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FOOD AND NUTRITION RESEARCH IN THE NETHERLANDS

TNO

Organization for Nutrition
and Food Research



CENTRAL INSTITUTE FOR NUTRITION AND FOOD RESEARCH TNO

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foreword

One of the results of the first World War (1914-1918) was that many people in various countries, including the Netherlands, realized what the application of the results of scientific research could mean for the national economy, not only as regards the conduct of the war but also for the development of industry, housing, traffic, agriculture, animal husbandry and fishery and for the improvement of public health. This led in 1930 in the Netherlands to the passing of the Applied Scientific Research Act (the 'T.N.O.' Act), which came into force in 1932 and which, with the necessary additions and amendments, is still in force. By this Act a 'Central Organization for Applied Scientific Research' was created, whose task was to put scientific research at the disposal of the general interest in the most efficient way. This task is fulfilled by carrying out, stimulating or coordinating applied scientific research through close, voluntary cooperation between scientists and society, with government support.

The Central Organization T.N.O. can create T.N.O. organizations for special interests or branches of welfare. For example, in 1934 the Organization for Industrial Research T.N.O. was founded, and in 1940, under the pressure of World War II which had just broken out, came the Organization for Nutrition and Food Research T.N.O. This was followed, in 1946, by the National Defence Research Organization T.N.O., in 1949 by the Organization for Health Research T.N.O., whilst in 1957 the whole of agricultural research was coordinated under the National Council for Agricultural Research T.N.O.

In conformity with the Applied Scientific Research Act, the Organization for Nutrition and Food Research T.N.O. was given the task of putting food and nutrition research to advantage in the general interest. Thus, in 1940, the Central Institute for Nutrition and Food Research T.N.O. was established in Utrecht; this institute directed its activities into two fields:

1. Food research, which covers the composition and properties of fresh and

processed foodstuffs, the industrial production of foodstuffs and the techniques applied. It is unnecessary to say that close cooperation with the food industry in this field is imperative.

2. Nutritional research, which deals with the significance of the composition of food for man, whether in health or in disease. This research has a strong medical trend and therefore requires collaboration with the medical world. Especially in the first field activities have expanded considerably. This is shown by the fact that since its formation two departments of the Institute have developed into independent institutes: the Institute for Cereals, Flour and Bread T.N.O. at Wageningen and the Institute for Fishery Products T.N.O. at IJmuiden.

The Meat Products Department of the Utrecht institute cooperates closely with the Research Group for Meat and Meat Products T.N.O., founded in 1959, in which all institutes carrying out investigations in the field of the production and processing of meat are coordinated under the auspices of the Organization for Nutrition and Food Research T.N.O.

Finally, the Commission for the Dutch Food Composition Table also comes within the province of this Research Organization.

Each of the institutes has its own governing body, on which sit representatives of various sectors of the field concerned, government representatives and scientists. The governing bodies supervise the planning and execution of activities involving research and information on behalf of the industry. The research may be independent and of a fundamental nature, or may be undertaken at the request of the industry. These activities are financed by government grants and contributions from the organized industry and by the income from investigations commissioned by the industry.

Dr. M. van Eekelen,
Chairman Organization for Nutrition and
Food Research T.N.O.

**CENTRAL INSTITUTE
FOR NUTRITION AND FOOD
RESEARCH TNO**

Since its foundation in 1940, the Institute has carried on research work in two fields:

- a. analysis of foodstuffs and the search for methods of improving the quality and keeping properties of foods.
- b. study of the influence of nutrition on the health of man, in particular of children.

In addition to its research work, the Institute has an important task in assisting the Dutch food industry in tracing and solving difficulties in the factories ('trouble shooting'), in analysing samples sent in from the factories and in giving advice on foodstuffs and on nutritional problems. Moreover, industrial research workers are given the opportunity of carrying out certain investigations at the Institute, where they can avail themselves of all facilities.

The funds necessary for the fundamental research on foods and nutritional problems mainly originate from government grants and contributions from the organized food industry. The costs of analyses, trouble shooting, advice and institute facilities are charged to the particular firms concerned.

At present the Director is assisted by a staff consisting of 25 University graduates, 50 chemical and technical assistants and 30 other personnel.

In the following pages a brief survey is given of the main activities.

food research

Analysis of foods

In the analysis of foodstuffs, good and reliable methods of analysis and determination are available. Apart from those which are generally known, the most modern methods also are applied, and often new methods are worked out by the Institute itself.

Determinations of the content of proteins, fats, carbohydrates, trace elements, preservatives, anti-oxidants and other additives are regularly made in all kinds of foods.

The Institute is also specialized in the determination of vitamins by chemical and microbiological methods; as for instance the fat-soluble vitamins A, D, E, K₃, carotenoids and the water-soluble vitamins B₁, B₂, B₆, B₁₂, C, K₃-bisulphite, nicotinic acid, pantothenic acid, panthenol, choline, biotin, folic acid, inositol and para-aminobenzoic acid. A further activity in this field is the study of the stability of vitamins added to raw materials and foodstuffs.

Column-chromatography is used for the determination of the amino-acid pattern; individual amino-acids can be determined microbiologically, lysine and 'available' lysine chemically also.

In addition to foodstuffs auxiliary substances such as meat curing brines and packaging materials are studied. Unknown components can be identified with the infrared- and ultra-violet-spectrophotometer.

Many analyses are carried out for manufacturers or at the request of importers or exporters who desire an official certificate of analysis.

Fraction-collector for amino-acid determinations



Tanks for paper chromatography

In the course of years, many new methods of analysis have been worked out, for example for the determination of water, sugars, starch, fat, crude fibre, polyphosphates, nitrate, nitrite, vitamins, anti-oxidants, theobromine and other components. Attention has also been paid to analytical methods for the trace elements mercury, cobalt, manganese and copper.

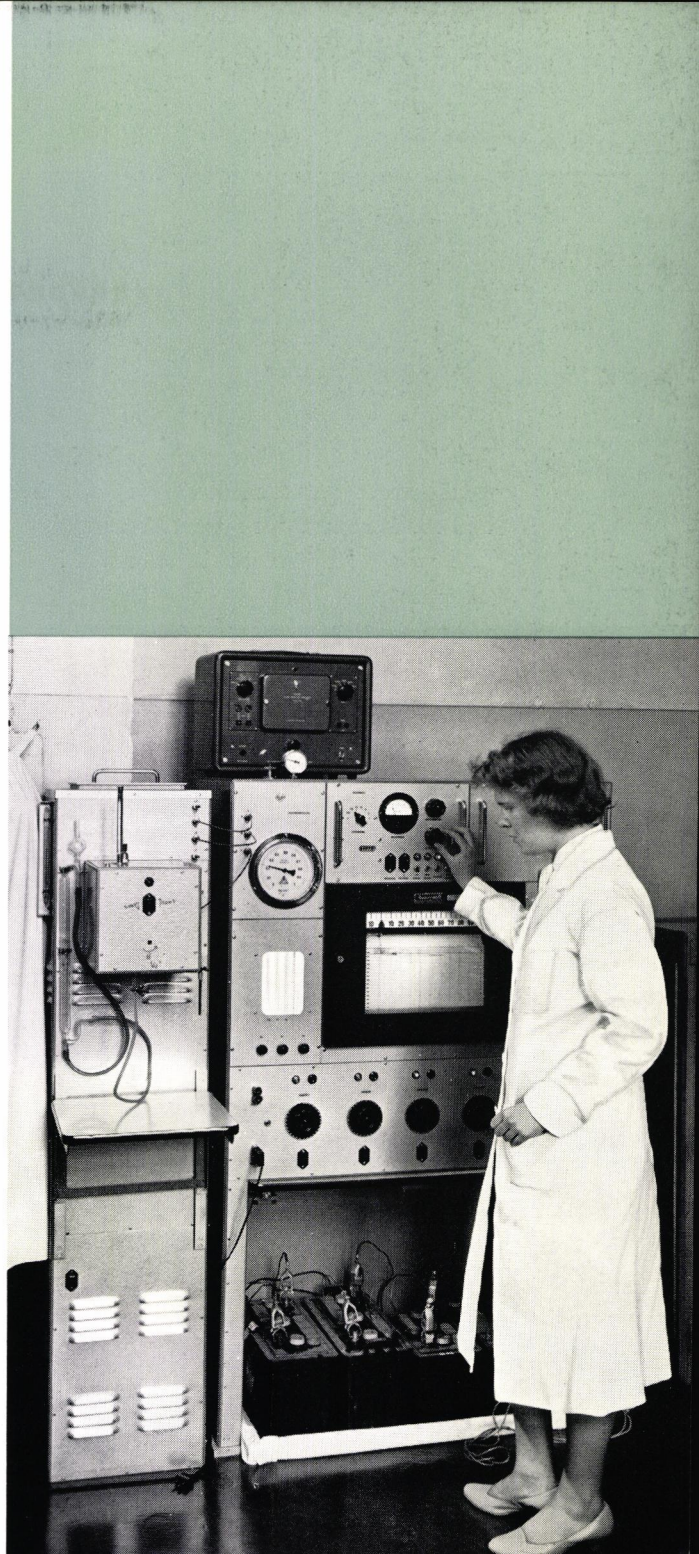
In addition, microbiological methods for the detection of preservatives and antibiotics have been elaborated.

