# New proteins, new problems, and new possibilities

by Mogens Jul (to be presented at the 22nd European Meeting of Meat Research Workers, September 1976)

Meat - and for that matter dairy products - are generally expensive products whether judged on a protein or food energy basis. The very considerable effort, especially in the last years, aimed at extending them, or even replacing them, with less expensive products, mostly of vegetable origin, must be seen as a result of this price factor. The trend is not unlike that which many years ago lead to the development of oleo margerine as an alternative to butter.

By the more involved consumers, and for that matter also among food technologists and especially among meat technologists, such steps are generally viewed with some scepticism. Extending meat, or even replacing it, with less expensive products is considered fraudulent or at least a somewhat questionable practice.

I personally have difficulty in accepting this view. It appears to me that the purpose of agriculture and the food industry is to provide products, which are useful to the consumer and available to these at sufficiently low prices. If new products can be developed which are less expensive than those we used before and are acceptable such a trend is certainly in the interest of the consumer and to quote Adam Smith: The only purpose of production is consumption.

In so far as industrialized countries is concerned the development of various meat extenders and meat replacers, so-called meat analogues, are highly desirable from the consumers' point of view since they provide less expensive, acceptable substitutes to meat and meat products. A similar service is performed for the consumer as the development of the oleo margerine industry. For low-income countries, often referred to as less developed countries, the benefit of this development is less direct. In these countries all low-income consumers obtain practically all their food energy and nutrients, including protein, from vegetable products. An attempt to upgrade these vegetable products to make them similar to meat would result in making the food more expensive without adding to its nutritional value. Indirectly, however, the less favoured nations may have a considerable benefit from this development. It is well known that their greatest need is for food grain. When looking at table 1 one will notice that the industrialized world, and to a certain extent also the centralized planning countries, use a large share of their cereal production for feeding domestic animals, eventually turning the cereal into more expensive animal products. The convertion rate involved therein is quite unfavourable as suggested by table 2.

It is for this reason that a development towards replacing parts of the meat consumption in industrialized countries with consumption of products of other origin may relieve the pressure on the cereal resources and thus make more cereal available for the less priviliged nations.

## Non-protein extenders

It is well known that meat and meat products per gram contain relatively high amounts of good quality protein. This has resulted in a general tendency to feel that all meat should be extended by other protein rich products. This is by no means a necessity neither quality wise nor nutrition wise, and other extenders can therefore be considered. Thus, Dr. A. Ferro-Luzzi has estimated that the protein intake in per cent of requirement is as indicated in table 3 in the European Community.

This shows clearly that replacing even considerable parts of meat protein with non-proteins would not result in protein deficiency problems.

Water. Meat is often extended with water as it is general practice in sausage manufacture, meat curing, etc. Stretching our meat supplies by adding water to the extent to which the meat protein will bind this water, even assisted by the addition of phosphates, can result in meat products of superior quality which can be sold at considerably lower prices. Table 4 shows an investigation which the Danish Meat Products Laboratory carried out on various types of canned ham. It will be seen, that only when the amount of water added exceeded by some 20 per cent of that naturally present in the raw ham, did a deterioration of quality set in. This series of investigations did not include hams salted without any increase in yield, from early experiments we know that these would be rated as inferior to the ham with about 15 per cent of water added.

Starches and carbohydrates. Using starches and soluble carbohydrates as so-called binders in meat is in well known and established practise. It is known from the manufacture of many sausage products and meat patés and meat pastes. Even adding sugars to curing brines has an effect, not only a certain flavour improvement, but also an improvement in yield and the practise is widespread.

Fat. Fat other than that naturally occurring in the lean meat, normally considered a suitable raw material for meat products, is a frequently utilized ingredient. It is well known that animal fat fetches much lower prices than lean meat. Therefore fat is often considered a natural material for stretching and for extending meat in such products as sausages, meat pastes, etc. A certain addition of fat often improves the organoleptic qualities of such products, and even large additions of fat may not impare them. A product like Salami may often contain 60-70 per cent fat. In more primitive societies, including Western Europe some 50-100 years ago, fat was often considered a luxury food and frequently eaten in its pure form. Nowadays, however, many consumers object to excessive fat and nutritionists have started to warn against products with a high fat content. For instance, the abovementioned Danish Salami has come under heavy attack. One reason for this is probably that the general recommendations in Scandinavia call for a reduction of the total amount of calories derived from fat in the diet should be reduced from the present average of about 40 per cent to an average of about 25 per cent. From these figures a fat calorie content of some 90 per cent in Salami may sound alarming.

