Potential Benefits of Functional Foods and Nutraceuticals to the Agri-Food Industry in Canada

FINAL REPORT

On Behalf of
Agriculture and Agri-Food Canada (AAFC)

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EXECUTIVE SUMMARY

Nutraceuticals and functional foods represent a potentially significant opportunity for Canadian farmers and food producers. Quantifying this industry is difficult, even from the demand side, where the data is relatively easy to obtain. It is currently believed that the demand for nutraceuticals and functional foods in Canada is in the CAD$1-2 billion range, though estimates depend on the definition of the industry. Estimating the size of the industry from the supply side is more difficult, as the products are extremely variable and input totals cannot be calculated. Based on an analysis that incorporates the functional penetration rates of various food categories, estimates of the opportunity from the supply side can be made. It is estimated that between $300 million and $1 billion of farm production value goes to supplying ingredients for functional foods.

This farm production value is broken down by region and production category as well. The largest apparent opportunity for functional foods and nutraceuticals exists in the Prairie region in the grain and oilseed category, which represents approximately $290 million. Other areas of significant opportunity include dairy through all regions, vegetables in Quebec and Ontario, fruit in Ontario and British Columbia, and herbs and botanicals throughout Canada. Primary food categories that present little in the way of opportunity for functional foods and nutraceuticals include meats and poultry. Legumes are rarely considered functional, though this is believed to be due to a lack of research in the area.

Scientific research is believed to drive the supply side of the industry. Many new research facilities have opened in many regions in Canada, and interest in nutraceuticals and functional foods has been on the rise. Many new industry associations have also arisen to meet the needs of this industry. These organizations will be expected to provide a coordinated effort in developing processes and technologies that will further the industry and provide value to the food industry.

The value chain for functional foods and nutraceuticals differ from the standard food model in a few key ways. Three components are added to the value chain: research, technology development, and product commercialization. While these three components are also present in the value chain for conventional foods, they are generally considered insignificant, and are ignored in most value chain models. With functional foods and nutraceuticals, scientific research and technology development are often the driving force behind product development, and product commercialization takes on added significance. It is believed that farmers and raw ingredient producers receive a relatively lower proportion of the consumer value of nutraceuticals and functional foods than for conventional foods, but this may represent a larger total received per unit production. Estimates are that raw material producers receive from 5% to 25% of the value of the end product.

Functional food and nutraceutical products carry higher prices and greater margins than do conventional foods, generating a great incentive for companies to enter this market. There are an estimated 300 Canadian companies that have developed interest in the nutraceuticals and functional foods industry, though it is unclear how many of these have developed functional products that are currently available. These companies have approached the industry from many standpoints and with many different strategies. This

report presents three of these companies that have each utilized unique strategies in entering the market and develops estimates for the value chain for each.

The Flax Consortium developed as an association between several researchers who had developed a technology to extract specific beneficial compounds from flaxseed. This company is now licensing its technology to Archer Daniels Midland, potentially generating new markets for flaxseed. These markets should enhance the demand for flaxseed, either raising the prices for the product, or at least stabilizing the market somewhat. Through these means, farmers are expected to benefit. Through the value chain, the Flax Consortium has added value in the processing of flax ingredients, and flax growers hope to benefit from increased market exposure.

Bioriginal Inc. has focused its efforts on developing healthy oil products to be sold directly to consumers or as private labels, or to be used as ingredients in functional foods. Bioriginal has developed strong oil processing capabilities and has developed contractual arrangements with growers to provide top quality inputs. Bioriginal's success will depend on the strength of these arrangements, and producers benefit from a guaranteed market and a certain price for their production.

Burnbrae Farms has extended their egg product line to include several functional products such as omega-3 enriched eggs. These functional products are being sold throughout Canada at a price of approximately twice that of their conventional counterparts despite the relatively low technology involved in their production. This product depends upon new ingredients into chicken feed that provide new markets for farmer production as well as for egg producers.

All three of these cases, and others, demonstrate that there are strong possibilities in the nutraceutical and functional food markets, but the value is generally added downstream of primary producers. Regardless, farmers will benefit from the development of this industry in several ways, including increased markets for certain products, improved price stability as a result of the markets, and the possibilities of engaging in contract production.

Despite the opportunities presented by the industry, there are several challenges that will be faced. While Health Canada has taken a proactive role in defining functional foods and nutraceuticals, it has historically taken a strong stance against allowing health claims on foods. Research initiatives will need to support the industry by providing scientific evidence in support of functional ingredients and technologies. Methods for undertaking clinical trials for preventative products such as nutraceuticals and functional foods must be devised. Organizations such as Statistics Canada must also begin to consider this industry as an entity and support the industry development by providing industry-specific market research.