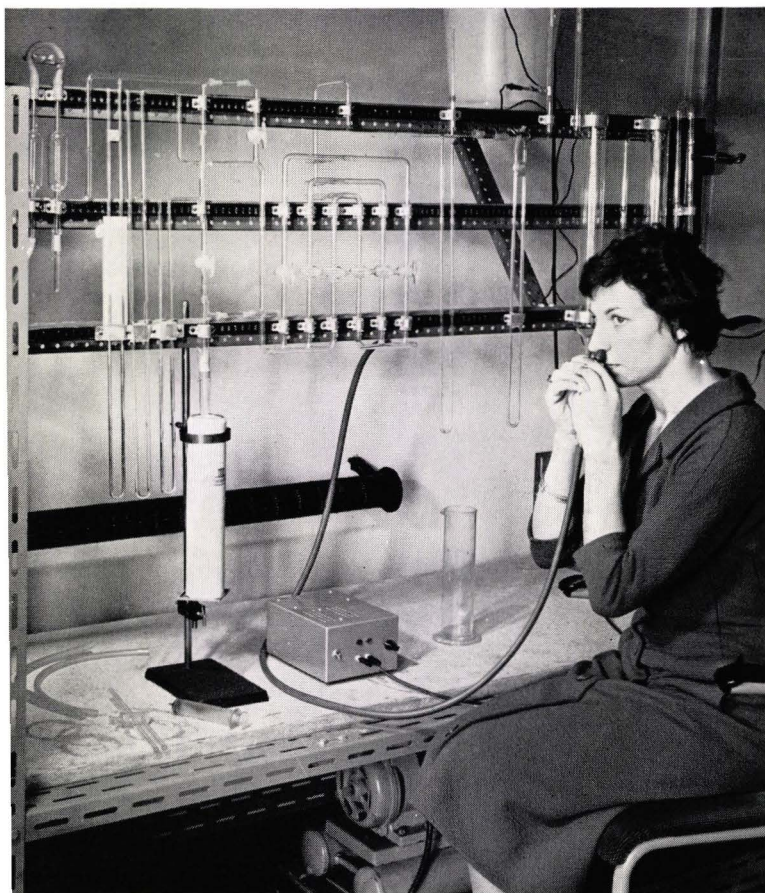
Research on food flavours

Research is at present being carried out on methods of isolating volatile compounds in foods and beverages. Distillation, extraction, adsorption and other methods of concentration are applied, whilst paper, column and gas phase chromatography are used for the separation of the components.

Also studied are the compounds in wood smoke which are of importance in the development of the characteristic flavour and taste of smoked meat and fish products.

Gas phase chromatograph for flavour research

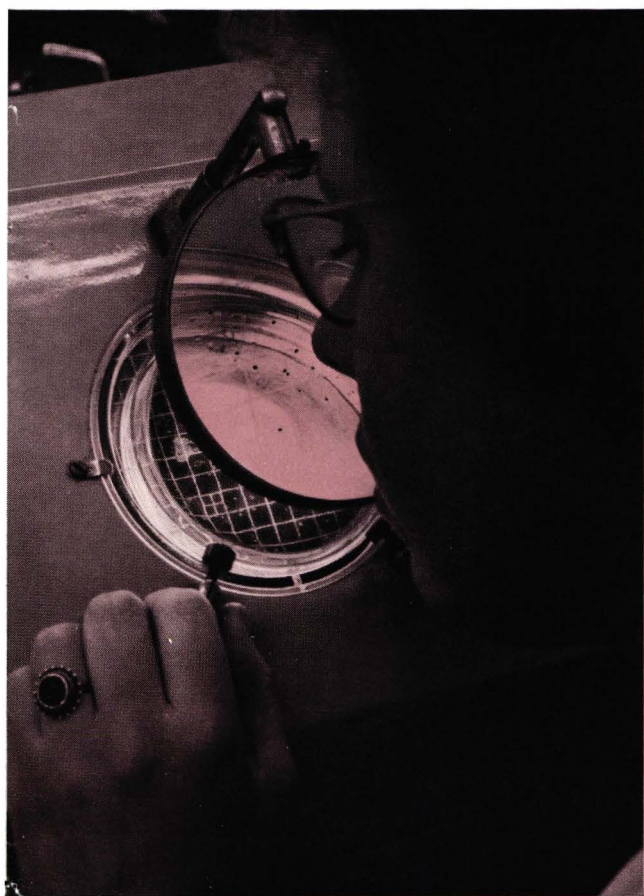




*Measurement of odour perception.
An accurately measured quantity of
flavour is administered to the
test subject*



Examination of the sterility of canned foods



Counting of bacterial colonies

Organoleptic analysis

In addition to the chemical analysis of foods it is often necessary to evaluate the quality of products by smelling and tasting. This is the 'organoleptic' analysis. For this purpose, groups of experienced, selected tasters are available who are capable of noting even slight changes of taste.

Besides this routine work, fundamental research work is carried out, in cooperation with the Psychological Laboratory of the State University of Utrecht, on the nature of smell and taste sensitivity.

Microbiological investigations

Many investigations are conducted for the purpose of establishing the causes of microbial spoilage and the hygienic status of foodstuffs. A great number of techniques, many of which have been developed by the Institute, are available for the counting, isolation and identification of bacteria, yeasts and moulds. Apart from this, the wholesomeness of canned foods is regularly determined by means of storage tests at temperatures between 15 and 55° C., followed by microbiological analysis.

In connection with the prevention of food poisoning, food manufacturing plants and kitchens are examined for their hygienic condition and the disinfectants and other aids that may contribute to hygienic improvement are evaluated.

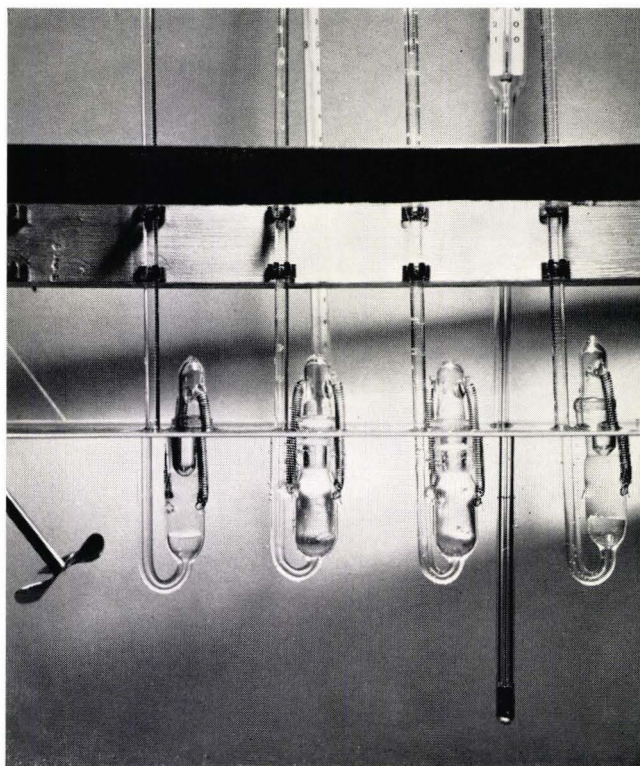
Investigations are in progress on the spoilage associations of foods, on the psychrotolerance of bacteria, on the microbiological condition of soft drinks and on the pasteurization and preservation of weakly-acid foods by thermal and other means.



Apparatus for the rendering and refining of animal fat



Chromatography of anti-oxidants



Dilatometers for measuring the solid fat index

Oils and fats

Much attention is given to improvement of the quality of oils and fats, for example in the prolongation of the keeping quality of butter, margarine, lard and vegetable oils. In many cases the keeping quality can be improved with the help of anti-oxidants. It was at first especially the gallic acid esters which were studied, but recent research has shown the advantages of using mixtures of anti-oxidants. If desired the fat-processing industries can be given advice on the most suitable mixtures of anti-oxidants.

