Meat technology update

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MEAT TECHNOLOGY UPDATE

Cutting edge technology for the meat processing industry

Bioactives, nutraceuticals and functional foods

- **Certain bioactive substances can be purified from foods, including meat, that can prevent or reduce the effects of some chronic diseases in both humans and animals.**
- **There is considerable market interest in producing foods that have particular health benefits (functional foods) and, therefore, considerable demand for bioactives and nutraceuticals.**
- **Bioactive and nutraceutical production involves considerable downstream processing. Meat processors will need to participate in value-adding or manufacturing activities in order to access the potential returns from this developing market.**

Functional foods and nutraceuticals now comprise the dominant trend for the food industry in developed countries. Consumers who are interested in functional foods and nutraceuticals consider therapy, prevention, performance and weight loss products as the most important functions.

Over the past 20 years, there has been increasing consumer and food industry interest in the concept of food and food components as major contributors to health. It has long been known that adding particular components, e.g. vitamins and minerals, to the diet can give health benefits, particularly where the diet is deficient in certain nutrients. Vitamin-fortified milk and iodized salt could be considered to have been the first functional foods.

All foods affect health by providing energy and nutrients. Certain foods have been noted to be particularly beneficial or detrimental to health—for example, diets rich in fruit and vegetables can help to reduce the risk of heart disease. Researchers are now focussing on finding the specific components of certain foods that offer specific health benefits. So far, however, there are few substances for which scientifically valid claims exist. Even so, the food industry and consumers are keen to produce and purchase products with added health benefits.

Bioactive: a substance that can interact with, or affect, any tissue in the body—usually in a beneficial way.

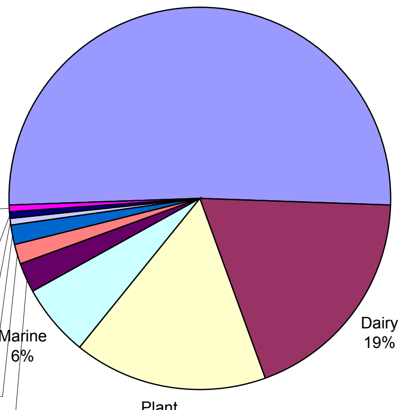
Nutraceutical: a food extract that has a physiological benefit or can protect against chronic illnesses.

Functional Food: a food which has physiological effects on the body or protects against chronic disease, over and above the effect of its basic nutritive value.

Sources of bioactives and nutraceuticals

Bioactive substances have been identified and purified from a variety of sources: plants, microbes, milk and meat. From 2005 MLA data, it was found that cattle provided 69% of recognised bioactive substances. Many nutraceutical substances are found in multiple sources, because the biochemical needs of all organisms are quite similar. For example, plants, animals and microbes all contain choline and sphingolipids, although animals are the best sources.

Note that the food source may not necessarily be the point of origin of the substance, e.g. CLA, found in beef and dairy foods, is actually manufactured by rumen bacteria.



Sources of bioactive ingredients produced in Australia

The best sources of carnitine and taurine are heart and skeletal muscle, while the glycosaminoglycans can be produced from the cartilages of the trachea.

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Uses of bioactives and nutraceuticals from animals

Nutraceuticals can be: anticancer; antioxidant; antibacterial; anti-inflammatory; antihypertensive; antihypercholesterolemic; antiaggregate; osteoprotective etc. In both human and animal medicine, nutraceuticals are used to reduce the symptoms of a number of chronic conditions, including osteoarthritis, allergies, heart disease, age-related loss of mental capacity and cancers.

The 2005 data indicated that 32% of bioactives and nutraceuticals were used in human therapeutics for the treatment or prevention of illness; 27% went into functional foods; 20% were utilised in research and biotechnology applications; and 17% in the veterinary therapeutics market.

Some examples of nutraceuticals from animal sources:

Conjugated Linoleic acid (CLA)

Eicosapentaenoic acid (EPA)

Docosahexenoic acid (DHA)

Gamma interferon (INF-γ)