I. INTRODUCTION

Background

Markets for the nutraceutical and functional food industry are driven by consumers' recognition of the link between diet and health, and the increasing wealth of the large and aging baby-boom generation. These consumers represent a relatively well-educated and affluent market that is willing to pay for food products and dietary supplements that will enhance their lives. As a result, this sector of the food industry has shown significantly greater growth than the larger general food market. Because of this, interest has developed in the potential business and economic benefits of functional foods and nutraceuticals. There is both potential for higher value agricultural crops and value-added food processing opportunities.

Most of the commodities grown in Canada have the potential to be processed into functional foods or nutraceuticals for both domestic and global markets. To this end, Canadian companies are increasingly becoming involved in extracting, purifying, and processing the most nutritionally valuable crop, dairy, and livestock components. Companies are developing specialized crops and technologies to create functional ingredients and nutritional supplements. Feed ingredients are being studied for nutritive implications on meats, dairy, and poultry.

Agri-food accounts for approximately 8.5% of the Canadian GDP. Food production and manufacturing in Canada has always played a large part in the economy. According to Industry Canada, in 1998 there were approximately 1400 companies involved in food and beverage manufacturing, with total revenues from these companies at $59.3 billion. In addition, Canadian producers generated total agricultural farm receipts of $27.9 billion in 2000, with production export revenues valued at $14.6 billion. Including food processing, the value of Canada's agri-food exports in 2000 exceeded $23 billion. These data suggest that Canadian producers and manufacturers stand much to gain from the worldwide interest in nutraceuticals and functional foods, but efforts must be well placed.

The interest in nutraceuticals and functional foods is not limited to the food industry. University departments including agriculture, medicine, pharmacy, human ecology, food science, animal science, and botany are all currently involved in nutraceutical research. Active compounds are being sought from plant and animal sources to be used as pharmaceuticals as well as food ingredients. These factors help to make the industry nebulous and difficult to quantify. Traditionally, medicine in particular has avoided identification with food science and nutrition, creating a growing 'alternative medicine' industry. Medicine deals primarily with disease states and attempts to find cures for these states. For years, eastern medical practices have taken a more holistic approach to disease, emphasizing prevention through healthy living. This is also the driving force behind the nutraceutical and functional food movement, so it is little wonder that this movement has its origin in Japan, and that Japan represents the most mature market for nutraceuticals and functional foods both from the perspective of consumers and regulators.

Study Objectives

The overall objective of this project was to provide the industry and government with a better understanding of the nature, scope and magnitude of potential benefits of nutraceuticals and functional food in terms of their ability to generate an economic return for primary producers and manufacturers in Canada.

More specific objectives were to:
- outline the potential benefits to producers and manufacturers;
- profile the distribution of benefits through the value chain;
- outline the potential benefit by region within Canada for major product categories; and,
- identify areas where further study may be warranted.

This report continues with a description of the nutraceutical and functional foods industry. The size of the global and regional markets will be considered from both the demand perspective and the supply of food commodities and products in Canada. Scientific research considerations will be made within the framework of the Canadian market. Specific opportunities for the agri-food industry in Canada will be presented. An analysis of the value chain for functional products will follow, including three case studies of successful Canadian companies involved at different places in the value chain and a summary of their key success factors. Recommendations for further study will summarize the report.

The information contained in this report is based on data from numerous industry reports as well as information from industry newsletters and websites. All sources used are listed in Appendix C at the end of this report. Interviews were conducted with industry stakeholders to gain insight into the challenges and opportunities that exist in the Canadian industry. These interviews included stakeholders from all of Canada's regions and included government officials, company executives, farmers, researchers, and industry association board members.

II. DESCRIPTION OF NUTRACEUTICALS & FUNCTIONAL FOODS

Definition of Nutraceutical and Functional Foods

Recently, the Bureau of Nutritional Sciences of the Food Directorate of Health Canada proposed the following definitions for nutraceuticals and functional foods (Health Canada website, www.hc-sc.gc.ca).

- A *nutraceutica*l is a product isolated or purified from foods that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease.

- A *functional food* is similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions.

These definitions are supplemented with five broad categories that encompass the full range of nutraceuticals and functional foods. These are:

- Raw food, e.g. carrots that contain beta-carotene.
- Processed foods without added ingredients, e.g. oat bran cereal.
- Processed foods with added ingredients, e.g. calcium-enriched orange juice.
- Genetically engineered foods, e.g. enhanced tomato with higher concentrations of lycopene.
- Isolated/purified preparations of active ingredients sold in tablet, capsule, or tincture form.