This investigation has necessitated the study and development of a number of analytical methods, e.g. the analysis of anti-oxidants and their mixtures, the



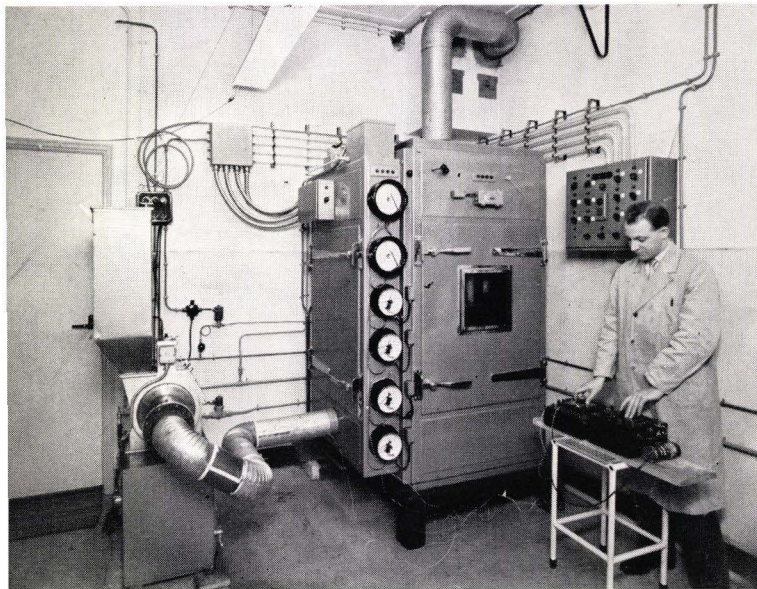
determination of peroxides, carbonyl compounds and other products of autoxidation of fats.

A prognosis regarding the keeping quality of animal fats can be given with the aid of a stability test at 100° C., which in a few hours gives an appraisalment of the behaviour of the fat during normal storage.

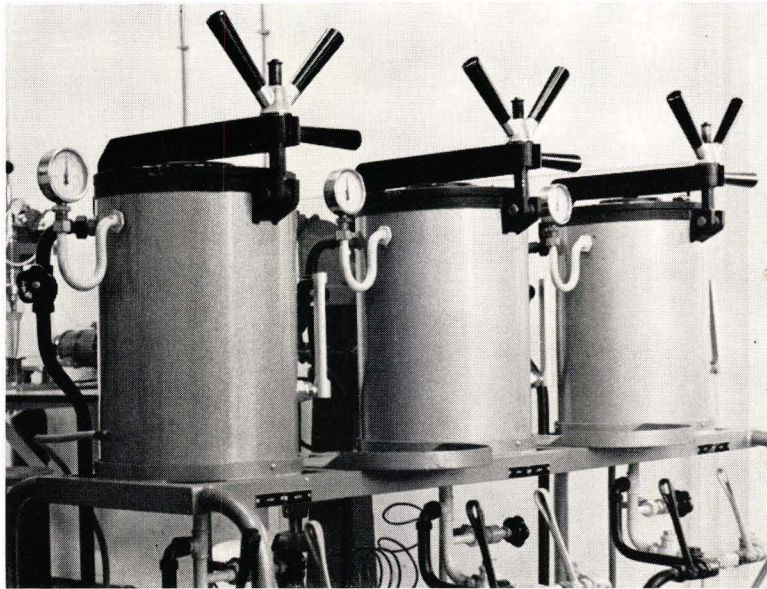
The composition and industrial usefulness of edible oils and fats is studied analytically, e.g. by spectrophotometric determination of unsaturated fatty acids and by determination of the expansion on melting (dilatation method). Gas chromatographic separation of fatty acids is also carried out.

The study of the technological and chemical processing methods (refining, hydrogenation, isomerisation etc.) to which edible oils and fats are subjected before consumption also comes within the province of the Institute; here emphasis is placed on the possible consequences of these processes on nutritional value.

Apparatus for smoking meat



Autoclaves for the determination of the thermal death time



Meat and meat products

The examination of meat and meat products is a responsibility of the Department for Meat Products, which is provisionally housed in a villa at Zeist on the site where, within a few years, a new Central Institute for Nutrition and Food Research will be built. This department has at its disposal all the apparatus needed for the processing of meat, such as cutters, cooking cabinets, autoclaves, freeze-drier, curing tanks and an experimental smoke cabinet. Various subjects call for study:

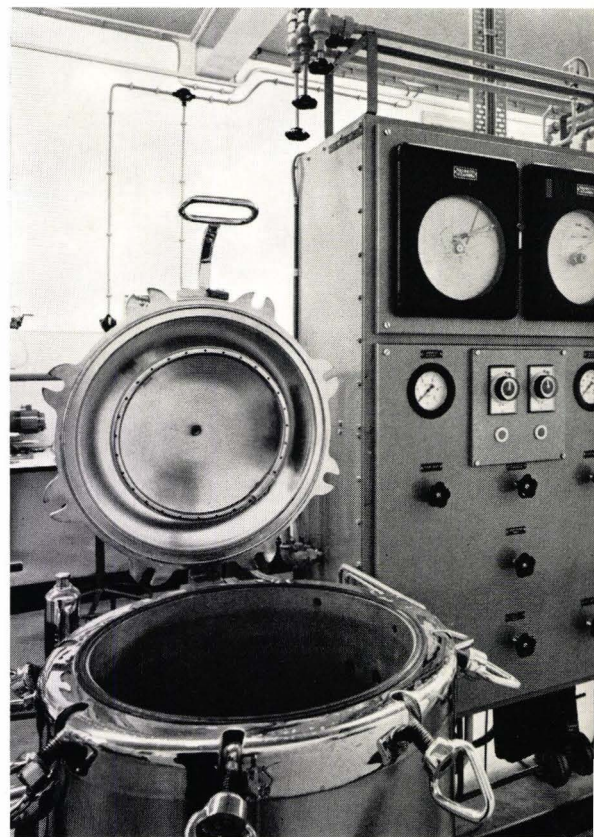
Water binding capacity in meat products is chemically investigated, special attention being given to the influence of pH, concentrations of added salt (sodium chloride) and phosphates.

The chemical and bacteriological changes arising during ripening in dry sausage are studied with a view to the identification of the bacteria which exert an influence on ripening.

The bacterial flora which may be present in canned meats are also studied in connection with the keeping quality of these products. A special object of study is their thermal resistance, which is of importance in relation to the heat treatment to be applied. To establish the correct thermal treatment of a given product, autoclaves are available with automatically phased time/temperature and time/pressure control.

In connection with the curing of meat products, the composition of curing brines is examined, e.g., the importance of the redox potential and the microbiology.

The smoking of meat products can be studied under practical conditions: for this purpose a special smoking cabinet with variable smoke density, temperature and humidity has been designed and constructed in the Institute's own workshop.



Experimental autoclave with fully automatic control



Poultry and eggs

An important investigation is in progress on the production of canned chicken of good quality in which the disadvantages of normal canned foods and deep-frozen products are overcome. Sterilizable plastic films are used for this purpose.

Another problem which calls for attention is that of the physico-chemical changes which arise during the storage of frozen whole egg, so far as the practical use of this material in various products is concerned. Efforts are being made to effect considerable improvement in keeping quality.

Thickening agents

Various kinds of thickening agents, stabilizers and emulsifiers are used in foods. Many problems arise here also. These problems are studied in detail and formulas are worked out; viscosity measurements on thick-fluid products are carried out both with ordinary viscometers and with the rotational viscometer.

Thickening agents are analysed and efforts are made to arrive at a good evaluation of quality.

Food packaging problems

The great development which modern packaging has undergone, particularly in plastic materials, clearly raises many problems in the realm of foodstuffs. The inter-relationship between packaging material and food is an important aspect. Chemical and physical methods are used to demonstrate the presence of any harmful compounds in the packaging material and to establish the suitability of the material for packing a given product. For these purposes storage tests on packed foods are also carried out, if need be under varying climatological conditions.

nutritional research



Administration of a vitamin preparation

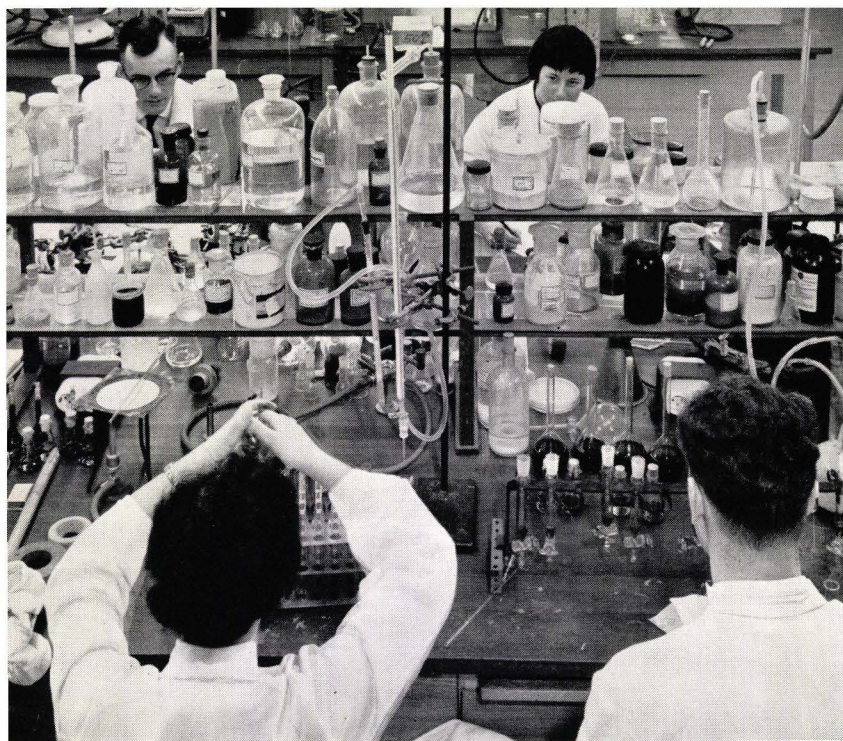
Animal experiments The Institute has an experimental animal department housing rats, guinea-pigs, chickens and baby pigs, where nutritional experiments are carried out.