Serum proteins

Coenzyme Q_{10}

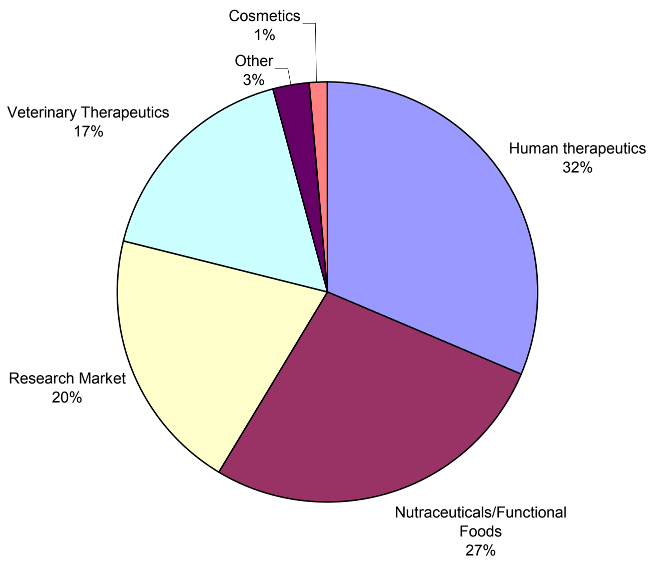
Glycosaminoglycans

Carnitine and Taurine

Conjugated linoleic acid (CLA) is found in the milk and fat of ruminant animals. CLA represents a family of fatty acid isomers of octadecadienoic acid. They are reported to have antioxidant and anti-inflammatory properties. The most consistent benefits shown in research are in anti-cancer effects, and in reducing body fat in growing animals.

EPA, DHA (omega 3 fatty acids) and Gamma interferon (INF-γ) contribute to the immune system and help to reduce inflammation. They can be found in the fat and plasma.

Serum proteins, such as albumin and immunoglobulins, are found in bovine plasma and used in dietary supplements for body-builders and athletes. Studies have shown that immunoglobulins promote protein synthesis and lean muscle growth.



Market applications for bioactives

Coenzyme Q_{10} (CoQ10) may have an important nutraceutical role as an antioxidant. Oxidative stress has been reported to play a role in inflammation, ageing and brain damage. There is a strong correlation between congestive heart failure and deficiency in CoQ10. It is highly concentrated in heart muscle cells. CoQ10 is an effective and safe treatment for heart disease. It was first isolated from beef heart in 1957.

Osteoarthritis (OA), or degenerative joint disease, is a common chronic disorder in which the joint cartilages degenerate, and the body responds by forming new bone at the joint margins, which reduces mobility of the joint. Antioxidants such as vitamins A, C and E may help to limit the cartilage degeneration. Omega-3 polyunsaturated fatty acid (PUFA) supplements (derived primarily from fish oils) help to reduce inflammation. The glycosaminoglycans (glucosamine sulphate and chondroitin sulphate) support healthy joint function. Supplementation seems to slow degeneration of the joint, reduce pain and improve mobility. The glycosaminoglycans can be produced from the cartilages of the trachea.

The amino acid carnitine encourages the loss of fat while preserving muscle mass during weight loss programs in cats and dogs, while another amino acid, taurine, is needed for normal heart and kidney function in cats. It also has protective activity against heart disease in certain breeds of dog that are prone to taurine deficiencies.

Production of bioactives

The production of bioactive molecules represents a significant challenge, but also a real opportunity for the meat processing industry. At the moment the industry focuses on selling carcase parts. This clearly includes the muscle being sold as meat cuts, but also other parts for various uses and for rendering. To process waste or low-value parts for the production of high-value bioactives is a significant change in approach to value-added processing. It is likely that a meat processor who moves into this area will opt, in the first instance, to make a bulk product that is packaged and distributed as a retail product by another company with appropriate marketing infrastructure. If so, the processor won't need the capability to package and retail a product. Companies in the dairy industry have followed this model, although there is likely to be a move to the bulk manufacturer of dairy- derived bioactives producing and marketing their own retail products to increase the value they gain from bioactive production. A noteworthy example is the New Zealand-based company Fonterra, the world's largest exporter of dairy products.

A variety of technologies are available for obtaining bioactive agents from the source tissue. Once extracted or separated, the substance must be purified to the standard required—food-grade or pharmaceutical—and then treated in some way to preserve the substance against deterioration.

Extraction is the process by which the bioactives that are in a tissue are freed from the tissue and dissolved in a liquid. The extracting liquid may be water (in which case the process is called an aqueous extraction) or in an organic solvent such as alcohol (in which case the process is called a solvent extraction). The resulting liquid is referred to as the extract and is typically a very dilute solution.

Separation can be carried out by centrifugation, filtration or flotation techniques.

Purification is the process of capturing and selectively concentrating the target compound from all other compounds in an extract.

Purification is carried out using reverse osmosis (RO) or adsorption. RO uses pressure to force a solution through a membrane that retains the solute on one side and allows the pure solvent to pass to the other side. Adsorption is the process in which components of a fluid stream (liquid or gas) bind to the surface of a solid. For a given solid (adsorbent) each component of the fluid stream tends to bind with a different strength. This allows adsorption to be used to separate out target compounds selectively. The most common types of adsorption operations used for bioactive production are ion exchange and chromatography.