These categories do not encompass all of the functional foods and nutraceuticals industry. Missing are foods enhanced in functionality through means other than genetic modification, for example, breeding or special livestock feeding. Common elements among these categories are: functional products either are or contain traditional foods or food components, functional products contain naturally-occurring biologically active compounds that are different from traditional nutrients, and the active ingredients in functional products provide a beneficial physiological impact and/or reduce incidence of disease.

Of the above five categories, the first four comprise functional foods, and the fifth category represents nutraceuticals as defined by Health Canada.

For the purposes of this report, all foods that have not been altered through the addition of ingredients and are not marketed as functional in their unprocessed forms will not be considered functional. Products that have achieved market standard status will also not be considered functional. This report will not include raw foods that are not marketed as functional or market standard products in the functional foods definition. Nutraceuticals will not include vitamin and mineral supplements.

Functional foods are seen as a concept that captures the marketing of food, nutrition and health taking place on an unprecedented scale by the international food industry. The concept also extends to the scientific and nutritional role of food in relation to health. Despite this, and the high level of scientific activity geared towards unraveling the health-promoting secrets of food and food components, functional foods and nutraceuticals have defied consistent definitions among academics, scientists, business analysts and policy experts. As a result, market data varies widely between reports.

Many new terms have been used to describe functional ingredients in foods or nutraceuticals. These terms include bioactives, phytochemicals, phytonutrients, botanicals, biologicals, and are often used interchangeably. While the definitions of many of these terms overlap to some degree, there is disagreement in certain areas, for example, phytochemicals are chemical extracts taken from plants, while bioactives include extracts with health effects from all biological sources. In this report, vague use of these terms are avoided where possible, and terms are defined where used.

Scope of the Industry

Nutraceuticals in particular, but also functional foods, represents a unique intersection of the pharmaceutical and food industries. The pharmaceutical industry is well known for the high costs of research and development associated with drug development and the use of patents to protect the discoveries from this R&D; therefore, the industry is associated with high product margins. The food industry is notorious for its low margins and the commoditization of its inputs and in some cases its products. Nutraceuticals and functional foods are somewhere in between. Scientific research is leading to patentable discoveries of potential food ingredients and extraction and purification processes that could allow companies a great competitive advantage for a time. Furthermore, manufacturers are looking to obtain higher value components from waste or low value products. These processes are possible because consumers are willing to pay more for food products that confer health benefits. From the perspective of food manufacturers and producers, the interest in nutraceuticals and functional foods stems from the higher margins that companies can expect to gain in the general food industry.

It may be essential for food companies in the short term, and commodity growers in the longer term, to become involved in producing functional foods simply to maintain market share. This may become a necessity of survival for food companies as the food industry becomes more dominated by functional foods.

The question is: where does the increased value of the product go? Agricultural farmers that produce healthier raw materials expect to benefit from their production choice, processors of these raw materials involved in the extraction of the active compounds in the raw materials also expect some benefit. Functional food manufacturers who formulate and market products that are both palatable and healthy expect to benefit, and wholesalers and retailers expect their share. Finally, any research has gone into discovery or processing of the functional compound must be paid for through the value chain. The question of whether farmers and primary processors receive any of the added value in the products is a valid concern. This report will address the value chain for nutraceuticals and functional foods and will identify opportunities for producers to extract more value from their production.

Market Entry Strategies

The nutraceutical and functional food market is extremely broad, representing a sector that encompasses parts of several other sectors. Because of this, there have been many different strategies employed to enter into this industry. Strategies that have been used by Canadian companies include:

- focusing production on whole products that are considered functional, e.g. growing ginseng, or milling buckwheat.
- development of proprietary processes and technologies for extracting functionally active compounds from food sources, e.g. omega-3 fatty acids from hemp, or stanols from plant sources.
- production of a wide range of nutraceuticals ranging from vitamin and mineral supplements to herbs and oil extracts as a broad, branded product category.
- initiating product extensions to include functional product lines, e.g. Tropicana Orange Juice with Calcium.
- developing nutraceutical research and development capabilities and divisions to take advantage of the large market, e.g. Abbott Laboratories.
- increasing value-added processing, e.g. Agricore United.
- dedicating their business to the formulation of functional foods.
- genetically engineering plants to carry improved health nutrition profiles.

Table A1 in Appendix A includes a list of approximately 300 Canadian companies that have entered into the nutraceutical and functional foods industry using one or more of the above strategies.

