROCESSING

Modern food processing is considered a separate industry with fixed objectives, distinct technological and engineering problems, and well defined standards in microbiology and marketing methods.

A typical food process consists of several steps, which explains the necessity of having specialists in different areas for the current project.

Raw materials are inspected, cleaned, graded, categorized, cut up or ground, mixed with other food ingredients and chemical additives, formed into the desired shape and size and packaged. They are subjected to various processes, including heat, refrigeration, dehydration, smoking and canning.

Proper care and handling of raw materials

The condition of the animals and the treatment they receive before slaughter have a decisive influence on the quality and preservative properties of meat products. This is especially true of canned sausages and raw or cooked ham. Careful selection and care of the animals to be slaughtered is therefore essential.

For the successful preservation of meat, i.e. to obtain meat that will lend itself to transportation and long storage, it is necessary for animals to be completely rested at the moment of slaughter.

The flesh of animals slaughtered after a long journey (in Mongolia transportation over long distances is usual) often contains a large number of bacteria. The risk of decomposition is thus increased, particularly on account of obligate anaerobes. Furthermore, the meat of hungry animals is unsuitable for the manufacture of preserved meat products.

The following rules should be observed:

(a) Feeding of the animals should cease eight hours before the time fixed for slaughter, so as to prevent the penetration of bacteria from the intestines into the blood and flesh via the lymphatic system. In Mongolia animals intended for slaughter are sometimes kept for as long as three days without food and water;

(b) Great importance must be attached to the rigor mortis as a criterion by which the quality of the meat may be judged. It must be remembered that if rigor mortis develops too rapidly after slaughter, it is always a sign that the meat of the animal will not keep well and will be unsuitable for preparing preserved meat. So far, insufficient attention has been paid to this factor in Mongolia;

- -

(c) Meat inspection has two aspects:

(i) Ante-mortem inspection, without which no adequate inspection of the carcass or meat is possible. Ante-mortem inspection should be made solely by veterinarians, preferably with long experience in general clinical practice;

(ii) Post-mortem inspection, which is carried out by veterinarians after the slaughter. The inspection is concerned mainly with the head and abdominal cavity opening, the viscera, the halved carcass and finally the dressed carcass. The veterinary inspector should control every stage of these operations. Neither ante-mortem nor post-mortem inspection is carried out systematically and accurately in Mongolia, and it is felt that the importance of these controls is not yet realized;

(d) The method of stunning also plays a considerable role in obtaining meat that will keep well. The stunning methods employed in Mongolia are not always properly carried out. Since blood is particularly susceptible to contamination, bacteria are more likely to penetrate and multiply rapidly in tissue full of blood. Generally speaking a method of slaughter should therefore permit the maximum bleeding possible without causing the animal unnecessary suffering. To obtain good bleeding, the heart and respiratory system must remain in action as long as possible.

Conditions in slaughter-houses

Hygienic precautions in the slaughter-house are essential. From the point of view of hygiene, slaughter-house operations may be divided into two parts: (a) the unclean operations, including killing, bleeding and skinning; and (b) the clean operations - dressing the carcass, opening it, removing the viscera, cutting the meat etc.

Concurrently, a proper system of hygienic meat control falls into two divisions of equal importance: (a) control of slaughtering; and (b) control of meat and meat products during transportation, storage, processing and distribution.

Every country has its own code of standards by which inspectors ensure that the public does not receive impure meat. In some countries this includes regulations that prescribe a list of diseases and infection for which bacteriological examination are obligatory. Obviously, protecting the public against the danger of eating diseased or unsound meat is a primary consideration. Nevertheless, the importance of avoiding losses of valuable meat and meat products means that only animals totally unfit for human consumption should be fully condemned. Hence, in doubtful cases the correct procedure is to conduct a post-mortem inspection supplemented by the requisite bacteriological list, before forming the final judgement.