However, this is an over simplified view since what matters is not the composition of each component of a diet, but the composition of the diet itself. We calculated the composition of various traditional Danish sandwich lunches and arrived at the data given in table 5.

The data indicated that the fat intake at that particular meal is practically independent of the fat content in the Salami.

In Canada regulations call for meat products extended with vegetable protein to contain not more than 25 per cent fat; in the case of poultry products even a limit of 15 per cent is stipulated. In my views such low limits are unnecessarily restrictive, they may result in products of questionable acceptability and are nutritionally without significance.

Non-conventional meat products

In the search for protein products which can be used to extend meat or for the manufacture of simulated meats, it is often not realised that we do not make full use of our edible meat supplies, and that improvements in this respect could bring about considerable economies.

Non-food edible parts. Because of local customs and aversions towards certain parts of the animal body, many glands, flesh from lips, snout, etc. are discarded although they could well be used in emulsion products if the public would accept their presence therein. Mostly it is so that a product which is discarded in one country is used in another, indicating that only tradition and certainly not considerations related to health or organoleptic characteristics are involved. Acceptance of the fact that our food supplies and meat supplies are limited and that one of the challenges of the present world is to achieve better resource utilization should justify efforts towards the full use of such products.

Unnecessarily restrictive meat inspection. It is generally accepted that meat inspection has as its purpose to inspect meat to eliminate from use for human food any such product which shows signs of disease on the assumption that such disease can be transferred to humans through the consumption of the meat. It is well known, however, that only in rare instances can such transfer take place. Furthermore, much condemned meat or parts of meat are rejected on the grounds of showing signs of abnormalities which can be traced back to some disease, but in no way can be considered as objectionable neither from a wholesomeness point of view nor from an estetic point of view. In this case also, a realisation of the limitation of resources forced on mankind suggest that a more realistic attitude be accepted.

Blood. Blood sausages, blood pudding, etc. are perfectly acceptable food products in some countries while in others the idea of consuming blood is abhorred. In general, however, there is little consumer reaction against the use of blood in sausage manufacture, etc. but collecting the blood is difficult because of the risk of contamination when the blood is collected, or because of the rather complicated safeguards which have to be introduced in order that no blood be used from diseased animals. Nevertheless, a very energetic effort is presently under way in this respect and considerable additionable resources of non-conventional proteins may be obtained through this technique.

Mechanically deboned meat. One may refer to the early experiments of Eugene Wierbicki related to the recovery of meat from bones, etc. normally discarded and send for rendering from meat plants. In recent years developments in this respect has been very impressive, various types of machinery has been developed for separating meat from bones after everything which can economically be removed by hand has been recovered. Some processes involve pressing the ground up bones against a seeve-type strainer, which will retain the bones but permit meat particles to go through. A similar effect is obtained by pressing compact masses of bones under high pressure, whereby the flesh particles will be pressed out through a strainer. Other processes involve the tumbling of the bones with water and ice, whereby eventually a wet meat slurry is obtained. Also methods employing centrifuging the ground up bones mixed with water have been used. The latter two processes have the disadvantage that a wet product results useful only for certain types of emul ion products. In general a recovery of about 50 per cent meat from the more valuable bones is reported.

These processes have been looked upon with considerable scepticism in most countries. In the USA a limit of about 1 per cent of bone in the meat fraction was permitted, in Denmark only 2 per cent addition of such product to any meat product is permitted. It is hard to see why these restriction were imposed upon the meat industry. Removing meat mechanically from bones is not basically different from removing it by hand. The meat may contain a certain amount of marrow, which is considered a wholesome product. The meat will also contain a somewhat higher calcium content but we fortify many of our foods with calcium because of a general trend toward calcium deficiency in the industrialized world. It seems that only normal precautions against the occurrence of even minute bone splinters and safeguards against bacteriological deterioration were necessary,not basically different from those which are taken in general in the meat industry. The effect has been unfortunate: In most countries it is now accepted that these materials are meats or at least meat byproducts, and authorities are trying to liberalize legeslation. However, now consumers have been alerted to the problem. The fact that severe restrictions were placed on its use earlier was interpreted to mean that the product is inferior and that they now react, both in the USA and in the Federal Republic of Western Germany,against liberalizing the use of this valuable product.

