c/o

SLAGTERI- og KONSERVESLABORATORIET
DANISH MEAT PRODUCTS LABORATORY
22nd June, 1973

KVALITETSKONTROL
Manuskript nr. 80

Quality and quality maintenance

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(for presentation at the 19th European Meeting of meat research workers).

Introduction

No uniformly accepted or acceptable definition of quality exists, and in fact, could not exist. The late British meat research worker, prof. John Hammond, of Cambridge, working on the improvement of meat animals, liked to suggest that quality is simply that, for which people are prepared to pay the most.

This illustrates well that quality must be determined on the basis of the market place and is not a matter of characteristics deduced from laboratory findings, e.g. a fish with a trimethylamine content of 0.5 mg/per gramme may in Denmark be considered rotten, in some export markets properly ripened. This example immeadiately suggests that the concept of quality varies from area to area and between population groups.

It is commonplace knowledge that for any one product and area, often more than one quality exists, e.g. the American grades fancy, choice and standard, or A, B, and C.

On one factor is there generally agreement, namely that the food must be safe, but disagreement arises when it is asked: how safe? As an example, some feel that meat should be Salmonella-free in any test, but microbiologists tell us that this is unattainable - and also unnecessary. It should probably rather be so low in Salmonella count that the presence of the organisms will cause no harm under even the most unfavorable of normal foreseeable circumstances. We are then left to define the latter and the corresponding safe level of Salmonella. Similarly, there is some area of acceptance that canned foods should be so heat processed that theoretically, a load of Clostridium botulinum spores of maximum heat resistance should be reduced from 10^{12} to 1.; however, this is not attained for most canned meats yet considered safe and widely used.

Safety as regards absence of chemical substances, i.e. pesticides, herbicides, antibiotics, heavy metals and naturally occuring toxic factors is an obvious requirement but we are far from having determined what is toxic, in which doses, and what is the permissible concentration in which food.

One might expect uniform agreement that foods should be wholesome. Surprisingly, little attention has been paid to that in the past in food control except for some baby foods and substitute foods, e.g. weaning foods, margarines and - more recently - meat analogues. In so far as most of our daily foods are concerned they are simply accepted as wholesome. In fact their nutritive value vary widely even for the same products, but this is rarely taken into account in defining quality.

One important criterion for food quality is that it should give the consumer what he or she expects, or possibly even something considered better. This must include also that the consumer should be satisfied with the food, if its history were known to him. This introduces into quality considerations the question of food habits and estethics, e.g. some would not eat a certain food, even if they like its taste, if they are told that it contains dogs meat. Similarly, we demand that cans be washed prior to filling in a cannery because we expect our food to be filled into clean containers, not withstanding that in the case of canned foods, the subsequent heat processing will destroy any microorganisms which might have been introduced with an unwashed can.

A central component of our quality concept is that a product and the circumstances surrounding its sale, particularly the labelling, advertising and presentation should not be misleading, e.g. a canned ham should not upon opening appear to be chopped ham or ham sectioned and formed even though those three products are made of the same material and basically taste the same. On the other hand, our concept of a canned ham has changed drastically over the last few years, i.e. from a large piece of cured ham placed in a can, to a composite of individually cured, tumbled or stirred ham muscles, reassembled and bound together into a very uniform piece of meat with little ressemblance to the hams of previous years.

Thus, in determining our quality criteria we are left to make rather arbitrary decisions, based on existing rules and regulations, our knowledge of safety factors, pending legislation,etc. Also, we have to consider consumers habits and preferences and the usual nature of similar products, consumed in the market we are considering.

Quality control in industry

Products safety and legality. A factory will wish to define the quality of its products so that the risk of any one of these being toxic is absolutely minimal; as an example the three latest cases of botulism from commercially canned food in the U.S.A. resulted in business failure for all of the companies concerned. In this respect factories may often have to take further steps than those which are legally required.

Factories may often have to try to anticipate legal requirement also since political decisions may be quick and arbitrary. Thus, the recent ban on cyclamates has, although highly questionable on toxicological grounds, forced several manufacturers to withdraw merchandize worth millions of D.kr. Similarly, the realization by public authorities that the mercury level in some tuna is rather high - although not higher than it has been for years - may force a major U.S. packer into bankruptcy. Likewise, the detection of pesticide residues in hams, stemming from imported feeds, recently became a serious economic problem for the Dutch meat canning industry. It is not inconceivable that some products, prepared with molds, although accepted to-day, may some day suddenly be seized as unsafe because of some suspicion of presence of dangerous levels of mycotoxins.

Thus, in respect to safety and legality, manufacturers may have to adjust their quality criteria beyond requirements made by public authorities and to attempt to anticipate areas where problems may arise in the future. The mere fact that a production is made in accordance with rules in force when it was manufactured will not be sufficient to safeguard against rejections, seizures or recalls.

Factories will, of course, want to make certain that their products comply with rules and regulations, both at the place of manufacture and at the market where they are to be sold. In Denmark, the Danish Meat Products Laboratory maintains an intelligence service for the industry, subscribing to foreign official gazettes and registers, and follows development in the field of food legislation and in the administration thereof by literature, correspondence, telephone and travels. This is by no means a simple assignment because many rules are not publicly available; also, administrative interpretation may change without notice or notification or be different from place to place. Yet, failure to adhere to these rules may result in heavy economic losses, e.g. an export shipment was recently returned because it was marked with the name of the country of origin in English (Denmark) and not in the language of the country of destination (Dänemark) nor in the language of the country of origin (Danmark).

Even in this respect, manufacturers have to live with compromises. First, countries often have laws and regulations which are not enforced and frequently not even enforceable. Thus, many countries require that ordinary canned products be sterile, although this is hardly attainable and seldom achieved and is also not necessary. However, the rule is seldom enforced, and a factory would normally settle for what might be termed commercially stable products, i.e. products free of any organism in such number that it might develop in the canned product at storage conditions to which it may conceivably be exposed. There are, of course, also many cases of food laws which are simply obsolete and no one adheres to them, yet, at the risk that some authority may suddenly require compliance with them.

Product quality. Once questions of safety and legality are solved, a factory will have to determine its own quality requirements. These will normally be worked out by close collaboration between the quality control, production, sales and marketing function, and are often the responsibility of the sales department. However, consultation with the economic or accounting department is often also required since organoleptic quality is a result of what the market desires, the production can make and economies allow.

Much experience is on hand to suggest that quality specifications cannot be left to the production department alone. In on case, a large manufacturer consulted an outside consulting laboratory because their market share for one of their major smoked products was decreasing steadily. The answer, which was quickly found, was that the product was made to suit the taste of the supervisors in the smoking section, i.e. a rather heavily cured product with a characteristic smoked taste, when the market preference in reality was for a rather bland, very lightly smoked product, a fact which had escaped the production people since they themselves would look at such a product with contempt.

In many cases, a factory may wish to make several different qualities of a product, e.g. satisfy different market segments, to meet the wishes of different buyers, or the taste preferences of different countries. In such cases, a specification needs to be agreed for each.

