PROCESSING AND MARKETING NON-MEAT PRODUCTS FROM LIVESTOCK

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Summary

The processing and marketing of non-meat products from livestock depends on their availability as by-products from the production of muscle meat as a primary product for human nutrition. When there is a protein deficiency most non-meat products will be used for human food, with the exception of feathers, hides, hair, and horn, and only in countries with an abundant food supply do more and more non-meat products become available for other purposes. A historical review shows that former use of non-meat products from livestock contributed considerably to the development of human civilization and that livestock in the past was often raised for the production of a specific non-meat product with meat as a by-product.

Responsible meat production cannot ignore the presence of non-meat products naturally associated with meat. High quality meat production will not convince the consumer on a long term basis when closely associated by-products are considered so dangerous (as in the case of bovine central nervous tissue, lymph nodes or intestines; specified risk materials in relation to BSE) that they must be incinerated. Meat production must therefore safeguard the quality of the by-products to allow a use of these raw materials at the highest possible level of recycling, where most of their natural structural elements can be utilized.

In a sustainable and durable world for humankind, non-meat products should be utilized *first* before possible replacement products from non-renewable sources or from plants are produced. To safeguard the utilization of *all* non-meat products from livestock under *all* circumstances, only part of the raw material should be transformed into consumer oriented products with high added value (e.g. gelatin capsules or photographic films) but with possible fluctuations of demand, and the other part should be transformed into bulk products (e.g. feed proteins) for an already existing market where they can easily be absorbed for a market price dominated by similar products from other sources (e.g. soy bean proteins). In all cases a total quality management has to guarantee the required quality of the product, freedom of pollutants, and safety of production.

Continuing research must safeguard the utilization of non-meat products for humans, animals and the environment and offer new applications at the highest possible level of added value. Education should transmit a realistic picture of livestock farming and agriculture including all relevant modes of non- meat product utilization: from fuel to fertilizer and feed ingredient, the various oleo-chemical products, bone china, gelatin and its applications, and pet food.

1. Introduction

Muscle meat for human consumption is at present the major product from livestock in high income countries (GNP > 20 000 € cap^{-1}). All other products from the slaughtered animal in these countries will hence be considered as non-meat products or animal by-products. The processing and marketing of these animal by-products will be treated in this article. From a historical view, however, non-meat products were often of major importance for the breeding of livestock and muscle meat was regarded as a by-product. Moreover, the human technical, social and cultural development in the last 10 000 years is unthinkable without the development of animal husbandry and the intensive use of all products which could be derived from livestock. This ranges from the use of leather for clothing and bags, to the development of textiles from wool, feathers for ornaments and heat insulation, animal fat derivatives for cleansing (soap) and light (candles), parchment for books, feathers and hair brushes as writing and painting utensils, strings from intestines for violins and tennis rackets and finally hormones and enzymes for medical care and biotechnology.

Outstanding examples of non-meat product based activities are the gelatin industry, part of the oleo- chemical industry and to a much lesser extent the pharmaceutical industry. Most of non-meat products in high income countries, however, are now being used for animal feeding in the compound feed industry to satisfy the growing protein and energy need in livestock and aquaculture for human nutrition or in the pet-food industry for the growing number of animals in high-income countries, mainly cats and dogs, as human companions. In low income countries non-meat products are still mainly used for human nutrition as was the case in the present high income countries more than 50 years ago. Currently there is a tendency in the industrial use of animal by-products towards a gradual replacement of animal products wherever it is possible either by plant products, by chemically synthesized products derived from fossil non-renewable carbon sources or by biologically synthesized products often through genetically modified microorganisms. However, these tendencies decrease the sustainability of meat

production.

A scheme for actual and possible recycling at the highest possible level of added value can help to make the right choice for future use of animal by-products and to support human responsibility for the adoption of non-meat products as a renewable source of prefabricated carbon compounds as long as muscle meat is regarded as a highly appreciated source of high value proteins for human nutrition. The ethics for a responsible use of non-meat products in a sustainable world requires the total use of animal by-products at their highest possible level of molecular and structural organization combined with a total quality and safety assurance for their further use.

2. Historical background

The evolution of human civilization was closely related to the use of animal by-products in daily life for various purposes. While meat and fat from wild animals provided proteins and energy for human nutrition in the hunter and gatherer society, the remaining part of the animal provided raw material for tools (bones and antlers), clothes, shoes and bags (hides and skins), ropes (guts) and beakers or musical instruments (horns) or ornaments (teeth and feathers).