Poultry meat. There is an increasing interest in the use of poultry meat in red meat products. Both manually and mechanically deboned meat can be used. Apart from the appropriate labelling requirements there seem to be no reason to object to such uses.

Milk proteins. Both casein and whey concentrate have been used as binders or extenders in meat products. In several countries casein is considered more acceptable than vegetable protein, because of its animal origin. Whey products have been more difficult to use because of the high content of lactose. Newer methods of separation have made whey protein available.

Fish protein concentrates. Much research effort has been expended towards the development of edible odour and flavourless fish protein concentrates for the use mainly in low-income countries. For obvious reasons the product would be difficult to use in such countries and the cost of production would place it out of reach of any needy group in such countries. An even more refined fish concentrate has been proposed for extending meat products in industrialized countries. However, fish protein is basically an unsoluble, non-swelling protein. Thus it has poor functional characteristics for the use in meat emulsions. For these reasons no immediate prospects are seen of its use there.

## Vegetable proteins

With the enormous quantities available and the low production cost of vegetable protein, concentrating or isolating these for use in meat products has attracted very large attention lately. It is well to remember that we have used such products for a long time, e.g. as cereal binders or soy meal, etc. Today methods of refining these products have opened up for a wide range of uses.

## Sources of vegetable proteins

Practically all efforts have been concentrated on the development of soy protein, one of the vegetable proteins most regularly available in the USA, where most development effort has taken place. Nevertheless, efforts have also been made to develop useful protein concentrates or isolates from rape seeds, wheat, and field beans.

## Characteristics of vegetable proteins

Vegetable proteins are generally available in the following basic materials:

Meal (protein content about 50 per cent)
Concentrates (protein content about 70 per cent)
Isolates (protein content about 90 per cent).

When the products are available as meal in a ground form, they are generally used as ordinary binders in chopped meat products.

Finely ground meal concentrates and isolates may also be used in larger quantities for communited meats as direct replacers of some of the proteins otherwise derived from meat.

The products have also been thought of as complete replacers of meat. Here it was first thought necessary to give them the same fiber structure as meat and several processes have been developed where protein isolates have been pressed through fine holes and formed into fine fibres which would be bound together, often by albumin, and thereby receiving a texture closely resembling that of meat. In recent years, however, more attention has been paid to extruded products, mainly meals or concentrates. When hydrated these products have a chewy gelatinous texture not dissimilar to that of some meat products, and they have been used with about the same amount of success as spun products as replacers for meats, so-called meat analogues, in ground meat products or even where otherwise finely chunked meat is used.

Originally most extruded products were made from meals. These have several undesirable characteristics. They generally have an off flavour which it is difficult to mask and the hydrated product is rather spongy. Besides they may contain about 8 per cent carbohydrates of a kind which easily lead to gas formation in the intestines (flatulens).

More recent arrivals on the market are extruded concentrates, they may be given a certain fibrous texture, in general they seem to be more suitable replacers for meat.

The development of these products which are to replace meat to a greater extent has been greatly accellerated by the development of modern flavour technology. It is often quite surprising how closely the flavours of these extruded or spun products resemble that of the product which they are to replace, e.g. ham, bacon, chicken, etc.

## Functionable property of vegetable proteins

The use of the various vegetable proteins in meat products is very much dependent on their functional properties. Most important among these are the following:

Fat absorption
Solubility
Water binding

An excellent review of methods to determine these various properties and factors which influence were made by Kinnella (1976).

## Uses of vegetable proteins

Traditionally vegetable proteins, even in a rather crude form as for instance soy meal, have been used in stead of starch binders in various comminuted meat products. More recently, however, the somewhat more sophisticated protein concentrates and isolates have been used in meat emulsions to replace substantial amounts of meat. One recent development of a more sophisticated nature, is the use of soluble vegetable protein isolates for pumping with pickle into hams and similar cured products. An addition of 4 per cent of vegetable protein can be obtained and an increase in curing of about 25 per cent yield, achieving a fully acceptable product.

Where a certain texture is required, e.g. in coarsely ground meat and even as meat bits in various dishes, the abovementioned textured or spun products are used. One specific case where these have become very popular is for chopped frozen products, e.g. frozen hamburgers. It turns out that the drip loss on defrosting and cooking is much less than for ground pure meat, the reason being the vegetable proteins higher water and fat binding capacity.

Both spun products and certain textured products have also found use as so-called meat analogues or meat replacers in products where they completely replace the meat component. This may be the case in such products as spring rolls, chop suey, stews, etc.