Food companies around the world are restructuring their operations and spending hundreds of millions of dollars to develop and market functional food and beverage products. Many large food-manufacturing companies have been forming nutraceutical divisions, but not all have met with success. For example, the Campbell Soup Company developed and marketed a functional brand called Intelligent Quisine, but, in a well documented move, pulled the brand from store shelves within one year. It was believed that the markets were not yet ready for such a product. Cargill formed Cargill Nutraceuticals in 1998, but has since closed this division and replaced it with a Health Food and Technology division. This change in philosophy at Cargill has come about because of a realization of very high costs to expected profits from nutraceutical supplement products, and has chosen to instead move toward functional ingredients that are likely to be used by their current customers. Novartis has been withdrawing from the functional foods area entirely, recently dissolving its joint venture with Quaker Oats/PepsiCo and eliminating the Aviva brand from its test markets. High price and a failure to meet consumers' taste expectations are cited as reasons for their withdrawal.

Smaller entrepreneurial companies have been entering the market in many ways, in some cases risking their entire business on the success of a single ingredient or brand regardless of the science behind the product. Larger established companies are more reluctant to take any risk of products whose health benefits have yet to be scientifically proven. These companies generally use functional foods to supplement their existing businesses.

The cost of research needed to prove product efficacy can be daunting to many companies. Food companies in particular that have little experience working with patents and high volumes of research appear to be on the fence when it comes to research funding. They would be interested in allocating resources if there was a potential payoff, but it is often believed that the health claims that are developed in the nutraceuticals and functional foods industry cannot be protected in the same way as in the pharmaceuticals industry. Furthermore, health claims can be copied very quickly and cheaply in food production.

Some industry participants believe that this industry is all about marketing products rather than health benefits. They believe that functional foods and nutraceuticals have simply become useful terms to describe nutrition marketing, which is being used by food and beverage manufacturers on a large scale regardless of the true health benefits to the consumer. Despite these doubts, it cannot be argued that this industry is large and growing quickly.

Market Profile

Demand Analysis

In order to determine the demand for nutraceutical and functional food products, the larger markets will be identified and considered separately. The drivers for demand, the regions of greatest demand including Canada, and the nature of the demand in these regions will be identified along with the regional differences. The demand of each region will be quantified, and an analysis will be presented.

World market growth in the natural health products, nutraceutical and functional food industry is being driven by demographic, economic and social trends. The key factors driving this growth in demand, as well as and changes in the supply chain, include:

- aging populations, particularly the large baby boom generation;

- increasing interest in 'healthy living';
- increasing affluence and education among world populations;
- increasing understanding of the link between nutrition and health;
- emphasis on preventative measures to control health care costs;
- increased acceptance and utilization of 'alternative' treatments;
- general consumer dissatisfaction with conventional treatments, therapies and drugs;
- rising acceptance among doctors, pharmacists and other health professionals;
- expanding body of scientific and clinical research to validate effectiveness and safety;
- expanding press coverage of such research;
- increased marketing and advertising activities by suppliers and,
- evolving public policy and regulatory environments.

This driver is consistent throughout the major markets for nutraceuticals and functional foods, Japan, Western Europe, and North America.

Quantifying the market potential for functional foods has proven problematic for market analysts since it is highly fragmented and covers a multitude of products with proven and unproven health benefits. As a result, market researchers are often vague about which products are used to build up their market numbers for functional foods. Reports that consider the widest possible definition for the market estimate it to be about half the entire food industry market, or about US$ 250 billion in the U.S. alone. The scope used in this estimate would include all products that are considered to be healthier than the industry standard, such as diet and low-fat products. Other reports take an extremely narrow definition of the market, allowing only products that can make specific health claims. The world market for this scope estimate suggests a size of only US $8 billion. Under this definition, Canada would have no market for functional foods, as health claims are not allowed on food products in Canada. In between these two extremes, many reports suggest that the market for nutraceuticals and functional foods is in the US$ 35-50 billion range worldwide and between CAD$ 1-2 billion in Canada.

Table 1. Estimated market size for functional foods for specific regions (US$ billions).

	1997	2000	2005
United States	13.6	17.4	25.7
Europe	12.3	16.4	34.4
Japan	9.6	12.8	22.6
Canada	0.4	0.6	1.0
Rest of the World	3.0	4.1	5.9
Total	38.9	51.3	89.6

Table 1 gives an estimate of the market size in select countries based on Nutrition Business Journal (NBJ) estimates. These data do not include raw foods that are not marketed as functional.

