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MEAT AND MEAT PRODUCTS*

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SUMMARY

Although meat production is not an efficient means of converting plant nutrients into food, its value for supplementing and improving plant diets is well established. Increasing population pressures and the need for nutritionally adequate diets indicate the necessity for better utilization of meat and its by-products. Additional emphasis must be placed upon utilizing the portions of the animal that are being either poorly utilized or not used at all. New developments and technology within the meat industry make more efficient utilization possible. Changing demands and increasing transportation costs are resulting in pre-cutting of the carcass into wholesale and retail cuts with removal of excess fat and bone. Such developments allow for conversion of waste into edible products. Thus, utilization of blood, all glands and organs, fat, bone and other waste is feasible. It is suggested that killing without bleeding, utilization of carcasses from old ewes, cull rams and boars for human food and utilization of the digestive tract and its contents, all glands, organs, cartilage and bone is possible. It is estimated that these sources would increase available meat protein by 25 to 35%. Disregarding the aesthetic standpoint, utilization of condemned carcasses and parts, and of crippled and dead animals is possible and would add another 5 to 10%, to give a total of 30 to 40%.

MEAT PROTEINS are probably the most sought after of all food proteins. Levels of meat consumption tend to be closely allied to level of economic development and standard of living. With increasing population pressures and the need for adequate utilization and improvement of nutritional standards (Whittlestone, 1970), it is appropriate that consideration be given to fully utilizing proteins obtained in the slaughtering and processing of meat animals. Furthermore, it may be expedient to project trends in handling and processing of meat and to speculate upon their effects not only upon meat *per se* but also upon the efficiency of utilization of by-products.

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For the purpose of this discussion, meat will refer to all parts of the live animal, *i.e.*, both those that are removed during slaughtering and processing and those that are utilized as meat in its more restricted meaning. Thus, discussion will be from three standpoints:

- (1) New developments in meat processing and their effects upon the products produced—both the primary and the by-products;
- (2) Making more efficient use of the products being produced; and
- (3) Some practices that could be adopted within the meat trade to increase the supply of products. Although the major portion of discussion will centre upon meat proteins, much of it will apply to fat which will also be considered from time to time.

TRENDS IN MEAT PROCESSING

Although traditional marketing has been based on selling meat in the carcass form with little emphasis upon further cutting or processing, further cutting and processing of meat appear inevitable in light of new developments. Several factors point towards increased processing and cutting, both in New Zealand and in all other meat exporting countries of the world.

SAVINGS IN TRANSPORTATION

First, present practices of shipping both bone and excess fat are wasteful, both from the standpoint of transportation costs and of utilization of waste. It is obvious that cheaper parts of the carcass are not of sufficient value to pay for the cost of transport and must be charged against the more valuable cuts. Secondly, shipping of intact carcasses is wasteful of both space and labour (Haughey, 1971).

Waste fat, bone and the cheaper cuts of meat from the carcass can be utilized more effectively at the slaughter works. Such by-products are of high quality and make first grade tallow, gelatin, meat extract, meat residue or other products at the works, but after reaching butcher shops and supermarkets are downgraded into poorly-utilized inedible products frequently not suitable for human consumption.

Since bone and fat constitute from 25 to 50% of the carcass, savings in transportation alone are tremendous. With increasing emphasis upon faster methods of trans-

portation, such as air freight or container ships, both pre-cutting and portion control are rapidly increasing. It seems quite likely that practically all meat will be exported as wholesale or retail cuts within the next 10 to 15 years. Emphasis upon portion control cutting and fabrication of special cuts could bring this about much faster. Although consumer demands will also influence processing and pre-cutting of meat, the savings in transportation costs alone will hasten these developments.

CONSUMER DEMANDS

Increasing numbers of housewives are working outside the home. The emphasis upon equality in pay and decreasing family demands within the home, point towards a higher proportion of the workforce being women. In countries where this has occurred, the growth of convenience foods has experienced a tremendous surge. The working housewife wants foods that require a minimum of time in preparation, with pre-cooked or partially cooked products being preferred. In United States, the result has been the growth of prepared dinners in which only heating is required before serving. The so-called TV dinner is one example of a convenient pre-cooked dinner where even the serving plate is disposable. There are also a variety of other such products on the market that are reasonable in price and convenient, in which meat is the main ingredient.

Another factor closely allied with increasing numbers of working women is the trend towards eating outside the home. Some estimates in United States have indicated that more than one-third of all meals are eaten outside the home. This has resulted in a tremendous increase in the restaurant business, but perhaps even more evident has been the increase in fast service hamburger stands and "drive-ins" which one eats in one's car. These developments, which are also growing rapidly in New Zealand, are placing new demands upon the meat industry. In general, restaurants and fast service "drive-ins" demand portion control with emphasis upon a uniform product. The restaurant trade requires specific cuts, which are preferably of a constant size. The fast service food establishment relies on a large volume of business for its profit, so careful control of size is important here also.