## Other protein sources

One of the most publicized unconventional proteins other than vegetable protein is probably single cell protein, i.e. a fermentation product where the microorganism quickly and with a very high conversion rate turns the substrate into a mass of microorganism, which then can be used directly as a protein source. Since the fermentation product contains also carbohydrates, fat, and a rather favourable number of vitamins, it is more properly referred to as single cell products than single cell protein.

Such additions have been known for years in that the bakers' yiests have been used in small amounts for adding to foods.

An interesting development was British experiments on the development of certain moulds. The specific feature of these was that the microorganism had a fillament structure and thus in a way resembled a meat product. Most efforts have, however, been devoted to the manufacture of single cell products from using bacteria, often on an parafin or gas oil substrate. Large plants exist for manyfacturing this product which so far has been approved for use as feed for animals only. One difficulty is the rather high content of nucleic acid, which cannot be tolerated by humans, but which can quite easily be removed from the product, however.

In considering the prospects of these products it may be worth noting two factors.

While the conversion rate of the substrate itself is very high, some two parts of substrate forming one part of bacterial mass with high protein and nutrient content, the process is very energy intensive and actually for the same amount of protein produced requires the same energy input as intensive production.

Second, however, that large amounts of cereal products today are used as animal feeds. If the single cell product is used as feeding stuff it will replace large amounts of cereals and make them available for human food, thus, indirectly serve the same purpose as if they were used as meat replacers direct.

Nutrition aspects

Where unconventional protein products are considered for inclusion in meat products precaution must be taken lest this change in time might have some undesirable effects with regard to nutrition and wholesomeness.

Where unconventional meat or dairy products are concerned, little concern has been expressed over these matters, conversely single cell products are yet so novel that little experience with them exists and additional data need be assembled before they could be released for human food. Therefore most attention has been paid to the consequences of introducing vegetable proteins.

Toxicity. Firstly, it need be considered that several of the raw materials used for vegetable proteins contain some antinutritive factors, e.g. the trypsine inhibitor in soy beans or directly toxic factors, e.g. gossypol in cottonseeds.

Protein value of vegetable proteins. Much concern is expressed over the protein value of vegetable protein. Their amino acid composition is less favourable than that of animal protein, a further reason for caution is that the manufacturing process, especially that of manufacturing spun products, may have a deliterious effect on the protein value of the product.

Conversely, it need be remembered that vegetable proteins are seldom taken alone. When used in a diet where proteins from other sources are also involved, the two protein sources may have a supplemental effect in that one may supply adequate amounts of one amino acid in which the other is deficient and visa versa.

Further, one need keep in mind that most populations in industrialized countries are over-supplied with protein as suggested by table 3, thus this matter seem to be of minor concern, at least until such time where vegetable protein constitute a very major part of the daily protein intake.

The protein value of vegetable proteins has been a matter of some concern in the USA. If a vegetable protein is used to replace less than 30 per cent of the protein in a product, the biological value of the protein is required to be at least 80 per cent of that of casein. If it replaces more than 30 per cent of the protein, the protein value must be at least 108 per cent of that of casein.

In Canada a protein rating of not less than 40 is required for vegetable protein used as meat extenders.

Fortification of non-conventional proteins. A very common theory is that a meat extender or meat analogue should have the same nutritive value as the meat which it replaces. Interestingly enough this is the position which is very much supported by industry. Industry claims that the cost involved in such fortification is insignificant. Obviously also industry is much interested in promoting the use of their product with the assurance that it nutritionally is as valuable as the meat it replaces.

This consideration has led to a requirement in the USA, that a plant protein product used as an extender or analoque must contain the following levels of nutrients per gram of protein:

| Nutrient | Amount |
|---|---|
| Vitamin A (IU) .................... | 15.00 |
| Thiamine (milligrams) ............ | .014 |
| Riboflavin (milligrams) .......... | .01 |
| Niacin (milligrams) .............. | .30 |
| Pantothenic acid (milligrams) ..... | .040 |
| Vitamin $B_4$ (milligrams) ........... | .02 |
| Vitamin $B_2$ (µg) .................. | .09 |
| Iron (milligrams) ................ | .13 |
| Calcium (milligrams) ............. | 10.0 |
| Phosphorus (milligrams) .......... | 10.0 |
| Folic acid (µg) .................. | .40 |
| Magnesium (milligrams) ........... | 1.14 |
| Zinc (milligrams) ................ | .23 |

Jos näistä puuttuu pieni osa lihaan verrattuna, ei se mitään, koska näitä saa muutenkin tarpeeksi. Katso taulukko 6.