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Bacteriological examinations

The use of bacteriological methods in post-mortem inspection is based upon the theory that the internal organs as well as the muscular and lymphatic tissues of healthy animals are sterile. If bacteria can be cultivated from these tissues, it indicates an abnormal condition. Naturally, killing and dressing operations change the bacteriological status.

Bacteria found in bacteriological examinations of meat may be either specific, pathogenic bacteria or a mixed flora of non-pathogenic bacteria resembling the natural intestinal flora.

Bacteriological examinations in some countries show that roughly 84 per cent of carcasses examined were sterile, 10 per cent had non-specific infection and 6 per cent had specific infection with pathogenic bacteria. The main causes of superficial contamination were the following:

	Approximate percentage
Dirt, particularly on the animals' skin	33
Pollution in the abattoir	5
Transportation and storage	50 or over
Miscellaneous, such as utensils and personnel	5-10

These findings lead to the following recommendations:

(a) Live animals should be washed;

(b) Skins should be rapidly removed from the workrooms;

(c) The premises, utensils and transport installations should be carefully cleaned;

(d) The cleanliness of personnel should be closely supervised;

(e) An adequate water supply should be ensured.

If these measures are enforced, the risk of contamination can be reduced by 80 per cent.

Ninety per cent or more of the cases of food poisoning caused by meat products can be attributed to post-mortem operations and handling; less than 10 per cent are attributable to diseased animals.

Food processing and packaging must be carried on in sanitary buildings that provide protection from the weather and keep out dust, insects and rodents. The floors and walls of the processing rooms must be as free as possible from pores and cracks where micro-organisms can collect and grow.

Provision must be made for employees' comfort and personal sanitation. A plant needs toilets, locker rooms and wash rooms, as well as wash basins where production workers can disinfect their hands in chlorinated water before and after work. Such standards should be strictly maintained.

Water

One of the most important factors in maintaining adequate standards of hygiene in slaughter-houses and meat processing plants is the purity of the water used for cleaning. The average amount of water required per head of livestock processed is 1,000-2,000 litres.

All water that comes into contact with foods should meet the bacteriological standards of drinking water; preferably all the fresh water at a plant should be that good. However, the water should also be satisfactory from a bacteriological standpoint for use with the particular food being processed. For example, water containing an appreciable number of psychrophiles might be unsatisfactory without treatment in a dirty plant, especially in canning factories, where the bacteria content of the water in which the cans of processed foods are cooled after heat treatment is important. If the water contains micro-organisms able to spoil the food, it will, after entering defective cans through minute leaks, increase the percentage of canned foods spoiled during storage. The cooling water ought to be chlorinated to reduce or eliminate this possibility.

Ice used in contact with foods should meet the bacteriological requirements for potable water. Recently much work has been done on the incorporation of bacteriostatic or bactericidal chemicals in both water and ice to aid in food preservation.

The water in Ulan Bator is periodically analyzed by Sanepidstation and conforms to normative standards. Examinations carried out by the expert during the project confirmed these results. Conversely, the ice used at one point in sausage production showed a very high level of contamination, and its use was therefore discontinued.

A large slaughter-house needs its own laboratory. In its absence, microbiological tests on the quality of foods and food ingredients may be conducted in the laboratories of food plants or of various control agencies.

Laboratories in food plants are concerned mainly with quality control. They test raw materials, ingredients and samples during handling and processing as a check on the success of the methods employed and as an indication of potential difficulties. They also ensure that bacteriological standards are met, that the product will keep and that no micro-organisms or microbial products injurious to human health are present.

Annex III

TRAINING PROGRAMME

Training of laboratory staff was carried out at the Ulan Bator, Darkhan and Choibalsan milk and meat plants.

In general, a food microbiologist must be familiar enough with the micro-organisms in food to identify the main types encountered and to use what is known about their characteristics to compare the results of his analyses with those of other workers.