Regular investigations are conducted on the nutritive value of proteins and the influence of technical processes on digestibility, biological value and limiting amino acid. Growth experiments are carried out for the qualitative and quantitative determination of vitamins and other growth factors, or for the demonstration of the presence of harmful compounds. These investigations may also be undertaken at the request of food manufacturers.

In connection with the problem of atherosclerosis, which at present is a topic of such great interest, the influence of proteins and fats on the blood cholesterol content of laboratory animals is studied, as also the influence of various dietary components on blood coagulation.

Chickens for feeding experiments





Laboratory for biochemical research

Nutrition of children

For many years an investigation has been in progress into the nutrition of healthy and sick children in cooperation with the Wilhelmina Children's Hospital of Utrecht.

The main problem of recent years is that of the cause and treatment of coeliac disease. It appears that the protein of wheat, rye, barley and oats, in particular the gliadin, induces a very strong reaction in the patient. On the other hand, the children respond very well to wheat-free diets. The study of the harmful effect of gliadin and its cause is being continued.

The absorption of higher saturated and unsaturated fatty acids is being studied in patients suffering from pancreas fibrosis, coeliac disease, chylothorax and other diseases. In this connection micromethods have been worked out for the determination of fatty acids in blood and faeces by means of gas phase chromatography.

Recent investigations have shown that chronic diarrhoea in children may be caused by the absence of enzymes necessary for the splitting of sugars.

If desired, manufacturers of baby foods are given advice on the correct composition of the food.



*Blood samples are received
at the laboratory*



Nutritional survey in the tropics

Nutritional status of the population

In collaboration with the Organization for Health Research T.N.O., data are collected on the nutritional status of various population groups, in particular of children. There is close cooperation with a number of school medical officers, whom the Institute assists in the collection and evaluation of data.

New methods of assessing nutritional status, e.g. by measurement of the subcutaneous fat, are under investigation. Chemical methods for the determination of nutrients in blood and for medical field research are studied and improved in close cooperation between the chemists of the Institute and physiologists and anthropologists.

Nutritional problems in the tropics

Investigations are also conducted on behalf of those parts of the Kingdom which are Overseas. The nutritional status of population groups in New Guinea, the Antilles and Surinam have been studied by investigators of the Institute. Continuous support is given to research carried out on the spot by physicians residing in New Guinea.

Tropical foods are regularly analysed and methods have been developed for the preservation of blood samples during transport from the tropics.

library, documentation and publicity

Documentation and information

The Institute possesses a research library of about 4000 volumes, about 300 current periodicals, a great many pamphlets and a large collection of foreign food laws and regulations. The books and journals can moreover be lent out and Dutch food manufacturers make frequent use of this facility.

Because the Institute has at its disposal such comprehensive material, as well as many abstract journals and a card index that is continuously kept up to date, it is able to provide, on request, fundamental information on foodstuffs and nutrition.

In the course of years staff members of the Institute have published a great many scientific papers, and many others of an applied nature for the purpose of disseminating information. For those interested they are available free of charge so long as they are in stock.

INSTITUTE FOR CEREALS, FLOUR AND BREAD TNO



The Institute performs its activities on behalf of the milling industry, producers of bakery materials, bread and pastry bakers, and other flour processing industries. For this purpose the Institute has a chemical laboratory with up-to-date equipment, a milling department, a bakery department, a drawing-office, a construction workshop and a well-provided library.

In addition to the investigations carried out at the Institute itself, difficulties and problems are discussed in the factories by the liaison officers, who sometimes give direct advice, and in other cases establish contact with their colleagues at the Institute. This liaison service is also helpful in the practical implementation of the results obtained by research.

At present the staff of the Institute consists of 46 persons, 10 of whom are university graduates. In the following pages a brief survey is given of the most important subjects which are now under study.

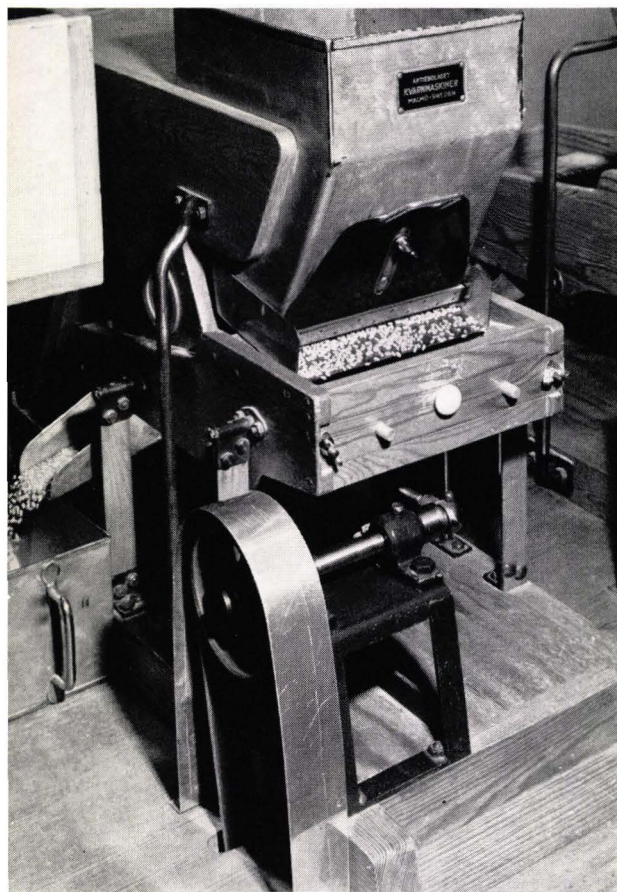
Industrial quality of cereals

As regards wheat breeding, attention at present in The Netherlands is not only given to the yield per acre and the resistance to pests, but also to the baking quality, i.e., the greater or lesser suitability for bread making. Each year the wheat varieties suitable for cultivation are tested in regard to these properties. The wheat is milled to flour or wholemeal, following which baking tests and various chemical determinations are carried out.

The investigation of baking quality also covers the examination of varieties that are being developed by breeders. In the early stages of the selection work but little material is available, which means that breeding samples have to be studied by special micro-methods.

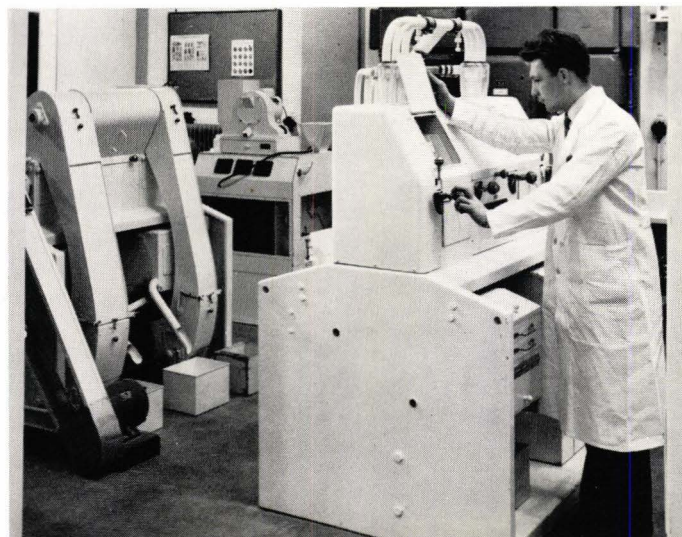
To record and analyse the baking quality of the Dutch wheat crop, a yearly investigation is carried out of breeders' samples from all important production areas of the country.

In view of the great importance in the Netherlands of wheat for human nutrition, the study of this cereal is given priority of place. In addition, however, other cereals are also studied for their suitability as raw material for the processing industry.