Specifications and manufacturing procedures. A company may draw up specifications for the finished products or, especially in the case of medium sized factories, rely on the knowledge and experience which the various operators in the plant have acquired. For perishable products, it will be particularly important to agree on the minimum keeping quality, the products should have.

Once these factors have been agreed upon, it becomes more important for a factory to work out specifications for each step in the manufacturing process, e.g. quality of raw material, ingridients packaging, and manufacturing, storage and packaging procedures.

Organization and execution. Adherence to strict specifications is often difficult under the stress of day to day problems. A quality control department is required to see to it that prescribed limits, e.g. storage times for raw meat, bacterial load, etc., are not exceeded. It is a common rule, therefore, that the quality control department must report directly to top management e.g. a director, vice-president, senior executive or some person of similar charge. Where several manufacturing branches exist, the quality controller in each plant should normally be on the same executive level as the local plant manager, but should report directly to the company quality controller.

Authority. The quality controller in a plant may withhold a shipment of raw material, ingredients or finished product, order it reprocessed, etc. Where concurrence is not obtained with the production manager, the decision will have to be taken by top management. Cases where safety and legal considerations are at stake must always be appealed to the very top management if the decision of the quality controller is questioned.

Execution. The quality control department must have its personnel dispersed throughout the plant, checking on materials and procedures. This is necessary because its function is not to find and withhold defective finished products, but to prevent such from being manufactured. This implies that personnel from the quality control department must

1) supervise that agreed procedures, e.g. production specifications, are followed,

2) check all raw materials, ingridients and packaging material, e.g. checking each can sealing machine at least once an hour,

3) check temperatures and holding times in coolers, smoke ovens, etc.

4) supervise heat processes in canning operations,

5) check clean-up procedures against specifications and at intervals also with flow sheet analyses.

Methods. A great many specific objective measuring or analytical methods have been developed which might be applied in quality control work. Most, however, have been developed for scientific work, for legal prosecution or for use in litigating; this means that most are very accurate but time consuming, too much so to be practical under actual operating conditions, where simple almost qualitative tests which provide quick checks against abnormal developments are indicated.

Meat quality may be determined with one of the reductase methods, using resazurin added to an extract of the meat, resazurin impregnated paper placed directly on the meat or tetrazolium sprays on the surface of carcasses. However, mostly only organoleptic tests are used in raw material evaluation since apperance and smell normally will be sufficient indicators for the trained person.

Freshness of the raw meat might also be tested by some chemical analyses, e.g. content of ammonia. However, such tests generally correlate rather poor with organoleptic findings and therefore are rarely used.

The quality of fatty tissue such as fat backs as raw material might be tested by the determination of free fatty acid (FFA) or by peroxide value or thiobarbituric acid tests. A simplified version of a peroxide test, for use on back fat stored long before used, was developed by the Danish Meat Research Institute, using ammoniumthiocyanate and freshly prepared ferrochloride, with choroform as a solvent.

The quality of fresh pork may depend on the feeds the pig has received; thus, a garbage fed pig may have a soft back fat, less desirable in manufacture and showing a reduced keeping quality. Such cases might be detected by determination of iodine number; however, visual examination of firmness is normally used since the laboratory tests are too time consuming.

Biochemical meat quality, e.g. PSE or DFD-pork, may be determined by pH-measurement using a spearformed glass electrode or by the use of indicator paper or sticks, inserted in the flesh. Tenderness may be determined by penetrometers such as the tenderometer developed by Armour & Co. in the U.S.A. for beef carcasses. For pork, thickness of back-fat layers may be measured directly or, for the uncut parts with an introscope developed by the Danish Meat Research Institute sometimes referred to as optical probe,or today with the more sophisticated meat-fat measuring devise also developed in Denmark, which measures thickness of both back fat and meat, using a principle similar to that used in a nautical echo sounder.

The other ingredients, e.g. salts, spices, acids, casein, gelatine, are generally tested in the company's laboratory for suppliers compliance with specifications. The methods used are generally those found in standard reference works. Small manufacturers may prefer to require of the supplier that the ingredients used be tested and approved by some specialized laboratory, often a government testing organization, e.g. the Danish Meat Products Laboratory.

Sanitary cans may be tested by the usual empirical tests for number of pores in the tin layers, adherence of enamel to the tin plate, etc. In practice, these tests are seldom applied since deviations in tin can manufacture can generally first be detected after storage of the finished product.

Packaging films and plastic containers, etc. may be tested by exposure to acid, alkaline and salt solutions and to some neutral oil to determine any possibility of any chemical substance being transferred to the product. Permeability for water vapor, carbondioxide and oxygen are today best tested in equipment where a test gas is passed on one side of the material and pure air on the other. The ratio of absorption of ultrared waves of two different frequencies is determined and used as a very sensitive indicator. Here again, such tests are mostly left to the manufacturer, the company relying on his control. Tightness of heat seals of plastic containers may be determined by exposing the package to a vacuum to determine, at what pressure the package will swell, and by introducing air under pressure into the container often under water to determine, at what pressure leaks will occur.

During processing it is normally very important to determine the fat content of batches of trimmings in order that a predetermined fat content of the finished product may be reached. Fat content may be determined using the "Anal-ray" equipment, or one may use the so-called "Fat-con" method, determining the specific gravity by the water replacement method on several samples of 10 kilos from each batch, a method developed by the Danish Meat Research Institute. One may also make a small representative sample of four grammes of each batch and determine fat by the "Foss-let" method, a procedure whereby the specific gravity of a solvent is determined after extraction of fats from a sample. In so far as non-salted batches of trimmings are concerned, one may more conveniently and with sufficient accuracy, determine fat by determining moisture content and calculating the fat content on the basis therof.

In sausage making, determination of water activity is often carried out using the hair hygrometer method developed at the Bundesforschungsanstalt für Fleischforschung in the Federal Republic of Western Germany.

When hams, bellies, etc., are cured by brine injection there will generally be a legal or company enforced limit on the amount of curing brine which each piece of meat may take up. This may be controlled by chemical analyses, relating amount of water and curing ingredients to protein content. However, such tests are not feasible during actual operations. Therefore, weighing a suitable number, e.g. 10, of marked pieces before and after pumping and calculating uptake and variation may be sufficient. For Wiltshire bacon in Denmark a meter is used to indicate the amount of brine with which each side is pumped.

Heat processing operations in canning are checked by the use of thermographs, but controls must include also such features as water level, water circulation, complete removal of air from steam retorts, etc. Normally, each retort basket must be marked with a cook check, i.e. a heat sensitive tag which is removed by quality control personnel when they have satisfied themselves that the basket has been heat processed. More recently, equipment has been introduced which marks every can with a dot of heat sensitive paint on the canning line so even the retail customer or more important, the health inspector at any point, may see that the can was heat processed.