The counterparts and other laboratory staff were instructed in:

(a) Organizing and equipping a bacteriological laboratory;

(b) Methods of sterilization;

(c) Preparation of culture media and treatment of glassware;

(d) Use of a microscope, including preparation of stains and smears;

(e) Kinds of microbiological tests necessary. Microbiological tests on food may be quantitative, to estimate the total number of organisms present or the number of specific organisms, or they may be qualitative, to detect certain kinds of organisms or their products;

(f) Sampling and aseptic sampling, including:

(i) Sampling devices. Liquid food is ordinarily sampled by means of sterile pipettes or sampling tubes, preferably after having been stirred or mixed to homogeneity. Solid foods may be sampled by of sterile sampling tubes such as cork borers or triers or by means of sterile sampling tubes such as cork borers equipment may be sampled by the rinse method, and flat surfaces may be sampled by pressing the agar surface of a contact plate against them. Another method of sampling equipment surfaces is the swab technique, in which a sterilized swab soaked in a diluted media is partially squeezed out, rubbed over the surface area being sampled and rinsed in the liquid, which is then plated or cultured on agar;

(ii) Number and size of samples;

(iii) Handling of samples. They must be cooled, kept at 0^{o}-$4^{o}C$ and tested within a few hours of collection;

(g) Identification and classification of moulds. Instruction on this subject covered the following aspects:

General characteristics of moulds

Morphological characteristics (hyphae and mycelium)

Microscopic examination

Cultural characteristics

Physiological characteristics

Temperature requirements

Oxygen and pH requirements

Food requirements

Classification and identification

A food microbiologist working at a meat and milk plant should be able to identify the genera of important food moulds and to recognize the common species;

(h) Identificationand classification of bacteria. The aspects covered included:

Morphological characteristics

Physiological characteristics

Factors influencing bacterial growth (food, moisture, temperature, hydrogen-ion concentration and inhibitory substances)

The discussion of specific bacteria important in food covered the Enterobacteriaceae and Brucellaceae families, including Clostridium botulinum, and the genus Staphylococcus.

Enterobacteriaceas

This family includes Escherichia, Proteus, Salmonella, Serratia and Shigella.

Salmonella and Shigella consist mainly of pathogens. Coliform bacteria are generally undesirable in foods. In some foods their presence may be indicative of sewage contamination and thus of the possible presence of enteric pathogens.

Salmonella

Some species of these enteric pathogens can grow in food and cause food infections, and others are commonly transported by food, e.g., Salmonella typhosa, the cause of typhoid fever, and S. paratyphi, the cause of B-type paratyphoid fever.

Salmonella-contaminated meats are a serious public health problem, particularly in a country such as Mongolia where meat and meat products are eaten insufficiently cooked. For example, infection often results from the consumption of improperly cooked minced pork or horse meat. Consequently, refrigeration and the hygienic handling of meat at all stages of processing, from the slaughter-house to the consumer's kitchen, are of utmost importance for the prevention of food-born diseases.

In milk, re-contamination may occur after pasteurization, e.g., through unhygienic bottling. The danger of such outbreaks is increased by the fact that milk, cream and other dairy products are excellent media for the growth of salmonellas.

The results of testing for coliform bacteria are a good indicator of the sanitary conditions that have prevailed on farms and during transport, processing and storing.

Brucellaceae

Some of the pathogenic bacteria belonging to this family may be transmitted in foods, especially in milk and meat products. Infections caused by Brucella can reach a high incidence. Since the micro-organism is not inactivated by certain processes, e.g., it can survive the preparation of cheese except during prolonged ripening, pasteurization of all milk is imperative in areas where the disease occurs.

In Mongolia, milk is transported long distances (up to 200 km), and during the hot season it reaches a milk plant in a condition unsuited for pasteurization. Sour cream and white cheese are made from this milk. Because these products were made from unpasteurized milk, they represent a grave danger to public health, especially to children, as potential carriers of Brucella. Many people working on farms, in diary plants and in meat factories are suffering from brucellosis. It is recommended that specialized agencies of the United Nations undertake joint activities to control the spread of this illness.

Clostridium botulinum

Human botulism results from the consumption of food in which Clostridium botulinum has grown and produced its toxin.