The modern fast-service "drive-in", and to some extent small restaurants, make use of untrained cooks so that the products must be designed not only for portion control, but must also contain specific cooking instructions.

Consumer demands as expressed through homemakers—both by those who work outside the home and those who do not—point towards an increase in convenience foods. This trend, in combination with the greater number of meals eaten outside the home, points toward a further increase in carcass cutting, portion control and more processing. These trends will increase the supply of waste fat, bone and meat trimmings at the works and serve to emphasize the importance of efficient utilization.

If the freezing works and slaughter plants fail to develop this segment of the business, specialized plants will arise to meet these needs. However, it seems unlikely that enterprising management of present works would turn their backs on this lucrative business. Regardless, utilization of the by-products of processing will play a major role in the business, and the success of freezing works will be closely allied with their efficiency in this important area.

EFFICIENT UTILIZATION OF BY-PRODUCTS

Although utilization of by-products in the form of fat, bone and lean trimmings has been mentioned, specific systems for reclamation as human food have not been considered. Although a certain portion of these products has long been reclaimed for human food, three developments have made it possible to process and utilize all of these products for human food: (1) Low temperature rendering; (2) Development of a solvent extraction procedure to produce fish protein concentrate; and (3) Development of efficient drying systems that can be applied to high moisture products.

RECLAMATION OF BY-PRODUCTS

Emphasis upon utilization of by-products is not new to the meat industry. The sausage industry of Europe was developed as the peasants evolved methods for changing many of the by-products from slaughtering and meat cutting into highly prized foods. Although most of these products were formulated from lean and fat, some, such as blood sausages, liver sausages and scrapple, made use of products that previously were wasted. The American packing industry has been credited with "wasting nothing but the squeal" in slaughtering of pigs, although this is obviously far from true.

Countries which export meat in carcass form have large quantities of by-products that are virtually unclaimed. These products include not only bones, fat and lean trimmings, but also the blood, the glands, internal organs, the

digestive tract and its contents, the hooves, the skin, and other miscellaneous parts. Although freezing works and packing plants have disposed of many of these products by washing them down the drain, emphasis upon improvement of water quality has forced the works into a reclamation process in order to avoid pollution. Even with emphasis upon reclamation, the industry has given little consideration to producing edible products but has largely concentrated upon production of inedible tallow and animal or fertilizer grade meat and bone meals.

Edible Protein

Production of edible protein from packing house by-products can be achieved by making use of the principles developed in low temperature centrifugal rendering and in the solvent extraction procedure as developed for production of fish protein concentrate (Moorjani *et al.*, 1968). Recently this procedure has been shown by Levin (1970) to be applicable to production of an edible meat protein concentrate produced from the by-products of cattle and pig slaughter. The protein concentrate contained from 80 to 90% protein and had a PER (protein efficiency ratio) of 68 as compared with casein with a value of 100. Supplementation of wheat protein with MPC (meat protein concentrate) showed the combination resulted in a PER of 91.

Locker (1969) has discussed the reclamation of edible protein from by-products of the meat industry, paying particular attention to utilization of the lungs, the spleen, blood, the digestive tract and its contents, and the connective tissue proteins removed upon low temperature rendering of fatty tissues. He proposes a scheme based upon low temperature rendering and boiling ethanol extraction which will result in substantial recovery of the protein by-products from the meat industry. Locker (1968) has also estimated that reclamation of the protein from the stomach and its contents, the lungs, trachea, oesophagus, spleen and diaphragm muscle from all cattle and sheep slaughtered in New Zealand would make 20,000 tons of protein available for human consumption. Technology is available to reclaim most, if not all, for human food.

Blood

Blood makes up a sizeable fraction of the protein lost at slaughter. Although blood is particularly valuable be-

cause of its high iron content and contains a fairly good quality protein, until recently much of it was washed away at slaughter with little effort towards reclamation. The amount currently available in New Zealand comprises some 10,000 tons (dried) annually, and is enough to meet the protein requirements of about 670,000 people (Locker, 1968). At present most of the blood being utilized is going into fertilizers at 9 to 11c per kg, whereas technology is available to produce protein acceptable for human food at an estimated cost of 35c per kg (Locker, 1968).

Collagen

Collagen comprises the major protein fraction of the body and is present in large quantities in the by-products from the meat industry. It is the major constituent of the connective tissues in the body, being present in large quantities in the skin, tendon, bone, the digestive tract, covering for the muscles and in many organs and other parts of the body. Although collagen is quite unreactive, it can be converted to gelatin by prolonged heating with water or alkali (Kendrew, 1954). It is characterized by its high content of glycine (33%), a high proportion of hydroxyproline and proline (22% combined) and the complete absence of tryptophane. Because of its poor amino acid balance, collagen has a low biological value. However, if properly supplemented with tryptophane, it provides a satisfactory protein.