Cleanliness of a factory is generally determined immediately before work starts. Where bacteriological flow sheet analyses are used, care must be taken that residues of disinfectants. do not mask the findings. Standard microbiological, plate count methods may be used or the simplified agar sausage or contact plate methods. The latter tests can be applied by personnel without any specialized training in microbiological techniques. However, the results must always be evaluated by a person with considerable theoretical training and experience.

On finished products, some routine tests are often carried out. On plastic wrapped meats this would concern keeping quality and - at least for cured meats - color stability.

Samples of batches of canned meats are frequently incubated because of legal requirements, to check for stability. Best temperatures for such tests are 30°C although 37°C is often recommended. Since only a few cans can be incubated from each cook, only instances of grossly undercooked lots will be detected by this means. Further, every can tested must be opened and examined organoleptically since, especially for cured meat, spoilage organisms are normally not gas-formers.

It is almost routine that samples of each days production be opened and evaluated organoleptically. This can not be a real check on product quality unless a large number of samples are tested. However, it provides management and quality control with an exellent opportunity for keeping informed about the general level of production quality.

Such tests should be standard practice and should include occasional review of factors which are otherwise often overlooked, e.g. how do the palletized product appear, how are outer cartons closed and labelled, how are the individual packages labelled, etc.

Such tests should be supplemented with consumers tests to verify such matters as: Did the designation of the product properly describe it, were the directions on the label clear and useful, was the container easy to open and dispose of, etc.

When a company has a brand where a uniform taste is desired, the finished product may be exposed to profile taste testing as originally developed by Arthur D. Little, Inc.

Statistical considerations. The frequency with which checks are made at the various points during manufacture, the number of tests carried out at each check, etc., will normally be determined by some simple statistical consideration. Through normal manufacturing experience, weak spots in the manufacturing process will be disclosed and stricter or more frequent checks will consequently be introduced until such time where overall losses incurred by failures are less than the marginal cost of additional controls.

Feed-back. It is obvious that all important deviations in raw materials, manufacture, or finished product must be properly recorded and appropriate action, e.g. modification of specifications, procedures, etc. must be made as a result thereof. Equally important are reactions in the trade, customers complaints, etc. and a system is required for monitoring this and channelling the conclusions back to the quality controller, who must then be able to pursue the matter, when indicated.

Official quality control

Determining official quality levels. Official quality control bodies must normally assume that other bodies, i.e. health inspection systems, etc. will look after health and safety aspects of foods. Therefore, while safety must be a primary concern in quality considerations, it may not normally be the concern of any official quality control body. On the other hand, these will normally be involved in many deliberations related to health and safety, since requirements made to ensure product safety may easily run counter to the achievement of what is considered high quality. Thus, to ensure the safety of smoked fish, steps to prevent toxin formation by Cl. botulinum may result in temperature requirements (USA) or rules regarding salt content (Canada) which make the products organoleptically unacceptable. In these as in many cases, official quality control bodies have to work with public health officials and where possible influence safety regulations in such a way that the product is rendered safe with as little undesirable effects on quality as possible.

In addition, it is not uncommon that some aspects of health and safety control is actually delegated to official quality control bodies, simply with a view to making the best use of available mainpower.

There may be other legal requirements, e.g. with regard to labelling, net weight, etc., which are not part of the official quality control requirements; nevertheless, quality control bodies may be expected to step in if they become aware of violations of such rules. Thus, such requirements will often have to be incorporated into the requirements as regards quality.

Where an export is concerned, this latter aspect becomes particularly important. An official quality control body is expected to require that products for export comply with the regulation of the importing country. Thus, export quality control in Denmark for meat products has to specify that products for some countries should not contain phosphates or vegetable protein, or they should not contain nitrite or nitrate in excess of the amount permitted in the receiving country, etc.

Here, the quality control body may face a difficult task. It is mentioned above that it is often difficult to get to know rules and regulations of foreign countries and even more difficult to keep informed as regards administrative practice, interpretations, etc. The Danish Meat Products Laboratory constantly faces this problem. Much effort is made to get information through official channels. In addition, authorities in foreign countries are frequently visited for information on methods of analyses, administrative interpretations, etc.

At times when rules or administrative practices cause difficulties for the Danish export they may be discussed with the foreign authorities who frequently have agreed to certain modifications after such discussions. As soon as possible foreign requirements to processes,products, labelling, etc. are incorporated into quality requirements.

The main part of official quality control, however, aims at maintaining a certain quality level, over and above that dictated by any other legal requirement. Here the desired quality level has to be determined. In this, it is well to remember that no government official can know exactly or determine objectively what good quality is. Even such a seemingly simple matter as desired freshness is not well defined, e.g. certain ageing is required for some meats or, as mentioned above, for some fish, in other cases it is not. Therefore, the level has to be selected on the basis of what happens in the trade. In export, similar products from the same market may have to be obtained and examined. Further, consultations are required with industry and trade. It is often suggested that consumers, i.e. consumer organisations, should also be consulted, and this probably should be a widespread practice to day. Even here, however, it must be kept in mind that consumer representatives are normally atypical consumers, i.e. they are far more interested in and knowledgeable about the products and therefore will often demand a level of quality which may not be much noticed by the ordinary consumer but may well result in the product becoming unnecessarily expensive.

One means of adjusting quality requirements is through customers complaints. These are mostly received by the trade and it may be discussed - as it is in the U.S.A. - whether official control bodies should have the right to review all customers complaints. Even this means, however, gives only incomplete information about the real desires of the market, because customers rarely state their grievances in writing, they do not record their objection to minor quality defects and seldom make realistic suggestions for quality improvements.

In most cases it will be practical to have a special committee or panel to assist in determining quality levels and discuss and approve quality specifications. In some cases, such committees are composed mainly of scientists and health officials. Here, industry has felt that decisions tended to be conservative and somewhat out of touch with what happend in the market place. At the Danish Meat Products Laboratory, industry representatives have been used for this purpose. Since quality control has mainly concerned export, this has proved to be practical while it was not practical to include consumers representatives. One panel is established for each product area.

The panels draw up specifications, for the various products and, since organoleptic characteristics cannot be described with any degree of accuracy, members of the same panels actually participate in passing final judgement on any product where the quality is questioned.

For each product type, these panels, together with laboratory personnel, examine a number of different samples, and where export markets are concerned, also comparison samples obtained by purchases on the market concerned. For each major product, specifications are drawn up. Exhibit 1 gives a sample of such a specification. Other product groups, having only a small market share are evaluated in each specific case, the quality criterion being that they should

(i) not be of a quality which might give rise to distrust in Danish meat products, and

(ii) be in accordance with what is considered good manufacturing practice.

Thus, a critical part of the system is the industry panel. It is composed of industry representatives, selected evenly from sales departments, production departments and research and quality control functions. Experience have indicated that sales personnel tend to have difficulties in determining exactly how quality should be; it appears as if they hardly can discuss quality without also considering price. Their counterpart on the panel is the production people; they have a tendency to be very strict when it comes to defects due to work carried out by inexperienced or negligent operators, etc., while they tend to be lenient when it comes to defects due to raw material or factors beyond the immediate control of operators in the manufacturing process. Also, they tend to be conservative and prefer a product and a quality with which they themselves have become accustomed.