Botulinum poisoning occurs only if all of the following requirements are met:

(a) The food is contaminated with Clostridium botulinum or its spores;

(b) The food is treated in such a way that the normal contaminating microflora is destroyed while the spores survive. Such treatment includes mild heating, salting and pickling;

(c) The composition of the food is suitable for the growth of Clostridium botulinum and for toxin formation by the multiplying organism. In general, growth can occur if the pH is above 5.0;

(d) The food is held at a suitable temperature for enough time to permit growth and toxin formation;

(e) The food is eaten uncooked.

Botulinum toxin is relatively sensitive to heat; exposure to a temperature of 80°C for 30 minutes or to boiling for a few minutes is sufficient to inactivate the toxin. Botulism can be prevented by any of the following measures:

(a) Destruction of the spore by heating;

(b) Inhibition of growth by:

Reducing the pH (acidifying fermentation)

Limiting the water content

Reducing the temperature (freezing or refrigeration)

Adding inhibitory chemicals such as nitrites

(c) Inactivation of preformed toxin by cooking.

Although relatively labile to heat, botulinum toxin is highly stable under acid conditions and will persist for long periods in pods with a pH below 6.0.

Staphylococcus

The multiplication of certain strains of Staphylococcus in food leads to the appearance of enterotoxin. It now seems certain that enterotoxin is produced solely by the so-called "enterotoxic" strains. In general, these strains show the usual characteristics of pathogenic staphylococci and in addition secrete coagulase. However, food-born coagulase-negative strains have also been reported to cause intoxication.

Contamination arises when food is derived from a sick animal, the commonest source of infection being bovine mastitis.

Indirect contamination usually comes from a food handler who carries the bacteria on the skin of his hands or forearms in conditions such as pyodermitis, furunculosis or an infected wound. The staff of processing plants should be watched for signs of such conditions and prevented from coming into contact with food if they exhibit them.

To be pathogenic for man, enterotoxin must be present in foodstuffs in sufficient quantity; this presupposes substantial multiplication of the contaminating staphylococci. Conditions favourable to multiplication include the following:

(a) A relatively high temperature. Multiplication occurs slowly at 10°C but increases progressively with rising temperatures, reaching a maximum at 30°-40°C;

(b) A fairly high pH. No appreciable multiplication occurs in acidic products (pH of 4.5 or less).

Staphylococci can also multiply in products with a relatively high salt or sugar content.

In contrast to botulinum toxin, which is thermolabile, staphylococcal enterotoxin preformed in foodstuffs is thermostable and can withstand boiling and even higher temperatures.

The most effective means of prevention are the following:

(a) Rapid refrigeration of food products to prevent the multiplication of contaminating staphylococci;

(b) Control of human carriers at critical points in processing plants and during distribution;

(c) Maintenance of hygienic standards in processing plants and during transportation, and by distributors, retailers and consumers.

Tests made on food

Instruction was given in testing foods for:

(a) Spore-forming anaerobes in canned food;

(b) Psychrophiles (Pseudomonas and Achromobacter in meat);

(c) Counting Staphylococcus aureus, coagulase-positive, enterotoxigenic and mannitol-positive strains;

(d) Halophiles cultivated in high-salt media;

(e) Keeping quality. These tests usually entail incubating the food under conditions simulating those under which it is likely to be kept after leaving the food plant. Samples are examined periodically for signs of spoilage;

(f) Bacteriological examination of utensils using the swab technique (higher counts are presumptive evidence of inadequate cleaning);

(g) Growth of micro-organisms in meat;

(h) The influence of relative humidity on micro-organisms (in Mongolia relative humidity is very low);

(i) The contamination and the pH of raw meat;

(j) Bad odours and tastes as a result of the growth of bacteria on the surface.