The market for functional foods in the U.S. is estimated to be about 3.4% of the overall food market, but this number varies between regions and between food categories. Table B3 from Appendix B provides data from the U.S. for the penetration rate for various functional food categories in 1999 and projected to 2010. Of the various categories, breads & grains, beverages, and packaged & prepared foods are the largest with close to 10% of each food category comprised of functional foods. Functional foods are expected to expand to 5.5% of all foods in the U.S. by 2010, with in excess of US$34 billion in sales. Packaged & prepared foods and beverages are expected to be over 20% functional by 2010, followed by breads & grains at close to 10%.

Note that these estimates do not include nutraceuticals. Data on world nutraceutical consumption and growth estimates were not obtained from any sources. U.S. data is included in Table B3. Nutraceuticals, or nutritional supplements as they are referred to by NBJ, are comprised of vitamins, minerals, herbs & botanicals, sports supplements, meal supplements, and specialty supplements. Of these, vitamins and minerals do not impact agri-foods except for use as ingredients in functional foods, where they would be included in the above table. The U.S. demand for nutritional supplements outside of vitamins and minerals in 2000 was US$9.4 billion, making the total U.S. market for functional foods and agri-food related nutraceuticals US$26.9 billion. The annual growth of some of the nutraceutical categories has been tremendous, particularly specialty supplements (probiotics, essential fatty acids, enzymes, etc.) at over 20% annually on average from 1997 to 2000. Overall, the nutraceuticals sector is expected to grow more slowly in the U.S. than the functional foods sector, averaging 6.1% against 8.1% for functional foods. The herbs and botanicals category had experienced high growth in the U.S. until 1998, but this growth has fallen off considerably and is expected to continue low growth through 2005, possibly due to negative publicity associated with particular products. Similar data was not found for other regions, though nutraceuticals are believed to represent a significant market in both Europe and Japan.

One thing that all market studies seem to agree on is that the market for functional foods is growing rapidly each year, with annual growth rate estimates varying between 8% and 14%. The range reflects the different definitions of the supply side. Among the difficulties associated with estimating growth in this industry is the fact that as functional products gain in popularity, they eventually become the industry standard, causing them to be removed from some definitions of the market. For example, milk fortified with Vitamins A and D have long been considered market standard, so are left off most functional food estimates, despite the health benefits associated with these vitamins. The addition of an additional functional ingredient would create a new functional product.

Another difficulty associated with growth estimates for the nutraceutical and functional foods industry is that certain well-known, standard foods can become functional seemingly overnight as research is generated in support of health claims. For example, as the Quaker Oats Company succeeded in its lobby of the U.S. FDA to recognize the link between beta glucan in oats and heart health, the entire oats industry became functional, which led to the inclusion of oats in other established products like General Mills' Cheerios brand. The inclusion of oats in such leading brands would suddenly place these brands in the functional foods industry, overstating its growth. Through this type of activity, the breakfast cereal category has effectively converted itself from regular foods to functional foods, with in excess of 40% of sales coming from functional products. Some reports indicate that this is happening on an increasing scale to an increasing number of foods resulting in misleading growth forecasts for the industry.

Japan

With estimated demand for nutraceuticals and functional foods of between US$4 and US$15 billion annually, Japan represents the most sophisticated market in the world for this industry. This industry is expected to grow at a rate of about 12% per year through 2005. The market is segmented based on function of the product. Promar International estimated that the Japanese nutraceutical market in 1998 was US$13 billion, and is broken down as follows:

- 44% toward products that increase energy levels and reduce fatigue,
- 16% to intestinal regulation,
- 12% to bone strengthening,
- 6% to skin care,
- 4.8% to vitamin/mineral balance,
- 4.1% to nutritional balance,
- 3.3% to tooth decay reduction,
- 3.3% to weight control,
- 2.6% to throat irritation reduction,
- 1.8% to halitosis prevention, and
- 2.5% to increased mental acuity, strengthened immune system, eye strain reduction, and reduced anemia, among other things.

The Japanese market is the best example of one taking preventative steps towards health care. Worth noting here is the lack of heart health or cancer-related products, which, as will be presented below, represent much of the North American functional food market.

Among the products popular in Japan that have had little impact on the North American markets are the intestinal regulation, or gut products. These products generally take the form of dairy-based products, usually milk drinks, yogurts, or spreads but also occur as soft drinks. They are categorized as probiotics, prebiotics, and synbiotics based on the active ingredients within the product. Probiotics are products containing specific strains of bacteria that are known to aid in digestion for humans. Prebiotics are products that contain compounds, usually oligosaccharides, which allow the probiotic bacteria to flourish. Synbiotics are products that contain both probiotic bacteria and prebiotic oligosaccharides. Popular Japanese intestinal regulation products are listed in Table 2.