In addition to making decisions as regards desirable quality levels, the panels review all procedural and technical matters regarding the quality control system. In addition, two of the evaluation panel members are invited to attend weekly evaluation sessions at the laboratory to decide whether decisions made by the laboratory staff during the past week have been in accordance with the agreed standards of the evaluation panel.

Since determining the required quality level realistically is the most critical part of the system, much effort is put into informing the quality panel. The laboratory has an extensive network whereby samples of products from other countries are purchased on the foreign markets, shipped to Denmark and studied by the evaluation panel in cooperation with the laboratory staff. Such comparisons make it easier to determine what the quality level should be. The labora-

tory also makes an effort to arrange for visits by foreign specialists to discuss quality requirements with the panels. Finally, where it is economically feasible, trips to the more important market areas are arranged for the panel in order that they may discuss market requirements directly with importers, and consumers panels, observe how the product is used, etc.

Obviously, official quality control can only fix what is considered minimum quality; it is up to each manufacturing group to determine if it wishes its product to be considered above that level.

Determining the quality level and what constitutes quality encounters all the difficulties referred to in the introduction of this paper. Both industry representative and government officials will tend to consider as high quality that which has been in use and preferred for many years. An example is low fat, casein fortified milk which was forbidden and considered an adulteration for many years in Denmark in spite of the fact that the product is nutritionally desirable and met with a strong public demand, when it was finally released. Thus, it becomes of the utmost importance that marketing people and even people wilh a background in human nutrition be heard when quality levels are determined.

In its quality control work, the Danish Meat Products Laboratory attempts to rely on describing and subsequently evaluating the quality of the finished product and avoid specifying in any way how this should be attained. The rationale behind this is that as long as a company can meet a given quality, it is up to the company to determine how it achieves it. The Laboratory will assist with consulting work, but anyone is free to design a better process for achieving the prescribed quality. Even for plant clean-up, the Laboratory does not prescribe approved cleaning procedures, but will only by flow sheet analysis determine, if sanitation is satisfactory and assist with advice if required.

However, complying with this idea is not possible in all quality control systems. Some give quite strict rules regarding prescribed manufacturing procedures, feeling that only thereby can the product quality be properly defined. Manufactures may even sometimes find this an aid in their day to day work since the quality control actually carries out a careful routine check on the manufacturing system. However, this may result in a stifling of process development.

The Danish Meat Products Laboratory deviates also in a few cases from its stated principle e.g. in the case of heat processing. This is done because no reliable objective method for product evaluation will indicate if all cans in a lot have been properly heat processed. Another case is the

control of canned pure beef products, to be shipped to areas where observers of orthodox religions require absolute certainty that no pork has been added. Since none of the immunological methods or other analytical methods work on fully cooked products, an inspection of actual manufacturing was found necessary.

Execution. Some quality control is frequently carried out by health inspectors and even more by meat inspectors. Thus, the use of certain organs from animals may not permitted even when no health consideration is involved. The control is frequently left to the meat inspection system. At times, as in the case of Danish fisheries products, quality and wholesomeness is controlled by the same official body. Much the same applies to the Meat and Poultry Inspection Program in the U.S.A. Here the emphasis is mainly on human and animal health protection aspects, with quality control being a secondary althrough important component.

In other cases, two systems exists, e.g. the Danish Veterinary Services and the Danish Meat Products Laboratory. In this case, direct personal liason has been established and the two systems supplement one another, e.g. the Veterinary Services often obtains samples for the Laboratory's control work and the Laboratory often evaluates organoleptically such shipments which have been submitted to the Veterinary Services for wholesomeness approval.

Sampling. Since most manufactured meat products vary in quality e.g. from can to can even within any one batch, it would not be correct to rely on the findings from the examination of one sample from a batch. The Danish Meat Products Laboratory has adopted the sampling plans indicated in exhibit 2 and 3. These show how the initial sample is 6 units except in the case of very large units, e.g. canned hams in 21 lb. cans, where each unit constitutes a considerable value. Here only 2 units are withdrawn. A decision is made on the basis of inspection of those 6 or 2 samples. If defects are found, the sampling plan indicates how many further units must be withdrawn and what decision should be reached with regard to the lot. Many other sampling plans are in use. The choice between these can best be made on the basis of the inspection capacity of the quality control body, out of which the most effective sampling plans and their characteristic curves can be determined. Exihibit 4 and 5 give the characteristic curves of the sampling plans here described.

Analytical methods. Brine uptake in the manufacture of hams for the U.S. market is determined by analytical determination of nitrogen, salt and water for products shipped to the U.S.A. using the conversion factors from nitrogen to protein given in exhibit 6. For some products, a statistical approach is used, as suggested in exhibit 7. The performance of each manufacturing establishment is monitored on control charts such as the one shown in exhibit 8.

For products to the U.K., the meat content is determined using a determination of protein and fat, the values inserted into the so-called Stubbs and More formula:

$$\frac{\text{Nitrogen content} \times 100}{R} + \text{fat content} = \text{meat content}$$

For pork, a value of 3.45 is used for the factor R as is officially required in the U.K. The test is used mainly on highly mixed products and may not be too reliable, e.g. rind is not normally considered meat but admixture of homogenized rinds is not detectable and will result in a high meat content, determined analytically. However, a product with a low meat content, determined in this way, will at least normally also be of inferior quality.

In analyses of mixed products for Germany similar formulae are used, relying on the so-called Feder number.

In some mixed products, the presence of non permitted "meat" ingredients may be determined histologically. Such tests are rarely used in Denmark.

The presence of vegetable proteins in canned products may be disclosed by electroforetic methods. On uncooked products, these same methods may be used and are then much more reliable.

The use of low grade meat is according to the EEC regulation disclosed by determination of hydroxyprolin. Here again the correlation of the test with actual composition may not be high but it is considered the best method available to-day.

The Danish Meat Products Laboratory checks on can closure and on permeability of films used for frozen and chilled products using the same methods as are listed above.

Contents of salt, nitrite and nitrate have to be determined in very large analytical series at the Danish Meat Research Institute. Here, an "Autoanalyzer" is being used. A number of other chemical and microbiological tests are carried out, using the methods normally in use by official control systems.

Methods for determining the temperature, to which a tin of canned meat has been heated, has been the subject of considerable investigation in recent years at both the Danish Meat Research Institute and the Danish Meat Products Laboratory. Sometimes, the so-called coagulation test has been used.