In addition, contamination of foods during handling and processing was dealt with and precautionary measures were enumerated under the following topics:

(a) Spoilage of milk and milk products:

- Limited keeping time for milk
- Acid fermentation in milk
- Proteolysis
- Ropines
- Flavour changes
- Colour changes
- Spoilage of milk and milk products at different temperatures
- Fermented milks (kefir, koumiss)

(b) Methods of food preservation:

- Use of high temperatures
- Factors affecting heat resistance (thermal death time)
- Heat resistance of micro-organisms and their spores
- Determination of heat resistance (thermal death time)
- Heat penetration (canning)

(c) Preservation by use of low temperatures:

- Growth of micro-organisms at low temperatures
- Lethal effects of freezing
- Temperatures employed in low-temperature storage
- Spoilage of food

Annex IV

TECHNICAL DOCUMENTATION PREPARED BY THE EXPERT FOR THE GOVERNMENT [a]

	Title	No. of pages
1.	Microbiological media preparation	2
2.	Microflora of canned food and interpretation of results	5
3.	Microbiological work in meat processing technology	9
4.	Organization of a laboratory in a meat plant	
5.	Microflora in meat	8
6.	Enzymes in the technological process	3
7.	Table for identification of Clostridium botulinum	2
8.	Anaerobes and media for their identification	2
9.	Table for identification of Bacillaceae	1
10.	Enterococcus sp.	3
11.	Moulds in food	5
12.	Series of written instructions explaining microbiological meat control	38
13.	Information about existing meat plants and suggestions for improving quality control (worked out by team of experts)	

[a] Items 1-12 were transferred to the Experimental and Research Institute; item 13 was transferred to the Ministry of Light and Food Industries.

Annex V

CHEMICALS ORDERED AND RECEIVED

Actinomyces broth
Anaerobic agar
Brilliant green bile agar
Brilliant green sulfa agar
Brucella agar
Endo agar
M-Enterococcus agar
Eosin methylene blue agar
Macconkey agar (without crystal violet)
M-Coliform broth
M-Tryptone glucose yeast broth
Nutrient agar
Nutrient gelatin
Orange serum agar
Peptone phosphate agar
Phenol red mannitol broth
Sabouraud maltose agar
Standard methods agar
Staphylococcus agar 110
Tomato juice agar
Salmonella Shigella agar
Agar granulated
Beef blood serum
Bile salt mixture
Gelatin
Malt extract
Polysorbate 80 USP
Crystal violet

Dulcitol

D-Mannitol

D-Mannose

Methylene blue

Sodium desoxycholate

Bismuth sulfite agar

Blood agar base

Trypticase soy agar

Brilliant green agar

Czapek dox agar

Desoxycholate agar

Desoxycholate lactose agar

KF streptococcal agar

Levine eosin methylene blue agar

Macconkey agar

Malt extract agar

Mannitor salt agar

M-PH agar (milk protein hydrolysate agar)

Indole nitrite medium

Potato dextrose agar

Sabouraud dextrose agar

Selenite cystine broth

Trypticase agar base

Trypticase glucose extract agar

Yeast extract

Coagulase plasma, rabbit

Abortus ring test diagnostic reagent

Annex VI

LABORATORY EQUIPMENT

No.	Item and description	Price per unit in $	Total value in $
1	Autoclave sterilizer	560	560
2	Hot-air sterilizer	250	500
3	Anaerobic system-gas-pak	50	200
4	Colony counter	140	560
2	pH meter	250	500
2	Hygrometer (psychrometer)	40	80
4	Incubator oven	250	1,000
1	Binocular research and laboratory microscope	3,000	3,000
2	Stereoscopic microscope	200	400
4	Mark counter	50	200
1	Nepho-colorimeter	528	528
1	Colorimeter	285	285
2	Refrigerator	500	1,000
2	Distillation apparatus	600	1,200
4	Stirrer (homogenizer)	25	100
2	Water bath		
1	Low-range pocket refractometer	220	220
1	High-range pocket refractometer	220	220
4	Can-opener	27	108
10	Thermometer		
	Chemical compounds		
	Glassware (Jena glass)		

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