No rules have yet been enacted in the U.K., but a report by the Food Standards Committee (1974) suggests that textured vegetable protein shall contain per 100 grams of dry matter no less than 10.0 mg iron; 2.0 mg thiamin; 0.8 mg riboflavin; and 5.0 microgram vitamin B12.

While it is easy to see that industry would support the idea that all meat extenders should be fortified to resemble meat in nutritive value, the idea in practice becomes impractical and questionable. One would probably not wish that vegetable protein should equal meat in all of the fifty known nutrients, e.g. also those where meat is only an insignificant source.

Thus, before any fortification is required one need to question whether we need to fortify these products with those nutrients for which meat is only a minor source. Thus, as quoted by the U.K. Food Standards Committee (1974) the U.K. Committee on Medical Aspects of Food Policy did not regard it as necessary to specify for novel protein foods required levels of nutrients, where these are already ambly supplied by other foods (i.e. potassium, magnesium, phosphors, and nicotinic acids. In other instances, including pyridoxine, pholic acid and pantothenic acid the working party of the above committee stated that there is no evidence in U.K. of dietary deficiency. Therefore the committee sees no grounds on which to recommend fortification in these instances, and limited itself, therefore, to consider nutrients of significance in meat and to the recommendation of the fortification mentioned above.

Even this could be unnecessarily cautious. It may be questioned whether we need to fortify at all in cases where the population is already over-supplied with the nutrient in concern. To get some inside of this point we have in table 6 listed the average Danish intake of various nutrients in percentage of the recommended daily intake. In the second column we have listed the contribution of meat to that intake. A study of the table will indicate that only in the case of iron would be complete elimination of meat from the diet result in deficiencies. Therefore, there may be little justification to recomment fortification with anything but iron.

This argument is valid for meat analogues and other products which are likely to replace meat. In the case of meat extenders, however, i.e. products which are used only in amounts of a few per cent of the meat product, there seem to be no justification for any demands for fortification.

The above arguments are valid for industrialized countries, but one may ask what the situation would be in less priviliged societies, i.e. very low-income countries. However, any manufactured meat extender or meat analogue will be a comparatively sophisticated industrial product beyond the purchasing power of the needy groups. Thus, it would be useless to fortify the product in order to improve their nutritional status.

Quite a different situation exists where meat analogues or meat extenders and similar products are used in emergency feeding in disaster situations. Here the product is generally made available from industrialized countries and may constitute a very large part of the diet of large numbers of severely deprived individuals. Obviously, adequate fortification is here indicated. The cost involved will be small compared to the very considerable cost of shipping and distributing a product.

## Methods of analysis for vegetable proteins

Because of the many regulations surrounding the use of vegetable proteins in meat, much effort has been expended towards the development of methods for qualitative and where possible quantitive determination thereof in meat products.

**Tracer material**. Since any such determination is difficult it has for long been the rule in the USA that any vegetable protein product present in a federally inspected meat plant, must be marked with titanium oxide. The same rule applies to plants exporting to the United States.

**Microscopic methods**. Presence of soy meal or soy concentrates may sometimes be determined microscopically by the presence of their characteristic cell fragments. Textured soy protein may be traced microscopically in both raw and cooked products using various dye staining methods.

**Serological-immunological methods**. Many methods have been developed which are based on the reaction between the protein and a serum containing anti-substance. Also these methods may be developed semi-quantitatively. They are difficult to use in material which has been heated.

A further difficulty is that few seras are available commercially. Their sensitivity is rather poor. High sensitivities have been found even for material cooked at as high a temperature as 125 C, but only in laboratories specializing in this and having developed the seras themselves.

**Electrophoretic methods**. Some electrophoretic methods have been quite successful. Smith at BFMIRA reports a sensitivity of such tests of 0.5 per cent isolate in raw products but only about 5 in luncheon meat, heat processed for one hour at 150 C.

**Computer calculations**. One method is based on determining the samples' amino acid pattern and from that deducing the proteins which have gone into its preparation. Such methods are said to have been quite successful.