It is based on the assumption that an extract of a core sample of the can content will show coagulation when slowly heated, at temperatures just above that to which the sample has been heated previously. However, maximum coagulation of soluble proteins occur in the temperature zone of 60 to 63°C. Below or above, only a very minimal amount of flocculation occurs, and the coagulation point becomes very hard to determine. More important, however, it appears as if the presence of salt and phosphates during storage may make small amounts of proteins soluble, and may result in erroneous readings. This source of error is unimportant in the zone of major coagulations, because a massive flocculation is observed. Above 63°C or below 60°C, however, the method becomes unreliable. Another disturbing factor is that coagulation depends not only on temperature but also on time.

Since a method was sought for temperatures around 69-70°C, tests based on phosphatase activity were considered. An acid phosphatase is present in substiantial amounts in fresh meats and the content is unaffected by storage. The enzyme is easily determined. It is stable up to about 65°C, above, a destruction sets in, having such a time-temperature relationship that at 72°C the destruction becomes almost instantaneous. With the shape of the time-temperature curve in large (4½" or 16" - 4½") cans of ham it appears that determination of temperature may be determined with an accuracy of 1-2°C. The method will, of course, not be applicable for heating below 65°C or above 72°C.

Organoleptic methods. Where organoleptic evaluation is part of a health or veterinary inspection system, the evaluation is often carried out by one person, normally an inspector with recourse only to his supervisor. This does not appear to be satisfactory, considering the many inherent difficulties in sensory evaluation, e.g. the need for several, trained and tested judges, anonymity of sample, statistical evaluation of results, etc. This seemingly rather perfunctory approach to organoleptic evaluation is unfortunate since considerable values, and even the reputation of a company may depend on one such subjective judgement, carried out by one person and by a procedure contrary to that deemed necessary in for instance scientific sensory evaluation. The reason for this state of affairs is probably that health or veterinary inspection systems are not primarily organized for undertaking sensory evaluation.

Where an official organization is specifically designated to evaluate organoleptic quality, procedures much closer to those used in scientific work are used. Thus, at the Danish Meat Products Laboratory, organoleptic quality is judged first by one trained inspector, using the two first steps of the

sampling plans indicated in exhibit 2 or 3. If the result is not accepted by the owner, 30 additional samples are then withdraw and presented anonymous to members of the above mentioned panel whose decision is the final.

Self certification. Demands as regards quality and safety of food products are rising very rapidly. Many more tests and analyses - some of them very elaborate - are required, e.g. analyses for presence of pesticides, antibiotics, heavy metals, etc. Public laboratories cannot be established, staffed and funded as rapidly as required and yet the cost of food inspection rises steeply. Also it may even be questioned if so much control work should be the responsibility of the public. It is probably more efficient that work to the highest degree which will still safeguard the public interest, be carried out in the laboratories of industry. These will have a much better knowledge of the product and will be able to trace any abnormality back to the source quicker and more efficiently, and thus initiate corrective action, etc. Two conditions must be met, however:

1. The industrial company's inspection system, analytical laboratory, etc., must be absolutely reliable, i.e. the methods and procedures must be approved by public authorities.

2. It must be absolutely certain that all findings of abnormalities which give cause for concern are reported immediately. An elaborate system is therefore required for registering all finding, using authorized report books, agreed inspection frequencies, etc.

In the U.S.A., such a system is presently bring established. As yet, little experience as to the results obtained is available.

The Danish Meat Products Laboratory has so far used the system for controlling the information given in nutrition labelling. Here, the Laboratory to a certain extent accepts the findings of the company's own laboratory if the latter fulfils some specified requirements.

Feed back. Even official quality control must have as its prime objective not to condemn products but to assist industry in avoiding that defective products are ever made.

This means that the manufacturers need extensive information as regards what the requirement are and how they can be met. The Laboratory has a staff of consultants who visit the various plants and advise on how the required quality can best be met. In addition, personnel from the plants are invited to participate in the sessions of the evaluation panel simply to give them an opportunity of becoming better aqainted with the requirements of those panels. Finally, the Laboratory frequently invites the industry as a whole to special sessions where the evaluation panel and the Laboratory staff present to the participants various samples of Danish and imported product and discuss in detail what the quality level is and what it should be, point out defects and discuss how they can be avoided, etc. In addition, of course, the plants receive a variety of information, e.g. each plant gets a list of the findings of each session of the quality evaluation panel, as shown in exhibit 9. In this the lots are identified by code only, and each plant is informed of the code of its own products.

The plants receive also lists of all analytical findings, and four-monthly and annual reports on all findings in such a form that it can easily determine areas where its own product deviates form those of other plants, etc. The companies also receive comparative lists of flow sheet analyses of plant cleanliness and of microbiological findings in products tested, e.g. exhibit 10.

Another means of keeping industry informed of the quality level of its product is the performance of evaluations in the plant themselves. Since mostly, a rather complicated arrangement for testing is required, the Danish Meat Products Laboratory operates a special test trailer, equipped as a sensory testing facility. This trailer is placed one day at each factory and the products are evaluated in the presence of managers, supervisors, foremen, etc., this affording an opportunity for conveying to them excactly what the requirements are, and how their products compare with those of other companies.

It is obvious that a great many data are obtained in such work. They must be tabulated, compared and accessible in such a way that they can be of maximum usefulness. The Danish Meat Products Laboratory has recently installed a computer terminal, with access to a large service center. The unit will calculate analytical results, record organoleptic findings and write up all tables, as well as letters, properly addressed to the companies concerned, etc., as seen in exhibit 11. All these efforts aim at helping the plants determining when improvements are indicated. The Laboratory will, if requested to do so, assist the plants in rectifying a situation or refer to assistance from the Danish Meat Research Institute.

Adjusting official quality control levels. The above describes rather elaborate and sometimes quite complex quality control measures. Yet, it must be kept in mind that trade, technology and consumer preferences often change very rapidly. Therefore, the most important elements of such systems are machinery whereby changes are quickly transmitted all the way back to the control system and the producer, since the ability to respond to such changes will determine success or failure. Thus, the most important characteristic of quality control personnel and of the system itself is that it must be quick to discover changes in preferences and requirements, etc., and to respond so that products continually meet these changing market demands.

Bibliography

Herschdoerfer, S.M. (ed.). (1967-72). Quality control in the food industry. Vol. 1-3. Academic Press, London and New York.

Kramer, A., and Twigg, B.A. (eds.). 1970. Quality control for the food industry; 3rd ed. Avi, Westport.

Exhibit 1

Specifications for luncheon meat, Country X

Composition

Meat ingredients. According to the legal requirements of country X, luncheon meat must consist of chopped pork or beef meat, i.e. skeletal, muscle, possibly mixed with the corresponding fatty tissue. The addition of rind , sinews and intestines is not permitted.

Maximum limits. Salt 2,5%

Nitrite (only as nitrite salt and in per cent of the total amount of meat and fatty tissue used 0,02 (country X requirement)

Spices and sugar may be added with no maximum limit (country X regulations)

Casein or blood plasma (in percentage of the total amount of meat and fatty tissue used) 2,0% (country X requirement)

Added water (calculated, using the Feder number) 4,0% (country X regulation)

Fat, when the product is designated lean, 8-15 % (country X requirement)

Fat, when the product is designated regular, 35% (country X requirement)

Ascorbic acid permitted (country X regulation).