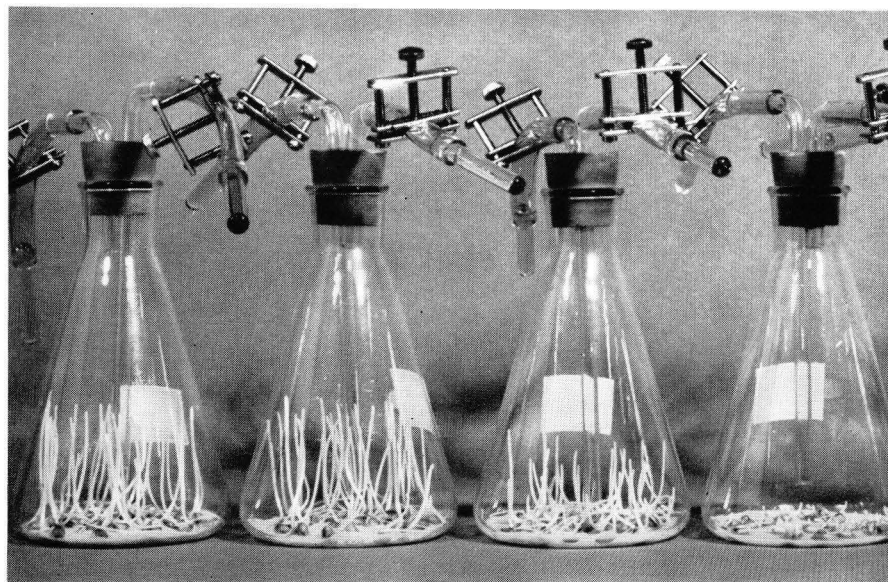
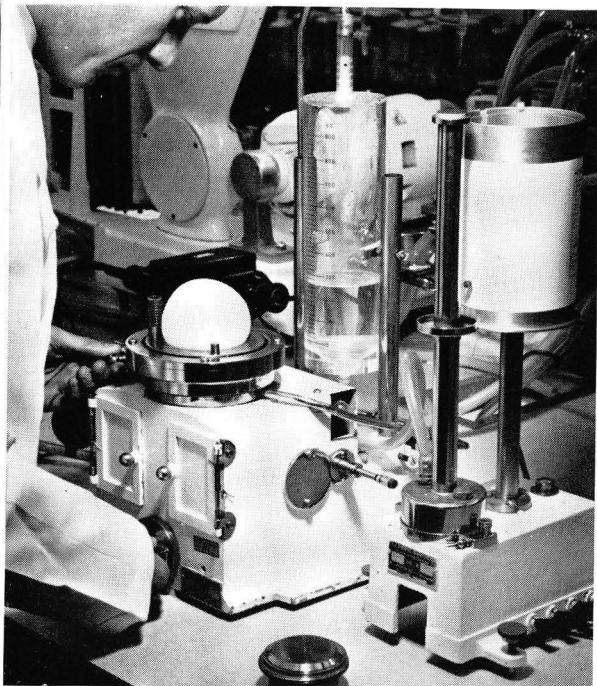


Grain cleaning

Milling department



*Apparatus for measuring mechanical
dough properties*



Germination tests with wheat

Dormancy and sprouting

Sprouting is the term applied to the behaviour of grain which in rainy weather begins to germinate while it is still in sheaves in the field. Even a low percentage of germinated grain may cause considerable damage to the baking quality of wheat and rye. Much attention is therefore given to methods of determining the degree of sprouting damage in parcels of grain.

The internal and external factors which influence the germination of wheat are also under investigation. One of the problems studied is the question of what properties of the grain determine the sprouting resistance of a variety.



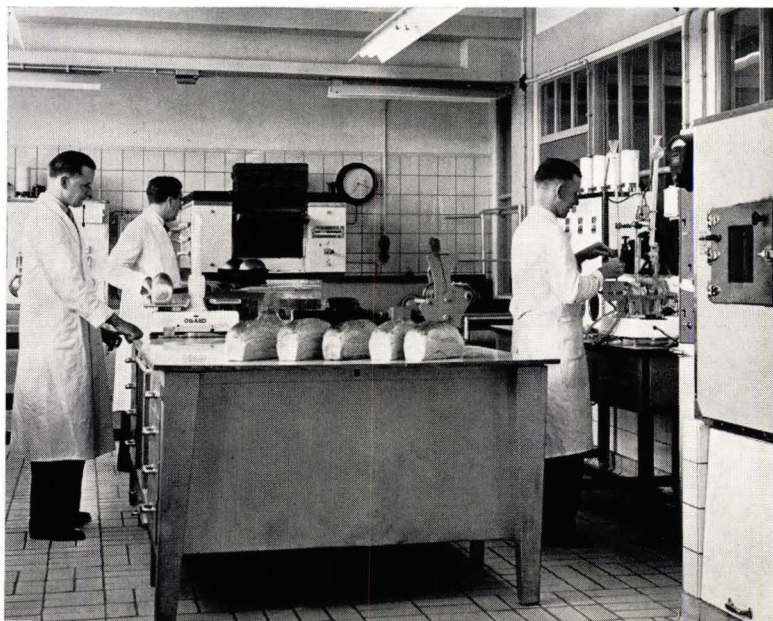
Deep-freeze apparatus

Keeping quality

During storage, chemical processes caused by micro-organisms or otherwise may cause changes in wheat and flour as well as in baked goods. These changes may become manifest in taste and flavour. The staling of bread must also be mentioned in this connection.

Methods are studied by which these undesirable changes can be combated. According to the nature of the product and the changes that arise, the influence is investigated of drying, cooling, deep-freezing, sterilization and the addition of preservatives or of agents which counteract certain reactions. Studies made as to the most suitable packaging materials should also be mentioned.

In addition to the practical aim of preventing the harmful consequences of these changes, efforts are also made to establish the cause and nature of the changes.



Experimental bakery



Micro-baking test for the varietal improvement of wheat



Biscuit cutting and moulding machine



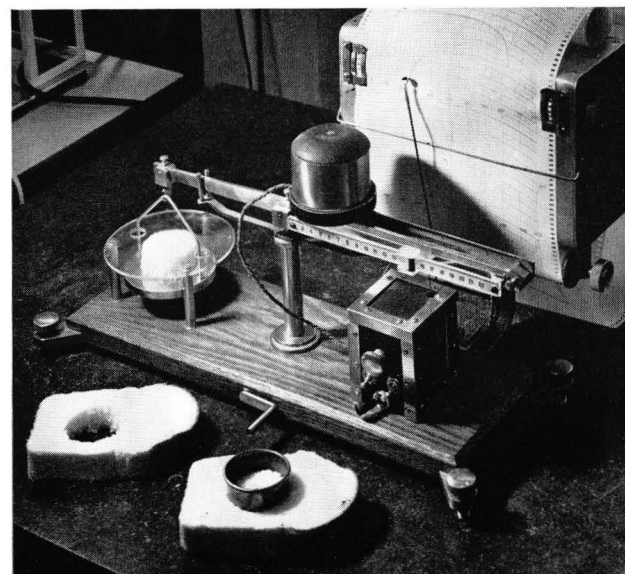
Mechanized bakery on semi-practical scale