Presently, much of the collagen is used for purposes other than food with most of the bone and tendon and the digestive tract going into animal feeds or fertilizers. The hides and pelts are largely being used for manufacture of leather. However, decreasing demand for leather, owing to development of substitutes, has already suggested that other uses need to be considered.

Some of the small and large intestines are being used for casings, and as such are being utilized for food. However, large quantities are still going into meat meal. Although additional manufacturing of natural casings could help to solve these problems, the difficulties of obtaining a product of good strength and uniform diameter have to some extent limited the market. Technology has recently shown that this can be partially overcome by drying at a uniform size. Even if the demand for animal casings should completely disappear, the intestines and stomachs could still be reclaimed for human food as meat protein concentrate, in which the amino acid deficiencies would be supplied by the other meat proteins.

Regenerated collagen is a relatively recent development which cross-links the collagen molecules and permits extrusion into casings. These collagen casings are meeting with considerable demand in sausage manufacture. Generally, skins are used as the source of raw material and have given a casing of uniform diameter and strength. Although the demand has been good, it would certainly use only a small fraction of all skins, and other uses must be found for the remainder. Extraction of the collagen and supplementation with the amino acids needed would be useful in adding a large amount of protein to the food supply. However, many problems must still be overcome before this becomes a reality.

Gelatin manufacture utilizes a small fraction of the collagen supply. When gelatin is flavoured and sweetened it provides a palatable product for human food. It could be used in larger quantities to extend the higher quality meat proteins. Supplementation of prepared gelatin with amino acids would also make it useful to that portion of the world's population subsisting on inadequate protein diets.

SOME OPPORTUNITIES FOR BETTER USE OF MEAT PROTEINS

Quite aside from opportunities to improve the amount of protein by more efficient production, there are some definite opportunities for increasing utilization of the protein produced by changing traditional practices, many of which are time-honoured, but probably of no practical significance. These will be discussed briefly—mainly as questions.

MEAT FROM RAMS AND BOARS

Why is the meat from mature rams and boars condemned or poorly utilized? It is wholesome and can be utilized for human food (Kirton and Paterson, 1972). Boar meat can be utilized quite effectively in a variety of products without serious complaints (Pearson *et al.*, 1971). The uncastrated male is known to be more efficient and to produce a greater proportion of lean meat. It behoves the meat industry to utilize the intact male animal more effectively.

MUTTON FROM OLD EWES

New Zealand produces some 9 million old cull ewes annually, many of which are poorly utilized. Some 5 million are exported, principally for manufacturing pur-

poses to Japan, United Kingdom and Russia, in order of volume. Of the 4 million ewes left for domestic use, it has been estimated that some 750,000 are utilized for dog food. Recent unpublished work at the Meat Industry Research Institute has shown that conditioning of old ewes made them superior in tenderness to regular export lambs. This suggests that there is considerable opportunity to up-grade mutton, and not only bring a greater economic return to farmers, but also improve the utilization of a wholesome product.

LEAVING THE BLOOD IN THE CARCASS

The time-honoured practice of bleeding animals at slaughter is questioned since blood is a wholesome product and can be more easily handled in the meat. Certainly bleeding is not necessary to kill the animals nor is it removed because it is unhealthy or unwholesome. Recent studies (M. E. Bailey, pers. comm.) have shown that the lysosomes present in meat are largely confined to the blood and may accelerate tenderization of meat. Furthermore, reclamation of blood on the slaughter floor is difficult because of the problems encountered owing to coagulation or to dilution with water. The food value of blood could be easily conserved by killing without bleeding and the entire problem of reclamation circumvented.

USE OF CONDEMNED OR DEAD ANIMALS

Losses through condemnation or death of livestock are tremendous, probably comprising from 2 to 5% of all animals. A small portion of these are tanked and utilized in production of fertilizer or perhaps animal feed. However, a large portion die on the farm and no attempt is made towards utilization. Aside from the aesthetics involved, it is possible to reclaim all of these by making protein concentrate. The process of extraction with boiling ethanol produces a completely sterile product, which would be suitable for human food. Although this practice may seem to be undesirable, production of fish protein concentrate has already provided the technology and shown that starving human beings will consume this protein material, which is made from the intact fish including its head, the viscera and its contents.

Tremendous opportunities are available for more efficient utilization of meat proteins and fats. Their reclamation is not only desirable, but essential if farm animals are to play a major role in meeting the needs of a hungry world.

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