All other added substances are prohibited, i.e. nitrate, phosphate and flour.

Containers

Can. Can must be marked with establishment No., date of manufacture, type of product, these markings can be in codes. Can to have visible vacuum, they must be clean and free from rust internally and externally.

Exhibit 1 (continued)

Label

1. In country X language, name of the product, i.e. ready-to-eat luncheon meat.

2. Name and address of manufacturing company or firm for which the the product has been manufactured.

3. Net weight (at the time of filling) in grams or kg.

4. Year of manufacture or latest year when the product should be used (the text must indicate which of these apply).

5. A list of ingredients is optional. If it is used, it should be in order of desending amount; nitrite may only be declared as nitrite salt.

6. The addition af casein or blood plasma should always be indicated separately from other text and in an easily visible manner as: Manufactured with YY per cent casein or manufactured with ZZ per cent blood plasma. (only one of these may be used in any one product.)

Other information

Information regarding food regulations etc. of country X are found in the laboratory's information series - country X.

Procedure for organoleptic tests

Any defects present should be noticed. Any defect of consequence should lead to the product being rejected.

The external surface should be smooth and of the same color as the cut surface.

Fat separation is tolerated in small amounts only. A discolored surface, corrosion, dirt, discoloration from the can, etc., is recorded as defects.

The product must fill the can completely. Slack fill is considered a defect.

The cut surface must have a natural meat color, presence of sinews, air pockets, discoloration of the cut surfaces are recorded as defects.

The presence of rinds or intestines always results in rejection.

The meat block must have a uniform consistency and a rather short chew feel. As defect is considered rubbery, dowy, or watery texture.

The product must have a pure taste. As a defect is counted off taste or dowy taste.

Exhibit 2

Sampling plan for canned meat control, normal cans

1 sample	No. of defects	Decision	2 sample	No. of defects	Decision
6	0	accepted			
	1-2 critical 1-4 critical and essential	new sample	10	1-2 critical 1-4 critical and essential	accepted
	3-6 critical 5-6 critical and essential	rejected		3-16 critical 5-16 critical and essential	rejected *

*At the manufacturer request, an additional sample of 30 cans may be withdrawn. 4 or more with critical defects, 7 or more with critical and essential defects means that the lot is rejected, less that it is accepted.

In addition, all lots are examined for major defects. If one is present the lot is rejected.

Exhibit 3

Sampling plan for canned meats, large cans.

1 sample	No. of defects	Decision	2 sample	No. of defects	Decision
2	0	accepted			
	1-2 critical and essential	new sample	10	1-2 critical 1-4 critical and essential	accepted
				3-12 critical 5-12 critical and essential	rejected *

*At the manufacturer request an additional sample of 30 cans may be withdrawn. 4 or more with critical defects, 7 or more with critical and essential defects means that the lot is rejected, less that it is accepted.

In addition, all lots are examined for major defects. If one is present, the lot is rejected.

Exhibit 4

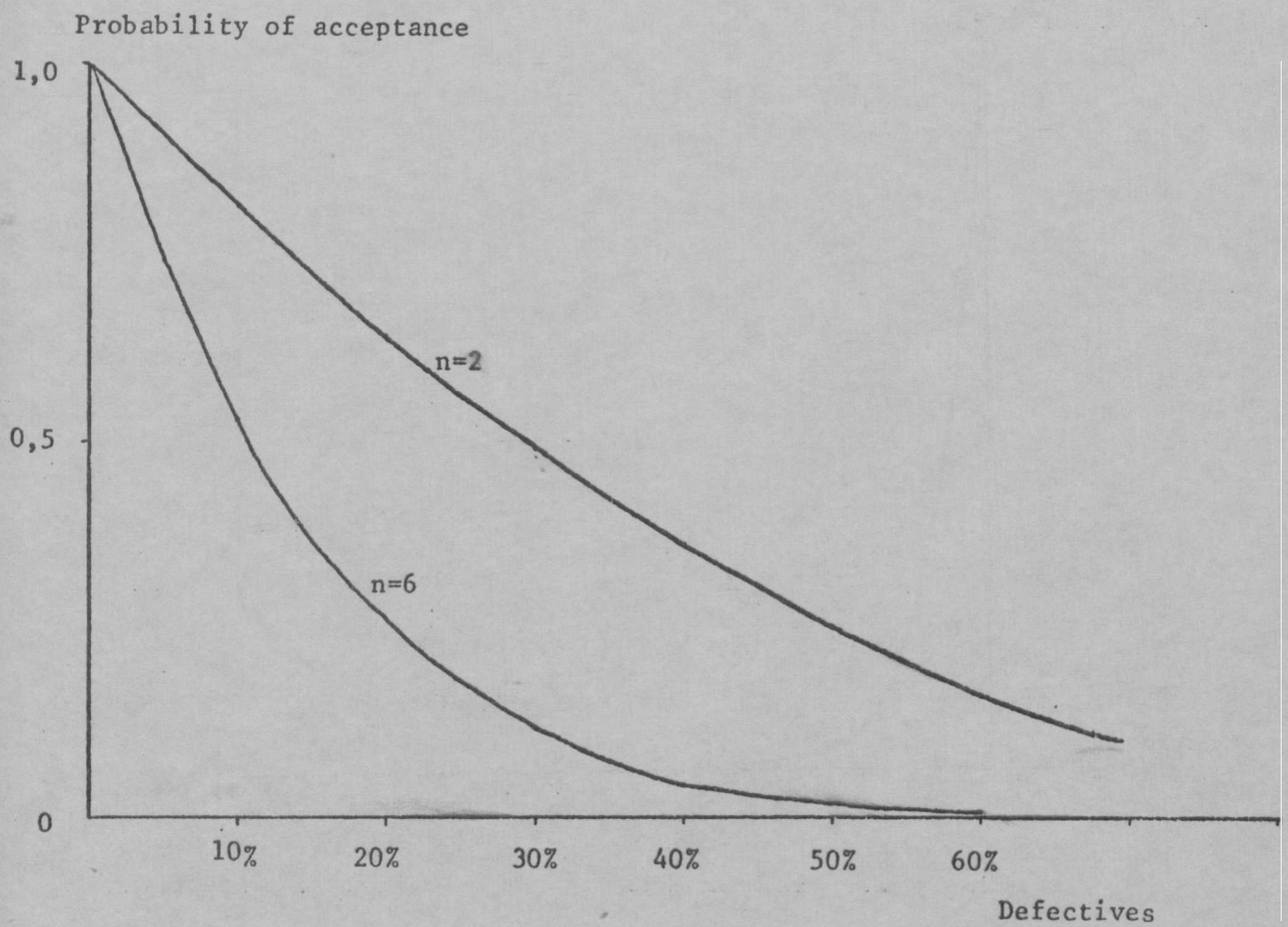
Probability of acceptance
1,0
0,5
0
n=2
n=6
10%
20%
30%
40%
50%
60%
Defectives