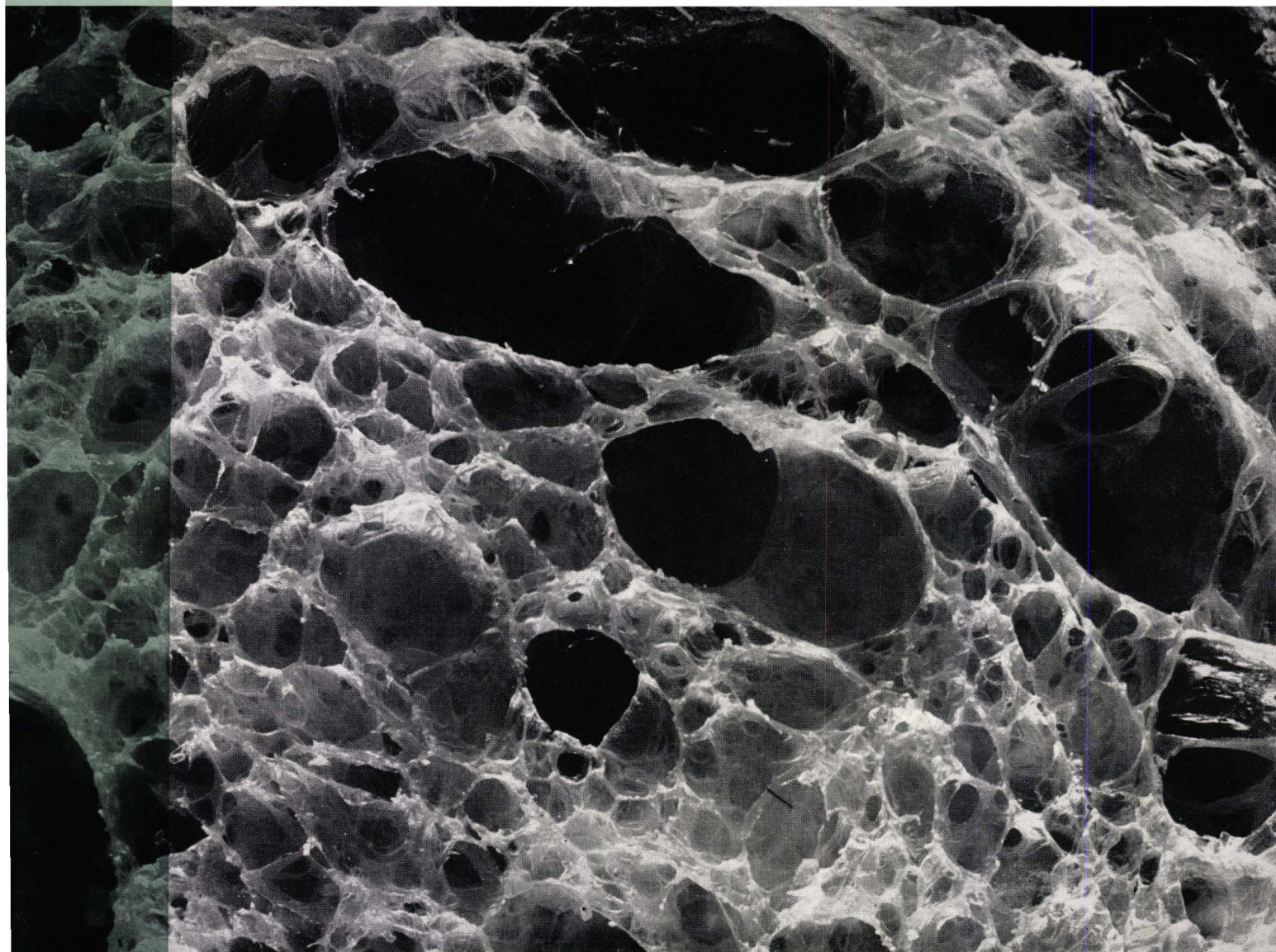
Bakery recipes and procedures

Much attention is given to recipes and working methods on behalf of the bakeries and flour-processing industries; for example the study of methods of simplifying and improving the process of breadmaking, the accelerated cooling and deep-freezing of baked goods, and the manufacture of biscuit, rusk and pastry goods. Further: the testing of the activity of auxiliary materials for bread- and pastry-baking, and the development of new such materials.

Where desired, experiments are also carried out on the spot in the bakery or factory.

Apparatus for measuring the softness of crumb





Crumb of gluten-enriched bread (magnified)

Chemistry of dough and bread

Dough and bread are colloid systems. Studies are made of the structure of these systems and of its development during the various phases of the bread-making process, or during the subsequent period of storage of the bread. For example the manner in which starch, protein and fat cooperate in the formation of structure is investigated, and also the question as to which components or atomic groups are responsible for differences in the baking quality of flour or are involved in the changes brought about by flour improvers.

The rheological properties of dough, which are related to the microstructure of the dough and the quality of the baked product, are likewise studied.

All these investigations form part of the technological research on the improvement of flour, on breadmaking and on the prevention of bread staling.

Methods of investigation

Special methods have to be developed for many of the investigations mentioned. Moreover, constant attention has to be given to improvement of existing working-methods as used for example in the production of bread, biscuit, cake, etc.

For the examination of breeders' samples, methods have been developed for milling and baking tests on very small samples of wheat, etc.

New methods have been developed for the objective evaluation of flour colour and of bread crumb by means of light-reflection measurements, and also for carrying out rheological measurements on dough.

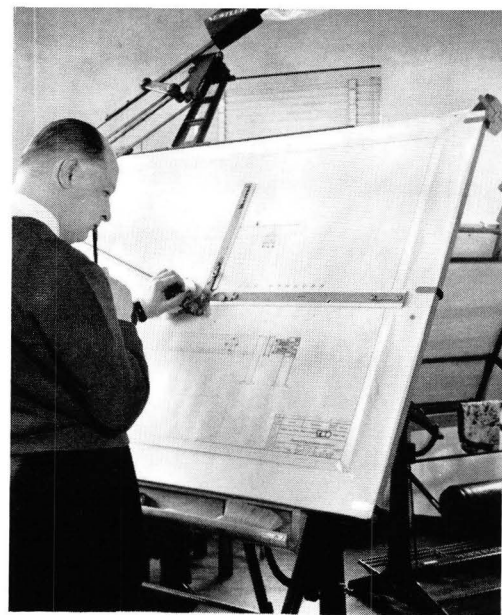
As regards the chemical analysis of wheat and wheat products, it is especially the enzymes, fats and various atomic groups of the proteins which necessitate the development of new methods of determination.

The Institute cooperates in the standardization in the Netherlands of commercially important methods for the analysis of wheat and wheat products, whilst it also collaborates in investigations directed towards the international unification of methods.

Industrial planning and equipment

A logical planning and a good choice of equipment are very important for the economic functioning of a factory. The Institute is called upon to an ever-increasing degree to give advice on the equipment of new factories, or on the mechanization and automatization of existing ones.

New apparatus is also developed for the industry should there appear to be a need for it.



Drawing-office

Construction workshop



Equipment

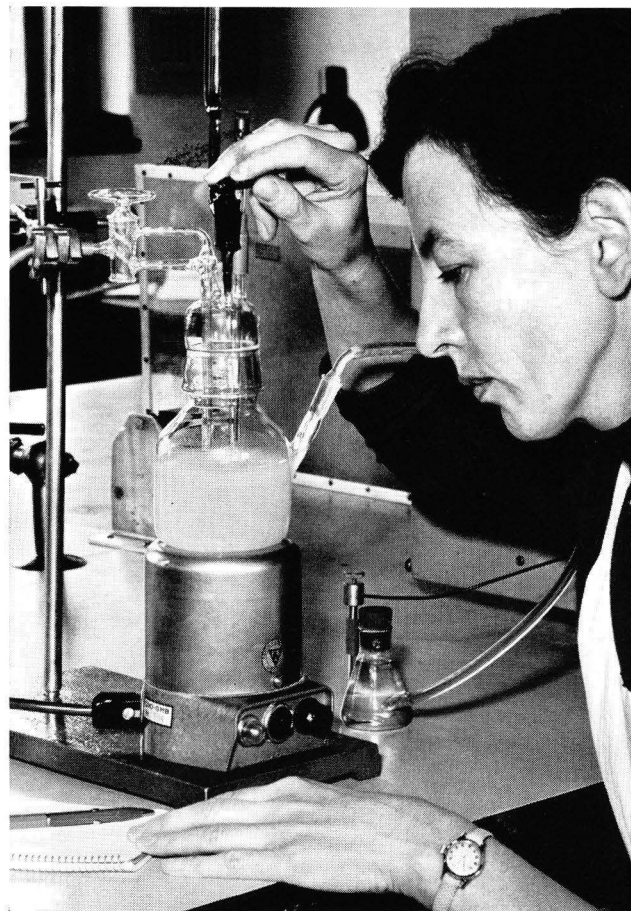
The chemical laboratory possesses modern equipment for chemical and physical analysis.