Preservation: Bioactive compounds tend to lose potency over time due to processes such as oxidation, microbial spoilage and thermal degradation. The rate of activity loss depends very much on the product in question. Powdered glycosaminoglycans can last for up to a year, but enzymes can degrade in a matter of hours unless subjected to specific preservation processes. Bioactives are seldom sold as pure substances and are usually found in a stabilising solution if liquid, or bound on inert fillers if solid. Stability in liquid solutions depends on the pH and mineral compositions of the liquid and is very dependent on temperature. Freezing is commonly used to prolong shelf life of liquid suspensions of stabilising bioactive compounds because most chemical reactions (including those involved in loss of bioactivity) require a liquid phase. Dried products are still prone to oxidation if exposed to air, and even under vacuum or nitrogen flushing gradually lose activity. Activity loss does occur during drying, and choice of the most appropriate drying process is critical. The major processes are spray drying, freeze drying and ball drying. Customers will frequently specify maximum intervals between manufacture and delivery of bioactives. Prospective manufacturers must be able to meet the requirement.

The Value Chain

Bioactive agents from carcases and dairy products are high-value products at retail; however, this is rarely translated into high returns for primary producers and processors. This is partially due to the amount of processing required further along the chain from the co-products exiting the meatworks, and partially due to the current value chain. Most of the raw materials for the bioactives industry are co-products not used in food production, and are therefore in a state of oversupply. The chart below illustrates the typical value chain for nutraceuticals derived from red meat. The value chain was created using known data on selling prices at various steps in the chain and information about company-wide economics from CSIRO and published financial reports. The resulting value chain can be assumed to be sufficiently accurate to be used as the basis for developing insight about the opportunities for competing at various steps in the chain. It shows that the value adder and the retailer add most value and accrue most profits. For individual bioactive substances, the manufacturer may feature more highly than in this example. So, in order to benefit from the developing market in bioactives and nutraceuticals, and to claim greater returns for their raw materials, processors need to consider moving further along the value chain and participate in the value-adding and manufacturing sectors.