Exhibit 5

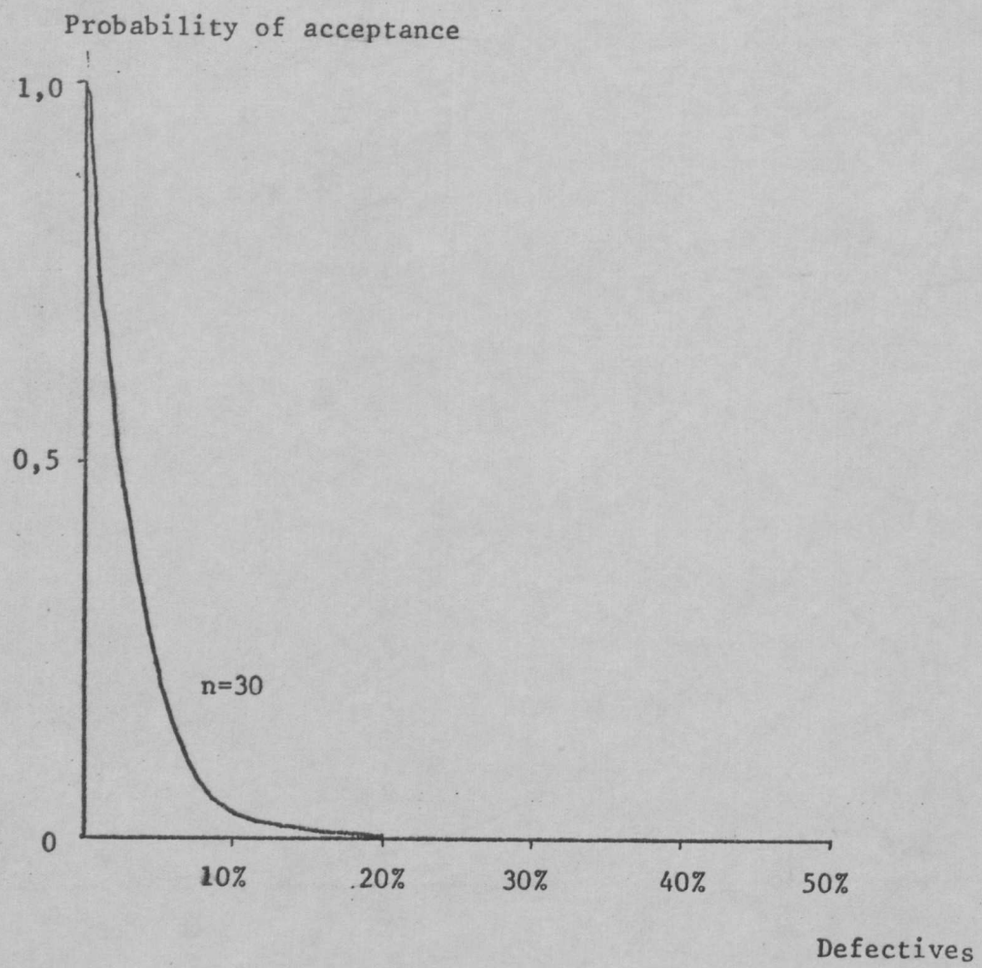
Probability of acceptance
1,0
0,5
0
n=30
10%
20%
30%
40%
50%
Defectives

Exhibit 6

Factors used for determining added water in pork

Type of product	factor
1. Chopped Ham	3,83
2. Chopped Pork	3,83
3. Canadian style bacon	3,83
4. Deviled Ham	3,83
5. Ham	3,83
6. Ham roll	3,83
7. Ham sectioned and formed	3,83
8. Luncheon meat	3,8
9. Picnic roll	3,93
10. Pork loin	3,83
11. Pork roll	3,83
12. Pressed ham	3,83
13. Sausages in brine	4,0
14. Pork Shoulder	3,93
15. Sliced bacon, baconslab	4,0

Exhibit 7

Control chart for canned pork shoulders

Normally, an establishment may ship products as they are produced. Analyses will be carried out by the Danish Meat Products Laboratory at intervals, the length of which is determined by the prior history of the production at each plant.

For content of added salt and water, the following zones have been established.

Upper limit	13,6%
Zone A	11,7% to 13,5%
Zone B	9,9% to 11,6%
Zone C	8,1% to 9,8%
Zone C'	6,2% to 8,0%
Zone B'	4,4% to 6,1%
Zone A'	2,5% to 4,3%
Lower limit	2,4%.

Shipments can continue until one of the following limits is reached.

8 consequtive samples fall in zone C or above
4 our of 5 consequtive samples fall in zone B or above
2 out of 3 samples fall in zone A or above
1 sample fall above upper limit.

If this is found, the following productions may only be exported after prior approval by the Danish Meat Products Laboratory requiring an analysis of 8% or lower, or in zone C, but with at least one out of the previous seven samples in zone C' or lower.

Results are plotted in a control chart as shown in exhibit 8.