## Legislation

It is probably fair to say that in the past legislation has tended to be rather conservative, in that products that have been in use for a long time in certain products, are permitted while new products even though of much superior quality and giving the consumers greater satisfaction are frawned upon. One example might be food cereal binders in traditional meat products compared to the addition of sophisticated spun soy isolates with flavour almost indistinguishable from that of the meat product itself.

More recent legislation seem to have moved in two directions. One is towards a purer and purer food with less and less additives, the other is towards a better utilization of resources, e.g. acceptance of the addition of vegetable protein products to meats.

In general, however, ligeslation has tended to follow consumers' whims rather than taken a bold initiative which would place, in front of the consumer, a wide variety of products of different price ranges and different organoleptic qualities in order that developments might take place and consumers might eventually choose and let their preference decide what should be found in the market place. It goes without saying, that legislation should make certain that foods are nutritious and not sold under misleading names. Apart from that, however, no restrictions appears to be justified on scientific grounds.

On these criteria any of the abovementioned unconventional proteins, except single cell products, could be permitted to meats. As mentioned above even fortification is only rarely indicated. It goes without saying that appropriate labelling should tell the consumer what she or he is buying or consuming. Here again, however, legislagtion has in general not been helpful. One may well question the many terms such as mechanically deboned meat, cereal binder, etc. A multitude of such terms has little meaning for the consumer, who is known not to know the significance of the expression a 40 per cent cheese.

It is appropriate to mention that one area does not lend itself to appropriate consumer protection by labelling, namely institutional feeding and catering. For instance it is known that vegetable proteins are used in considerable quantities in that trade in countries where their addition to meat products is otherwise prohibited. The example shows that consumers do not react to such products, but also indicates the difficulties in keeping the consumer informed.

<u>USA</u>. The addition of soy meal, soy protein concentrate, and isolate are permitted added to a number of standardized meat products as a binder along with cereals or milk powder. In some cases the binder must be declared in connection with the product name. It must of course always be declared in the appropriate position in the list of ingredients.

Using non-meat proteins in standardized products over and above the amount in which they are specifically permitted, normally requires that the product be sold by another name, wieners with a high concentration of soy protein are sold as "soya links".

In May 1976 USDA permitted the addition of non-meat proteins in unlimited amounts as replacers for meat in whole salted cooked meat, e.g. hams, picnics, etc. Permitted were such proteins as isolated soy protein, wheat protein concentrate, yeast, non-fat dried milk and dried meat. These products must be designated combination products, e.g. combination ham. The content of meat must be declared in connection with the product name. As mentioned above the non-meat protein must be fortified as indicated. It is said that the USDA will soon issue similar regulations for chopped meat products.

It is well known that in the US vegetable proteins are permitted for use in school lunch products, where they may replace up to 30 per cent of the meat protein.

<u>Canada</u>. Traditionally non-meat products have not been permitted in standardized meat products in Canada, except for milk powder in a few instances.

In 1975, however, new rules were issued according to which all non-meat protein products may be used as replacers for meat in all meat products. It is required that the non-meat protein which is turned to meat extender contains at least 16 per cent protein in hydrated form and it must have a minimum content of various vitamins and minerals. In addition it must have a minimum protein rating which is determined by multiplying the protein percentage with the PER value.

The labelling must be such that both the meat and the non-meat protein is mentioned in the name of the product, e.g."pork and soya loaf". There is no regulation calling for a quantitive declaration of the amount of non-meat protein added, and there is no limit to the amount of meat which might be replaced by a meat extender.

<u>U.K.</u> For most meat products sold in the U.K. are prescribed certain minimum contents of meat. Present legislation does not permit that these products be prepared with less meat content than thus indicated. However, non-meat proteins would generally be permitted as binders over and above the required meat content. In 1974 the Food Standards Committee issued a report on novel protein foods which suggests the following regulation: No more than 30 per cent of the meat may be replaced by other protein products. As mentioned above, there is a certain requirement with regard to protein content, thiamine content, and vitamins and minerals. The product name must refer to the non-protein which has been used, e.g. "beef and spun bean protein products sausages".

<u>The Federal Republic of Germany</u>. No addition of vegetable proteins is permitted for meat products, i.e. products with a meat content of more than 50 per cent meat. Certain types of dairy products and egg are permitted as binders for certain comminuted products.

<u>France</u>. The use of vegetable proteins to replace other common binders has been permitted in France since 1974.