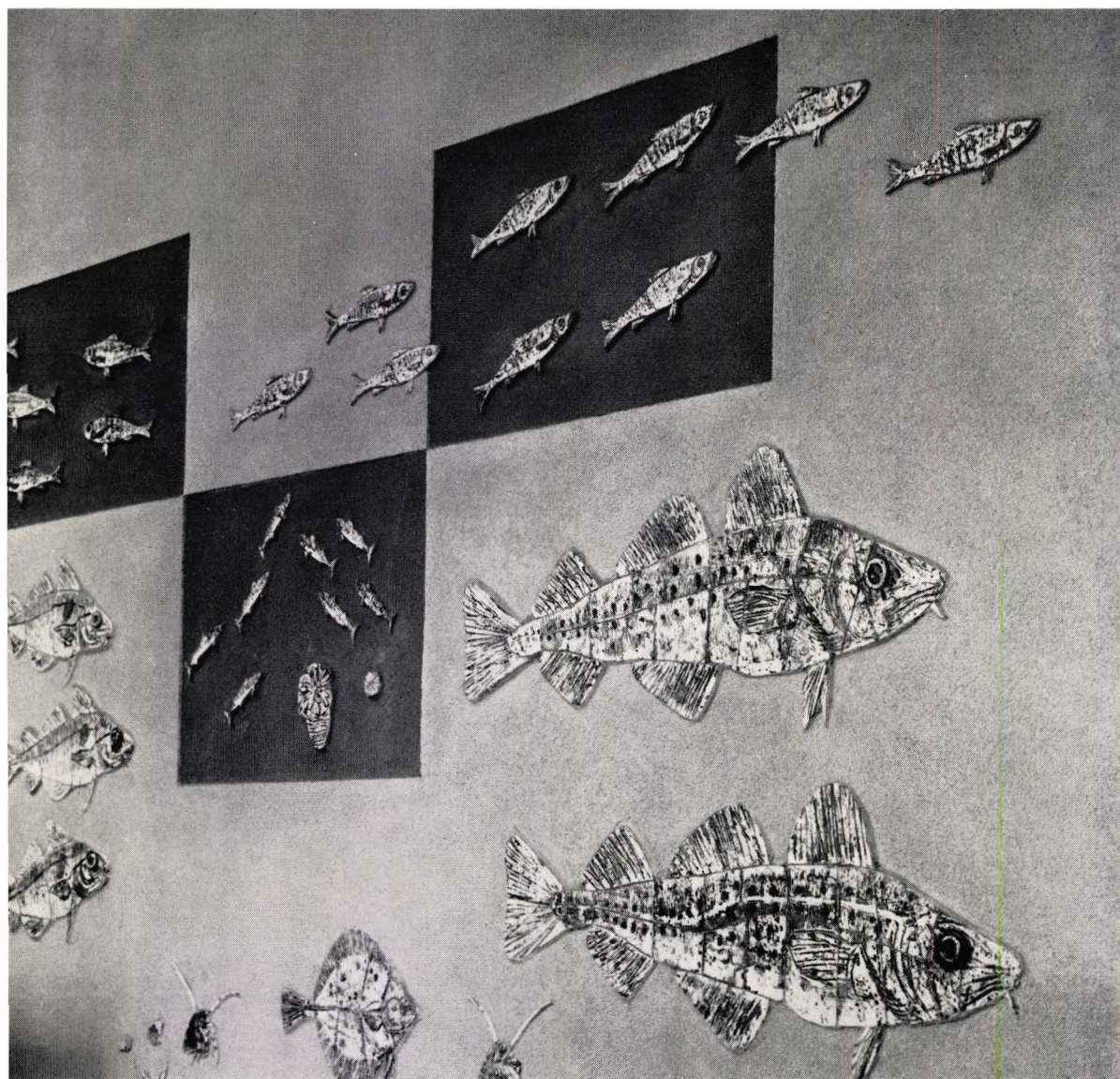
The experimental milling department has a large plant for the cleaning and milling of wheat (at constant temperature and atmospheric humidity when required), and for the treatment of wheat by heat, or with steam, vacuum, etc.

In the experimental bakery loaves on the laboratory scale from 10 to 800 grammes can be made. There is also an automatic pilot plant, with, amongst other things an electric oven which can be used as a wire mesh travelling oven and as an ordinary travelling oven. There are, in addition, many modern machines for the preparation of Dutch rusk, pastry goods, etc.

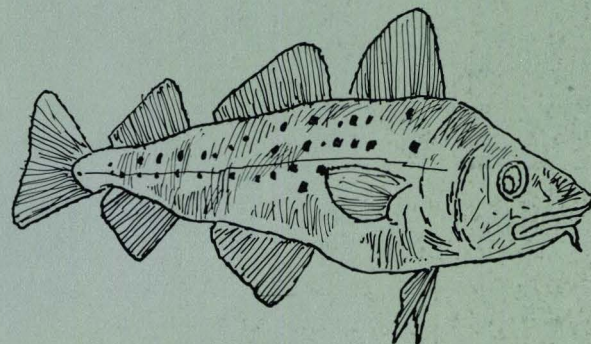
Other equipment of the Institute comprises a deep-freeze installation, humidity cabinets and an installation for the fumigation of incoming wheat and flour samples to prevent infection with flour moth, grain weevil, etc.

Amperometric titration of thiol groups





INSTITUTE FOR FISHERY PRODUCTS TNO





The Institute for Fishery Products T.N.O. is engaged in research and technical instruction on behalf of the fish-processing industry. The staff consists of 18 members, four of whom are university graduates.

Some important subjects at present under study are discussed in detail below.

Glazing of blocks of frozen herring to prevent desiccation

Refrigeration and freezing

The handling of fresh fish is included in the work on refrigeration. Apart from conventional ice cooling, the technological aspects of the use of preservatives are studied, as well as of storage in refrigerated brine.

For investigations on the conditions under which fish and fishery products should be frozen, the Institute possesses an experimental freezing tunnel and a number of storage cabinets in which temperatures down to -30°C . (-22°F .) can be maintained. Packaging problems hold an important place in these investigations.

Attention is also given to the chemical and microbiological changes arising during the storage of fish and fishery products in refrigerated or frozen condition.

Salt herring

From the historical and economic point of view, salt herring is one of the most important Dutch fishery products. The investigations in this field deal with the products obtained by further processing as well as with the material destined for direct consumption, and are on the one hand concerned with undesirable changes such as all kinds of spoilage, and on the other with the desirable changes occurring during the ripening of the salt herring.

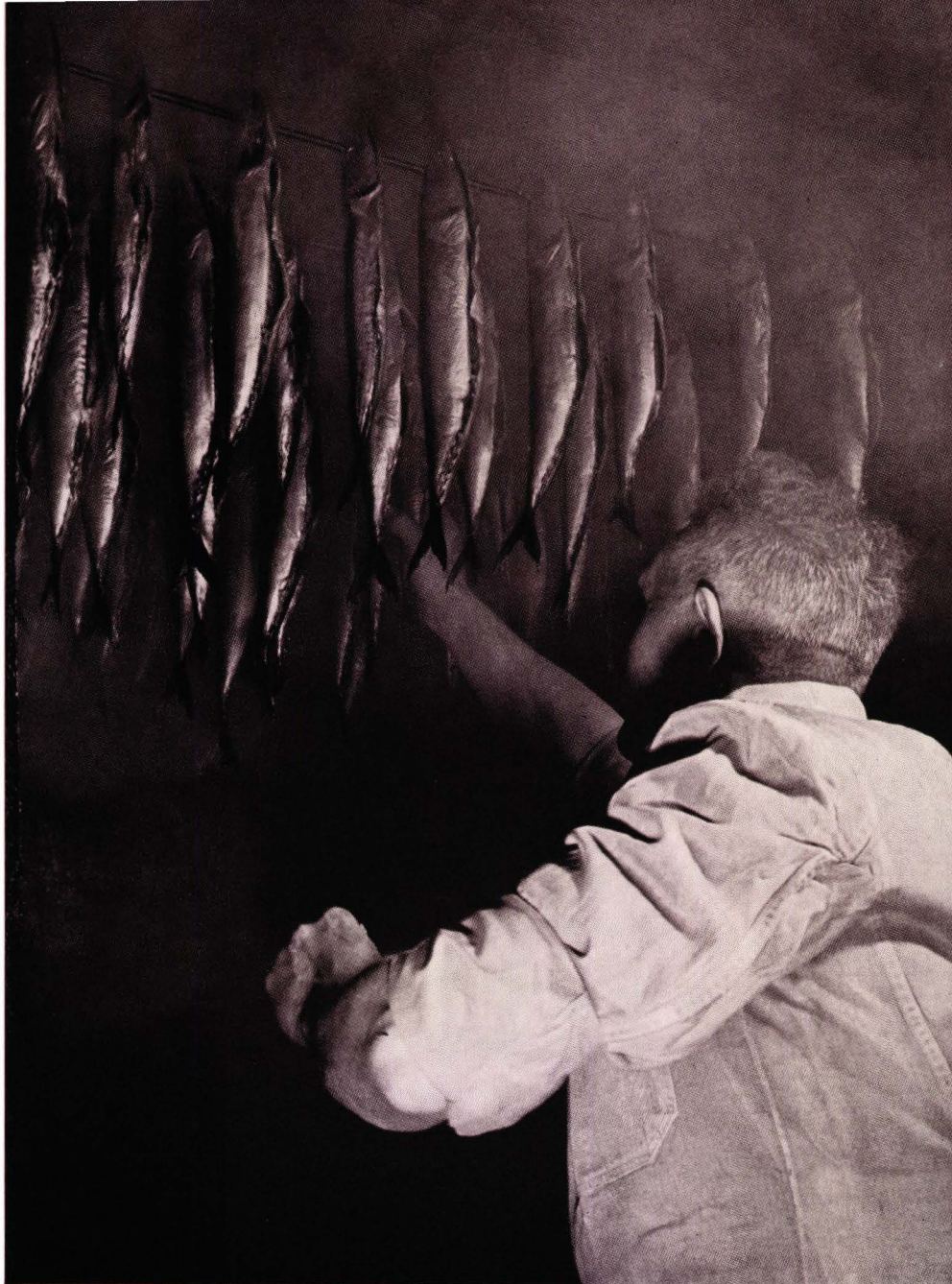
Smoking and drying

The Institute has a pilot plant for fish smoking provided with modern equipment for cold and hot smoking of fish.