Exhibit 8 Control chart for canned shoulders

Product: Canned shoulders

Establishment xx, No. yy

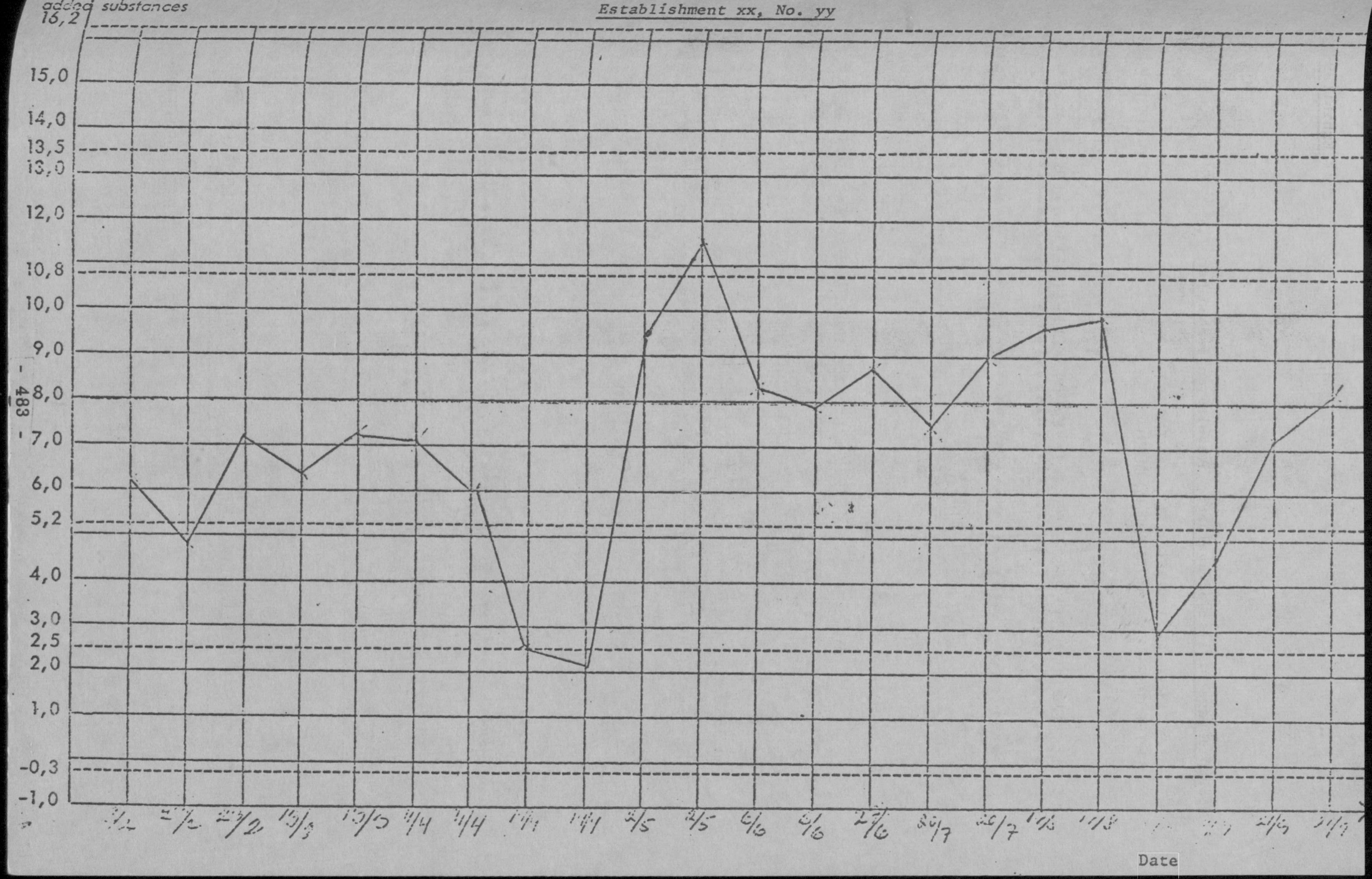

Exhibit 9

Sample page of list of evaluation results on canned ham

SLAGTERI- OG KONSERVESLABORATORIET
VETERINAR- OG LANDBOHOJSKOLEN
1973. 4.26

EKSPORTSKINKE
KONTROLBEDOMMEL

STRENGT FORTROLIG

15.KONTROLBEDOMMELSE AF SKINKE- OG KOLEKONSERVES,1973. 4.26

OBLONG FLAT SKINKE USA

LOBENUM.	OVER FLAD	FA- CON	IN- DRE	FAR- VE	SMAG	SAMM HANG	BEMARKNINGER
184/ 1	7	6	7	8	8	8	YDRE LUFTAFFARVNING DEFORM I LAAGEMDEN

GELE= 5.1 IRREG.SKIVER= 5.0 UDBYTTE= 89.9 6112 GRAM

LOBENUM.	OVER FLAD	FA- CON	IN- DRE	FAR- VE	SMAG	SAMM HANG	BEMARKNINGER
184/ 2	10	7	8	7	8	8	

GELE= 5.0 IRREG.SKIVER= 3.2 UDBYTTE= 91.8 6087 GRAM

OBLONG FLAT SKINKE USA

LOBENUM.	OVER FLAD	FA- CON	IN- DRE	FAR- VE	SMAG	SAMM HANG	BEMARKNINGER
187/ 1	10	7	8	9	8	9	

GELE= 6.3 IRREG.SKIVER= 3.8 UDBYTTE= 89.9 5444 GRAM

LOBENUM.	OVER FLAD	FA- CON	IN- DRE	FAR- VE	SMAG	SAMM HANG	BEMARKNINGER
187/ 2	7	7	8	8	8	8	YDRE LUFTAFFARVNING

GELE= 5.3 IRREG.SKIVER= 4.0 UDBYTTE= 90.7 5451 GRAM

Exhibit 10

SLAGTERI- og KONSERVESLABORATORIET
Veterinær- og Landbohøjskolen
6. marts 1973

Eksportkødfrysevarer
Bakteriologisk analyse nr. 5

Strengt fortroligt

Bacteriological tests of frozen meat

5. frysevarebedømmelse - bakteriologiske resultater 28. feb. - 2. marts 1973

Virksomhed	Løbe nr.	Kimtal i PCA	Fækale strept. på Slanetz	Staphylococ. på Carter	Coliforme i RVG-Agar	Fækale coli i RVG-agar
		Sliced Beef Liver				
	99	3.500	*1.900	<100	<10	<10
		Calves Liver Sliced				
	100	1.100	<100	<100	10	<10
		Pork Cutlets Chopped				
	101	330.000	<100	<100	520	<10
		Pork Chops				
	102	1.430	<100	<100	<10	<10
		Pork Liver Sliced				
	103	41.000	500	<100	60	<10
		Vienna Sausages				
	118	2.400	<100	<100	<10	<10
	119	40	<100	<100	<10	<10
	120	5.300	<100	<100	<10	<10
	121	420	<100	<100	<10	<10
	122	4.100	<100	<100	<10	<10
	123	1.400	<100	<100	<10	<10
	124	*23.000	*6.700	<100	<10	<10
		Fläskfile				
	125	5.900	<100	<100	10	<10
		Vienna Sausages				
	114	230	<100	<100	<10	<10
	115	1.200	<100	<100	<10	<10
	116	70	<100	<100	<10	<10
	117	*32.000	<100	<100	<10	<10
		Kinesiska Vårrullar				
	135	12.000	<100	<100	140	<10
		Frankfurter				
	137	<10	<100	<100	<10	<10
		Pork Chipolatas				
	138	*3,4 mill.	<100	<100	1.500	<10
		Krydderpølser				
	139	1.200	<100	<100	<10	<10
		Pork Sausages				
	140	*4,2 mill.	<100	<100	460	<10

Exhibit 11

SLAGTERI- OG KONSERVESLABORATORIET
VETERINÆR OG LANDBOHØJSKOLEN
HØWITZVEJ 13,2000 KØBENHAVN F
1973. 6. 7

Sample letter regarding meat content

HAFNIA KONSERVES A/S
ROSKILDEVEJ 161
2620 ALBERTSLUND

EKSPORTKONSERVES-ANALYSE-UK

LØBENUMMER	6432
VAREART	CURED PORK
KODE	21053
STR.	340 GRAM

	1	2
PCT.NITROGEN	2.254	2.135
PCT.FEDT	26.1	29.8
PCT.INDVEJET LEAN MEAT	74.2	70.3
PCT.INDVEJET MEAT	99.4	99.7

PRØVEN ER UDTAGET AF LABORATORIET
PRODUKTIONEN ER GODKENDT TIL EKSPORT TIL UK

MED VENLIG HILSEN

JØRN TORP MADSEN ARMIN HOLM

11.1