Table 2. Japanese functional food products

Brand	Company	Product
Yakult	Yakult Honsha	Probiotic drink
Danone	Calpis/Ajinomoto/Danone	Synbiotic yogurt
Aloe Nomu Yogurt	Morinaga Milk Co.	Synbiotic yogurt soft drink
Bikkle	Suntory Co.	Synbiotic multifunctional drink
Maiasa Sokai	Morinaga Milk Co.	Prebiotic soft drink
One a Night	Otsuka Pharmaceutical	Prebiotic
Yakult 80 Ace	Yakult Honsha	Prebiotic drink
Bifiel	Yakult Honsha	Prebiotic / multifunctional product
Oligo CC	Calpis Co.	Prebiotic

Japan has the most advanced regulatory environment for nutraceuticals and functional foods. They have developed the only formal regulatory framework for nutraceuticals and functional foods, known as the Foods for Specific Health Use (FOSHU) system. Under this system, the Japanese government approves functional food products and labeling practices allowing companies to make specific health claims on their packaging. Through the FOSHU system, the government has taken proactive steps in educating the public about healthier eating and improved nutrition while regulating the market to ensure product efficacy and safety. This regulatory system is believed to be effective at encouraging market participants, though only about 10-15% of the functional foods on the market in Japan are approved through FOSHU. The other 85-90% are not allowed to make specific health claims but can make factual statements regarding the presence of functional ingredients in their products. The FOSHU market, estimated at US$3 billion in 2000, is dominated by probiotics and prebiotics, with these categories making up over 85% of approved products. The overall market for functional foods in Japan is estimated at over US$10 billion.

Europe

The European market is somewhat less sophisticated than the Japanese market, but more so than the North American markets. As with so many things, Europe can hardly be considered a single unified entity with respect to the functional foods industry. Many products are very successful in some countries without even reaching others. Germany has the largest functional food market in Europe, followed closely by Great Britain and France. Italy, Scandinavia, Switzerland, Austria, and the Benelux nations represent smaller markets for functional foods. Eastern Europe is generally disregarded from consideration, as the markets in these areas are considered negligible.

Many European companies have launched successful functional brands, primarily in the dairy sector with probiotic drinks, yogurts, and spreads, but also with vitamin or mineral fortification of traditional foods. Examples are Danone’s Actimel, believed to be the largest selling functional food brand in the world, Nestle’s LC1 Go!, and Muller’s Prokult. Much like Japan, gut health products are dominant in Europe, but many products uncommon in Japan exist as well. Ready-to-eat breakfast cereals are more commonly considered functional in

Europe, and cholesterol-lowering products such as Raisio's Benecol are more common.

The functional food market in Europe is believed to be in excess of US$15 billion, and is growing quickly, expected to increase by as much as 16% annually through 2005.

U.S.

The U.S. market for functional foods and nutraceuticals is quite unlike the markets of Japan and Europe. In the U.S., the emphasis on functional foods and nutraceuticals has been heart health and cancer agents and more curative therapies rather than gut health and preventative therapies. The products offered reflect these differences as cereal and orange juice fortification and energy bars and beverages dominate the market. Probiotics, prebiotics, and synbiotics have only recently made headway in the U.S. market, and represent a potential high growth area for the future.

Canadian exports of raw food production and food processing largely goes to the U.S. Therefore, market trends in the U.S. are as important as ones in Canada for Canadian food producers and processors. Also, given that little data exists on the Canadian functional foods and nutraceuticals industry, extrapolation on the U.S. data is common for interpreting the Canadian market situation.

The market potential for nutraceuticals and functional foods in the U.S. is expected by many to be below that of European and Japanese markets over the next 5 years. Table 3 indicates the growth in the U.S. functional food and nutraceuticals market for 1997, 2000, and 2005. Only beverages, snacks, and packaged & prepared foods are expected to see over 10% growth per annum to 2005. With overall growth at only 6.1%, this estimate would be considered conservative.

A more detailed view of the U.S. functional foods and nutraceuticals markets is provided in Appendix B Tables B3 and B4. All categories of functional foods are expected to show declining growth rates with only packaged & prepared foods and snack foods exhibiting about 10% growth per annum by 2010. Breads & grains, which represent the largest category by total value, has been showing the lowest growth, a trend that is expected to continue through to 2010. All categories of nutraceuticals are also expected to show declining growth, with the herbs & botanicals category continuing its recent slowdown. Together with the specialty supplements category, herbs & botanicals is most affected by new scientific discoveries and negative publicity. The slow expected growth of the probiotics sector suggests the difference between the U.S. market and those of Europe and Japan.