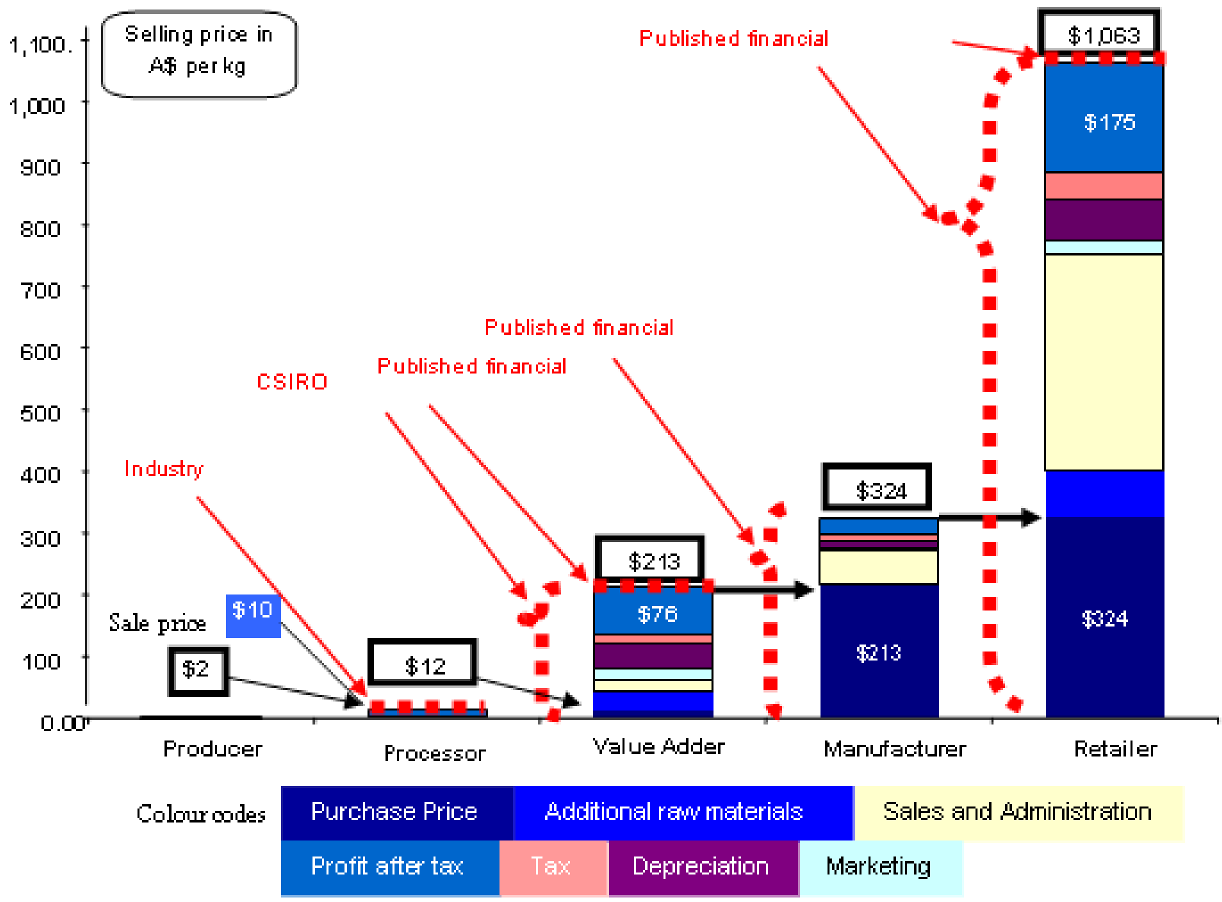


Figure 1: Example value chain for nutraceuticals extracted from red meat

Business case for nutraceutical production from meat co-products *(an example using carnosine)*

Carnosine is a dipeptide made up of the amino acids beta alanine and histidine. It is thought to have functionality as an antioxidant, and therefore may be able to improve athletic performance and slow down the effects of ageing. This molecule is commonly found in muscle tissue and spinal tissue. Currently the majority of carnosine traded internationally is derived from chemical synthesis, though we believe there is a clear market for a 'natural' derived product. For a detailed business case analysis, we recommend the use of an industry expert. MLA can assist in identifying and engaging the most suitable partner. The preliminary analysis that follows uses data that is freely obtainable on the internet, but may not be exact as prices can vary significantly over time and will not be specific for an individual company's situation. It is an approach for a feasibility study of carnosine production using a question and answer approach to provide some information about how a processor may begin the business analysis. Whilst we have used carnosine as an example it would be possible to substitute another bioactive provided the data required is available.

Questions to consider:

Q: How much carnosine can I sell? Are the quantity and price sufficient to justify establishing a business around its production?

A: Internationally approximately 30 tonnes of carnosine is traded per year. There appears to be demand for more. Thus, sales of several tonnes per year would not be difficult.

Q: What is my likely production volume of the bioactive?

A: The yield of carnosine may conservatively be 1 g per kg of meat offcuts or boning waste. Assuming that you kill 250,000 animals per year (5,000 animals per week over 50 weeks) and that you have meat offcut wastes of 20 kg per animal, approximate annual production could be 5000 kg of carnosine.

Q: What will be my annual gross income from sales of the bioactive?

A: We know good quality carnosine sells for approximately $230 per kilogram therefore, if you sell 5000 kg, the income would be $1.15 million.

Q: What would it cost to set up and produce these quantities?

A: The cost to set up a facility is likely to vary significantly depending upon the technology used, but could cost anywhere from several hundred thousand to over 2 million dollars. The running costs again will vary depending upon the technology used, but may be up to $200,000 per year.

Q: What is my pay-back time?

A: Assuming that sales of carnosine total $1.15 million dollars per year, it costs $1,500,000 to set up and $200,000 per year to run the facility, time taken to pay off the facility would be just short of two years.

Q: What is my annual profit?

A: Once the cost of set up is paid off then profit, using the figures above, could be $0.9 million per year.

Q: What about waste disposal?

A: Waste is likely to be in the form of solid material that could be sent for rendering, and aqueous solutions that may contain a variety of chemicals. The cost to treat or remove these will depend on the processes used to manufacture the carnosine.

Q: Any other issues?

A: The processor will need to ensure that they are compliant with the regulatory authorities such as the Therapeutic Goods Administration (TGA) and AQIS to ensure that the product can be exported, as the target market is likely to be international.

Also, to reduce market risk, a processing facility—once established—may be used to produce other bioactive molecules once identified by the processor/market. The facility should be designed accordingly and the establishment costs taken into account.

Further reading:

The following are available from MLA.

Top 5 Pet Food Nutraceuticals—MLA project PRCOPVA.001 report

Bioactives Market Analysis—MLA project PRBIO.009

Market Failure Case Studies—MLA project PRBIO.013

Links:

http://www.mla.com.au/TopicHierarchy/InformationCentre/Coproducts/Bioactives/default.htm

The information contained herein is an outline only and should not be relied upon in place of professional advice on any specific matter.

Contact us for additional information

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