In August 1975 the use of vegetable proteins in meat products was permitted in amounts up to 30 per cent calculated on dry weight basis. The condition for this use was that the product could not be sold under any traditional name for meat products, e.g. sausages, paté, ham, etc. The amount of vegetable protein added would have to be indicated in the list of ingredients.

<u>The Netherlands</u>. Non-meat proteins are not permitted in the Netherlands for traditional meat products, where these are designated as sausages or as a meat product. It appears, however, that these regulations presently are undergoing revision.

<u>Sweden</u>. Special standards permit in certain cases limited amounts of non-meat proteins as binders in meat products. In general a product is considered a meat product if it contains at least 20 per cent meat, regardless of the other ingredients.

Norway. Protein products are considered additives. They may be added only in such amounts that the protein from the addition does not constitute more than 2 per cent of the end product.

Denmark. There are no standards for meat products. Non-meat proteins may be used in any amount to any product provided consumers are not mislead. In government authorized plants the addition of such products may not exceed 3 per cent on a dry matter basis. Besides, the addition is only permitted in such cases where the country of import permits its use.

Table 1. World use of cereals, from U.N. World Food Conference (1975)

| | | Actual cons. 1970 | Projected demand 1990 |
|---|---|---|---|
| | | . . . million m. tons . . . | |
| Developed countries | | | |
| Food | | 160.9 | 164.6 |
| Feed | | 371.5 | 565.7 |
| Other uses | | 84.9 | 116.4 |
| | Total | 617.3 | 846.7 |
| | Per caput (kg) | 576 | 663 |
| Developing market economies | | | |
| Food | | 303.7 | 547.2 |
| Feed | | 35.6 | 101.9 |
| Other uses | | 46.4 | 88.5 |
| | Total | 385.7 | 737.6 |
| | Per caput (kg) | 220 | 246 |
| Asian centrally planning economies | | | |
| Food | | 164.1 | 225.3 |
| Feed | | 15.3 | 61.4 |
| Other uses | | 24.6 | 39.1 |
| | Total | 204.0 | 325.8 |
| | Per caput (kg) | 257 | 304 |
| World | | | |
| Food | | 628.7 | 937.1 |
| Feed | | 422.4 | 729.0 |
| Other uses | | 155.9 | 244.0 |
| | Total | 1207.0 | 1910.0 |
| | Per caput (kg) | 333 | 357 |

Table 2. The energy content of edible animal products as a percentage of the feed energy required

| | |
|---|---|
| Milk | 20 |
| Beef | 8 |
| Lamb | 6 |
| Pork | 15 |
| Eggs | 15 |
| Broilers | 10 |

Table 3. Average daily protein intake in some EEC countries

| | protein intake gram |
|---|---|
| Belgium | - |
| Denmark | 92 |
| Federal Republic of Germany | - |
| Ireland | 102 |
| Italy | 86 |
| The Netherlands | - |
| France | 103 |
| The United Kingdom | 85 |

Table 4. Consumers preference for hams with various curing yields

| % water added | overall acceptance* |
|---|---|
| 3 | 8.3 |
| 15 | 8.1 |
| 17 | 8.1 |
| 23 | 6.7 |

*10 for perfect, 0 for inedible

Table 5. Energy contribution of each nutrition factor in Danish open faced sandwiches

| | Energy contribution | | |
|---|---|---|---|
| | Fat | Carbo-hydrates | Protein |
| Bread, salami, onions | 50 | 35 | 13 |
| Bread, liverpaste, beets | 48 | 35 | 10 |
| Bread, pork sausage, beets | 51 | 30 | 11 |
| Bread, mackrel, mayonaise | 51 | 32 | 17 |
| Bread, 30% cheese | 55 | 28 | 20 |

Table 6. Contribution from meat in the danish diet, percent of calories and nutrients

| | Average calories and nutrient content in the diet | Contribution from meat | % "over"-coverage | % contribution from meat |
|---|---|---|---|---|
| calories | 3508 | 450 | 125 | 13 |
| protein, g | 105 | 36 | 188 | 34 |
| calcium, mg | 2070 | 20 | 203 | 1 |
| phosphorus, mg | 2210 | 345 | 217 | 16 |
| iron, mg | 25 | 5 | 175 | 20 |
| $B_1$-vit, µg | 2631 | 655 | 150 | 25 |
| $B_2$-vit, µg | 3648 | 390 | 170 | 11 |
| $B_{12}$-vit, µg | 11 | 4 | 300 | 36 |
| C-vit, mg | 140 | 2 | 250 | 1 |

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