When farming and domestication of animals started to develop about 10 000 years ago, livestock was chosen:

- to be a stock of fresh proteins for human nutrition,
- to supply power and transportation,
- to supply energy and fertilizers from their excrements, and
- to supply easily digestible fats and proteins through eggs and milk

while they were alive.

Once slaughtered, they were used for human nutrition and as a source of useful raw materials for various purposes.

The animal body provides several interesting materials for multiple use: a flat 2-dimensional sheet, the skin; a several meter long 1-dimensional flexible tube, the gut; a compressible material of different shape, horns and claws; an elastic 1-dimensional material, the tendons; and a hard and rather brittle material, the bones. Furthermore, thin short fibers, hair and wool, and a rather complicated structure in the feathers are provided by farm livestock.

Technological development was closely associated with the transformation of these perishable raw materials into durable items for daily life. Transforming skin into leather by tanning for the production of shoes, clothes, belts, bags, bottles and other useful objects probably dates from prehistoric times, whereas the production of soap from goat's tallow with wood ashes by the Phoenicians is reported by Pliny the Elder (about 600 BC). The transformation of sheep into wool producing animals during domestication fostered the development of the textile technology in competition with the use of fibers from plants like cotton and flax or from insects like silk. Sumeric documents from the 3rd millennium BC already show that sheep at this time where

mainly held for their wool and milk and not for their meat. Moreover, as one of the first adhesives animal glue from hides, bones or sinews was already known to the Egyptian and used in the fabrication of wooden furniture, from which the later plywood production can be derived.

The development of the bow, which became a decisive element in warfare until the invention of fire-arms, is a good example of making optimal use of the special properties of animal by-products combined with wood. The bow itself was made of a composite of timber blades combined at the inner side with compressible horn and at the outer side with elastic (stretchable) tendons whereas the string was often made of gut or leather. The arrow, on the other hand, was stabilized in the flight by feather barbs. In this way stored kinetic energy could be rapidly released and concentrated at one single point.

Examples from cultural development include musical instruments and script. Drums were made due to the elastic properties of skins as a flat resounding membrane and string instruments due to the elastic properties of gut strings, whereas the bow contained stretched horse hair to sound the strings. Early Chinese writing was performed on bones, often flat scapulas, in the 2nd millennium BC, and parchment made from sheep, goat and calf skins developed in the 2nd century BC in Pergamon in the Mediterranean world, provided excellent writing material until the 15th century, whereas quill pens provided a writing instrument that characterized writing in the occident for over a millennium until replaced by metal pens in the mid-19th century.

However, even in ancient time, goods from animal by-products were exposed to competition from other materials. For example, parchment was in competition with papyrus of plant origin, although not so durable, but probably cheaper to make and was later replaced by the cheaper, but also less durable paper based on cellulose of plant origin.

Until the late 18th century the transformation of non-meat products from domesticated farm animals into products of great demand was mainly the business of craftsmen including butchers, tanners, furriers, shoemakers, fullers, hatters, gut string makers, fletchers and others. A particular craftsman dealing with by-products from livestock was the knacker (French: equarrisseur; German: Abdecker), who bought worn-out domestic animals and carcasses to dispose of the products for use as animal feed and fertilizers and who sold the hides to tanners.

With increasing population density the knackers had difficulty in coping with the increasing numbers of dead animals especially in the vicinity of big cities. This led in the case of Paris in the beginning of the 19th century to considerable hygienic and environmental pollution problems, which were only solved after new technologies had emerged. These were based on advances in chemistry which were able to make valuable products out of animals or animal remains not used for human consumption and to solve the hygienic problems at the same time. In France, for example, bone char coal from bones and whole carcasses of discarded animals was obtained by heating the material up to 700 °C in an air tight vessel. The char coal turned out to be excellent for the final purification of sugar in the sugar refineries of the French colonies overseas. In England

at about the same time bone china was developed which was made using bone ash as the crucial ingredient to make light transparent porcelain.

In California and Australia, however, regions with a high livestock population with respect to their human population, non-meat products for export were often the main sources of income from livestock in the mid-19th century (hides and tallow from California to New England; wool and hides from Australia to England), since the local demand for meat was less than the production, and preservation of meat for export was not yet satisfactory. In those days the rendering industry developed, melting tallow out of the skinned carcasses and feeding the protein-rich remains to pigs or using them as fertilizers. Later, when the meat industry developed in these countries due to better preservation techniques (e.g. canning and refrigeration), rendering increased parallel with meat production.