Data from these tables also suggests that the current penetration rate of functional foods in the U.S. is 3.4% overall, and this number is expected to increase to 5.5% by 2005. Showing the greatest increases in penetration are the frozen prepared foods, snack food & nutrition bars, and the beverage categories with the exception of prepared drinks.

Table 3. U.S. Functional Food and Nutraceutical estimates for 1997, 2000, 2005

Primary Functional Food and Nutraceutical categories (US$ billions)					
Food Category	**1997**	**growth**	**2000**	**growth**	**2005**
Dairy	1.5	11.0%	2.1	8.2%	3.1
Produce	0.0	-	0.0	-	0.0
Breads & Grains	5.7	2.1%	6.1	2.0%	6.8
Meat, Fish & Poultry	0.0	-	0.0	-	0.0
Beverages	4.4	11.8%	6.1	10.1%	9.8
Snacks	0.6	27.9%	1.3	15.9%	2.8
Packaged/Prepared Foods	1.2	11.2%	1.7	13.0%	3.1
Condiments	0.1	1.9%	0.1	2.7%	0.1
Vitamins	5.3	3.5%	5.9	2.0%	6.5
Herbs/Botanicals	3.5	5.8%	4.2	2.1%	4.6
Sports Nutrition	1.2	8.9%	1.5	6.2%	2.0
Minerals	1.1	10.3%	1.4	7.0%	2.0
Meal Supplements	1.7	6.4%	2.1	4.2%	2.5
Specialty/Other Supplements	1.0	19.0%	1.7	8.1%	2.5
Total	27.4	7.7%	34.2	6.1%	45.9
source: Nutrition Business Journal Industry Overview 2001					

The U.S. FDA has allowed claims on certain food products that contain specific amounts of compounds demonstrated to have positive health implications. These claims can only be made if products adhere to strict content regulations, and the nature of the claims is restricted substantially. Despite these restrictions, companies such as Quaker Oats have spent a great deal of money lobbying the government to include their product for health claims. These companies believe that the ability to make health claims will have a significant impact on consumers' decisions as to which brand to choose. A list of the compounds eligible for health claims in the U.S. along with their specific benefits and claim requirements are listed in Table 4. Of the twelve compounds eligible for health claims, five are associated with coronary heart disease, and another three are associated with cancers. This fact further demonstrates the difference in approach between the Japanese, and even the European, market with that of the U.S.

Canada

The Canadian marketplace for functional foods and nutraceuticals is difficult to quantify, based primarily on a lack of data. Statistics Canada does not track this industry itself, and most market research groups simply estimate 10% of the U.S. market and reduce this number somewhat for a perceived lower use of dietary supplements in Canada relative to the U.S. Annual sales of alternative medicines and natural products in Canada has been estimated to be as high as US$2 billion, but NBJ estimated the Canadian market in 1998 to be about US$1 billion. Table 5 below provides a detailed estimate of the Canadian market.

Table 4. U.S. Nutrition Labeling and Education Act approved health claims

Compound	Health Benefit	Requirements for Claims
Calcium	Osteoporosis	Must be “high in calcium” Must have more calcium than phosphorous
Sodium	Hypertension	Must be “low sodium”
Dietary fat	Cancer	Must be “low fat”
Dietary saturated fat and cholesterol	Coronary heart disease	Must be “low fat”, “low saturated fat”, “low cholesterol” Fish and game meats must be “extra lean”
Fiber-containing grain products, fruits, and vegetables	Cancer	Must be “low fat” Must be “good source of dietary fiber” without fortification
Fruits, vegetables, and grain products that contain soluble fiber	Coronary heart disease	At least 0.6g soluble fiber per serving without fortification Must be “low fat”, “low saturated fat”, “low cholesterol”
Fruits and vegetables	Cancer	Must be “low fat” and be a “good source of fiber, vitamin A, or vitamin C” without fortification
Folate	Neural tube birth defects	At least 40µg , less than 400µg per serving
Dietary sugar alcohol	Dental cavities	Must meet criteria for “sugar free” Must not lower plaque pH below 5.7
Dietary soluble fiber found in whole oats and psyllium seed husk	Coronary heart disease	At least 0.75g soluble oat fiber or at least 1.7g soluble psyllium seed husk fiber per serving
Soy protein	Coronary heart disease	Must be “low fat”, “low saturated fat”, “low cholesterol”
Plant sterol esters and plant stanol esters	Coronary heart disease	At least 0.65g plant sterol esters or at least 1.7g plant stanol esters per serving Must be “low saturated fat”, “low cholesterol” Must have less than 13g fat per 50g serving