Temperature and relative humidity can be determined during the smoking process. Particular attention is paid to efficient and hygienic packing, both for retail and wholesale purposes.

The organoleptic and keeping qualities of products smoked in different ways, and with different methods of smoke production, are compared.

Interested persons from the industry are given the opportunity of obtaining experience in modern methods of fish smoking.



Hot smoking of mackerel

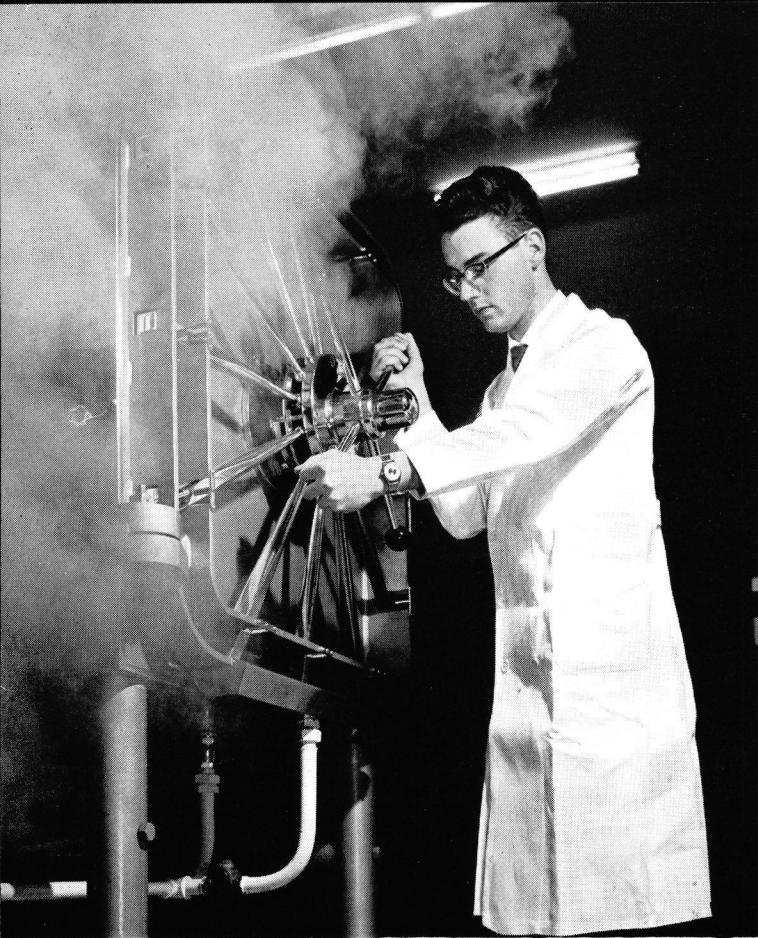


Organoleptic evaluation

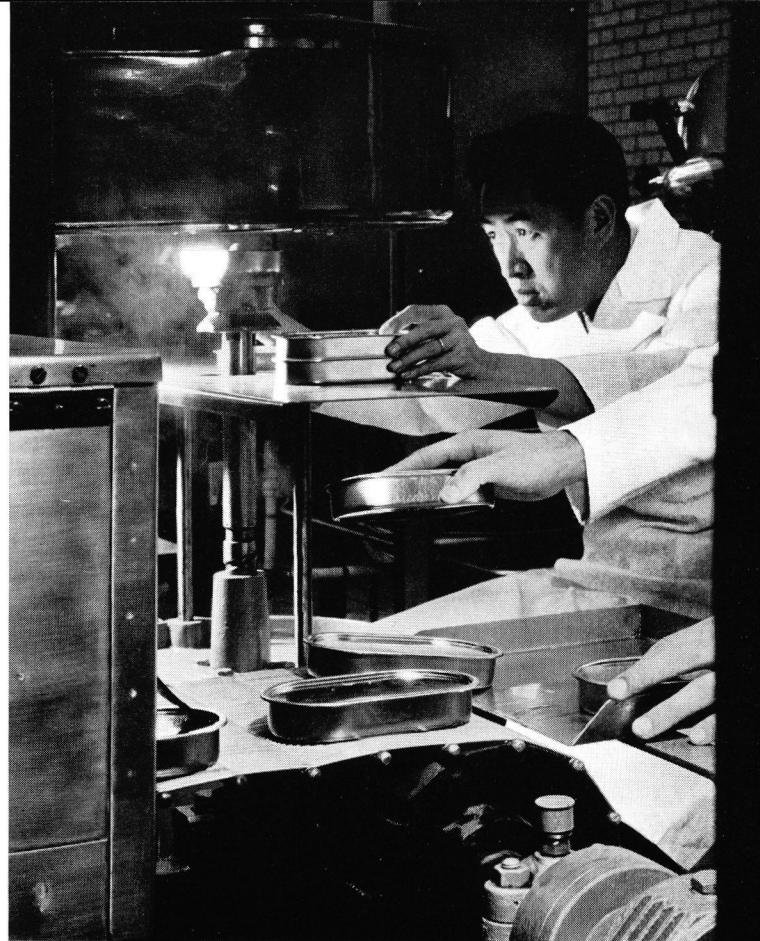
Canned and semi-preserved fish

For the study of problems relating to the preparation of sterilized products in cans and in glass, extensive equipment is available. Apart from the inquiry into the best conditions for pre-cooking, exhausting and sterilization, attention is also paid to the composition of stabilized sauces for canned fish. The results of bacteriological examinations are used to lay down the best conditions of sterilization.

As regards semi-preserved fish, attention is specially focussed on the improvement of stability. To achieve this, the causes and the nature of spoilage and the effect of preservatives are studied.



Steam retort for preserved fish



The sealing of fish cans

Processing of fish waste and offal

The Institute possesses an apparatus suitable for the processing of small quantities of raw material. With this it is possible to study the relationship between the quality and freshness of the raw material on the one hand, and the quantity and quality of the yield in fishmeal and oil on the other.

RESEARCH GROUP FOR MEAT AND MEAT PRODUCTS TNO

In 1959 the Dutch institutes engaged in research on the production and processing of meat decided, under the auspices of the Organization for Nutrition and Food Research T.N.O., to form a research group for the purpose of promoting efficiency in research by coordinating the investigations and by collaboration. The following institutes participated:

Institute of Foods of Animal Origin of the State University of Utrecht
(Director: Professor Dr. J. H. J. van Gils)
Zootechnical Institute of the State University of Utrecht (Director:
Professor Dr. P. Hoekstra)
Institute for Animal Husbandry Research 'Schoonoord' (Director: Ir. H. de Boer)
Institute for Animal Nutrition Research 'Hoorn' (Director: Professor A. M. Frens)
Laboratory of Animal Husbandry of the Agricultural University of Wageningen
(Director: Professor Dr. Th. Stegenga)
Central Institute for Nutrition and Food Research T.N.O. (Director: Dr. C. Engel)
Experimental Station for the Butchers' Trade (Director: C. C. van de Watering)

In addition regular contact is maintained with the Laboratory of Zoonoses and Pathological Anatomy of the National Institute of Public Health of Utrecht (Head: Dr. E. H. Kampelmacher), the Veterinary Chief Inspectorate of Public Health (Inspector: K. Hofstra) and the Veterinary Service (Inspector: J. P. W. Anemaet).

Apart from the investigations on meat products already mentioned under the heading Central Institute for Nutrition and Food Research T.N.O., the research group is active in the following fields:

1. Comparative investigation of the suitability for meat production of different breeds, the selection of cattle and pigs for meat production.
2. Study of the influence of feeding and other external conditions on the carcass quality of young cattle, pigs and sheep, e.g., on the softness of bacon.
3. Fundamental investigation of the objective evaluation of the quality of slaughter animals, and of meat and meat products.
4. Investigation of certain abnormalities in the quality of the meat of slaughter animals: muscular degeneration in pigs and calves, 'slight of lean' in bacon pigs.

Other food research institutes in the Netherlands not under the auspices of the Organization for Nutrition and Food Research T.N.O.:

NETHERLANDS INSTITUTE FOR DAIRY RESEARCH

2, Kernhemseweg, Ede - Telephone (08380) 92 45

Director in chief: Prof. Dr. J. W. Pette

**INSTITUTE FOR RESEARCH ON STORAGE AND PROCESSING OF
HORTICULTURAL PRODUCE**

6, Haagsteeg, Wageningen - Telephone (08370) 20 45

Director: Ir. T. van Hiele, Deputy director: L. de Vos

NATIONAL INSTITUTE FOR MALTING BARLEY, MALT AND BEER TNO

10, Polderstraat, Rotterdam 25 - Telephone (010) 17 67 55

Director: Dr. H. van Veldhuizen

The logo for TNO, consisting of the letters 'TNO' in a stylized, white, outlined font. The 'T' and 'N' are connected, and the 'O' is a simple circle. The logo is centered horizontally and vertically on the red background.

TNO

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