A better understanding of the degradation of animal tissues was a consequence of the findings of Louis Pasteur, the son of a tanner, in the second half of the 19th century. Pasteurization and sterilization were introduced as means to stabilize otherwise degradable animal by-products. Dry rendering with the production of dried animal protein meals was one of the consequences of these findings. It was introduced in Germany in combination with pressure cooking to eliminate highly heat-resistant microorganisms like the anthrax-spores from carcasses and to allow the safe use of the dried proteins in animal feed.

In other areas the products of animal origin served as templates for the development of new products based on raw materials from plant origin or on raw materials from fossil organic materials. These developments became possible with new technology in chemistry and chemical engineering in the second half of the 19th and the first half of the 20th century.

The manufacture of soap and candles mainly from tallow developed into oleo-chemistry with the invention of fat hydrogenation, which allowed the use of hardened oils of marine and plant origin for the production of margarine for human nutrition and later the production of various detergents and surfactants.

Wool, felt from animal hairs, horn and leather, all protein based materials, had always been in competition with materials of plant origin (e.g. cotton and wood), and were now exposed to competition with fibers from chemically modified cellulose from wood (rayon) or from synthetic polymers from fossil raw materials (coal or crude petrol oil). At the end of the 1960's the world production of synthetic fibers from fossil sources exceeded that of the production of wool. However, the products from animal origin could always be regarded as templates for the development of new products.

Leather as a 2-dimensional material can be regarded as the precursor of polymeric films. Horn can be regarded as the precursor of modern plastics, with a casein based thermoplastic material ("Galalith" in Germany) as an intermediate. The first break-through in synthetic plastics was achieved in 1902 by Baekeland with his phenol and formaldehyde based bakelite. Wool fibers found competition in the synthetic polyamide and polyester fibers. Felt from animal hair and wool was replaced by felt made from

synthetic fibers, and animal glue was replaced by synthetic adhesives, again based on fossil carbon.

With animal glue as a starting point more sophisticated products were developed on the basis of water soluble animal tissue. The gelatin industry emerged. Gelatin became a suitable support for the photosensitive substances in photographic films (since 1880). Furthermore, capsules for the encapsulation of drugs, made from gelatin could be designed to dissolve only in well defined parts of the digestive system.

Finally, with the discovery of hormones like insulin (1922) animal glands like the pancreas from slaughtered animals became important for the pharmaceutical industry for the production of a remedy against diabetes. Insulin was the first chemically synthesized globular protein and it was also the first globular protein which could be synthesized at an industrial scale from genetically modified organisms (GMO) to replace the insulin of animal origin.

Already, these examples reveal what a big impact the use of domesticated animals has had on the development of human civilization.

At present, 230 million tonnes of meat (slaughter weight; cf. section 4 in 5.11.6.3) from land animals are produced worldwide (2000). Furthermore, annual production from poultry is about 50 million tonnes of eggs, from cattle (including buffalo, sheep and goat) 580 million tonnes of milk, and from sheep 1.4 million tonnes of wool to be considered together with a continuous production of manure of about 2500 million tonnes. Parallel to the meat-production about 100 million tonnes of animal by-products become available from slaughtering ("fifth quarter"). From these raw materials a huge variety of products can be derived.

With the BSE epidemic in the United Kingdom in the late 1980's, great concern arose about the use of animal products in general, although bovine meat and milk were always regarded as safe for human consumption. Today a complete revision of the safety of the use of products from animal and especially bovine origin in all applications is underway mainly in Europe and may lead to a completely new approach to the utilization and marketing, with special stress on consumer safety, of non-meat products from livestock in the future.

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Biographical Sketch

Radulf C. Oberthür, born October 2nd, 1941, in Brögbern (Germany) in a family of renderers
Doctor's degree in science in 1975 from the Johannes-Gutenberg Universität in Mainz (Germany)
Research scientist at the Institut Laue-Langevin in Grenoble (France) from 1980 to 1987 (structural research in macromolecular and colloidal systems)

Since 1964 involved in the development and from 1984 to 1999 managing director of his family's rendering business until the merger with three other companies into the SNP-group of animal by-product processors

In 1994 founder of Labor Dr. Oberthür GmbH specialized in research, development, and quality control in the field of animal and plant by-products

Since 1995 research into the reasons for the outbreak of BSE in the UK and in other countries together with scientists from the UK, the Netherlands and Germany; from 1999 to 2003 coordinator of an EU-funded European project on "TSE-agent inactivation, product quality evaluation and sterilization process simulation in rendering processes for the production of feed grade animal proteins"

Member of the Board and of the Standing Technical Group of the European Fat Processors and Renderers Association (EFPRA) and German representative at the World Renderers Organization (WRO)

Consultant for several international organizations including EU, FAO, OIE, and WHO