Table 5. Canadian Nutritional Market Data

PRODUCT TYPE	ESTIMATE (US$ billions)
Nutraceuticals	0.13
Functional Foods	0.50
Vitamins/Minerals	0.04
Dietary Supplements	0.03
Medicinal Herbs	0.28
Sports Beverages	0.05
Total	**1.03**

source: Saskatchewan Nutraceuticals Network, www.nutranet.org, based on data from NBJ, 1998

The Canadian market for nutraceuticals and functional foods is believed to mirror the U.S. market in terms of popular categories of foods. The growth rate of the industry in Canada is believed to have been somewhat lower than in the more developed markets of Japan and Europe.

In summary, while the demand for nutraceuticals and functional foods worldwide is expected to grow by around 8% to 2005, there are some differences among the major regions. Japan's market will likely continue to grow in its traditional gut health and energy drink areas, while the U.S. and Canadian demand trends continue to emphasize heart health and cancer.

Supply Analysis

Supply analysis has not been documented often in industry reports concerning nutraceuticals and functional foods. From the supply side, providing lists of large multinational companies with well-recognized brands has been the usual manner of illustrating supply. This report will also evaluate the Canadian supply side of the functional foods industry from the perspective of both farmers and food manufacturers. To gain a regional perspective, Canada has been divided into five regions: the Maritime Provinces, Quebec, Ontario, the Prairie Provinces, and British Columbia. Primary production has also been divided into the following categories: Dairy & Poultry, Meats, Fruit & Vegetables, Grains & Oilseeds, Pulses & Legumes, Herbs & Botanicals.

Attempts were made to determine the contribution of Canadian food supply to nutraceuticals and functional foods. These calculations are then used to identify regional opportunities for food producers.

Where consumers' consciousness of nutritional health has been driving the demand for nutraceuticals and functional foods, adaptability on the part of food companies and strong scientific research and technology development have been driving the supply of products. As mentioned above, it is believed by some industry members that the functional foods industry is simply driven by nutrition marketing. While this does not appear to be the case, it is simple to understand how the communication between the supply side and the demand side of the industry is effected through marketing, both by companies, associations, research organizations, governments, and the popular media. Marketing is the means through which consumers are given an educated decision about which foods or nutritional supplements to choose.

The international market for functional foods that originated in Japan has sprouted many companies that have achieved varied levels of success in the industry. Some of the companies have dedicated their entire product line to functional foods and nutraceuticals, while others have developed functional product lines to supplement already successful activity in the food industry.

Table 6 lists selected major international functional food brands along with their manufacturer, region of operation, and food category. Despite the international success of many of these brands, it would not be possible to find them all on North American grocery shelves.

Table 6. Selected major international functional foods

Brand	Company	Country of origin	Food Category
Actimel	Danone	France	Dairy
Aviva	Novartis	Switzerland	bakery/cereals/drinks
Benecol	Raisio / McNeil	Finland / US	spreads/dairy
Danone Bio	Danone	France	Dairy
LC1	Nestle	Switzerland	Dairy
Take Control / Pro-activ	Unilever	France	Spreads
Tropicana Calcium	Tropicana	US	Drinks
Yakult	Yakult Honsha	Japan	Dairy
Ensemble / Smart Start	Kellogg	US	Cereals

Canadian production data is depicted in Table 7 below. The data represent total farm cash receipts from the year for each category regardless of functionality. Clear patterns of regional differences emerge. The Maritime region, while the smallest producer for almost all categories, adds significantly to Canada's food production by producing 15.3% of total fruits & vegetables, and 6.8% of the dairy & poultry products. Production in the other categories is negligible. Quebec represents a significant producer of dairy & poultry (33.0%), meats (14.3%), and fruits & vegetables (18.0%). Ontario is the country's largest region for dairy & poultry (33.7%) and fruits & vegetables (34.4%) and also produces 18.3% of Canada's meats and 15.6% of its grains & oilseeds. The Prairie region is a significant producer in all categories, but leads in meat production (62.1%), grains & oilseeds (78.4%), and legumes (94.7%). BC is a significant producer of fruits & vegetables (17.8%) and dairy & poultry (11.1%).

The herb & botanical data is uncertain as no published reports include all herbs and botanicals. Wild herb gatherers and small growers often do not report the value of crops, making this information difficult to obtain. This category is generally included in 'other crops' by Statistics Canada, though to assume that it occupies this entire category would be erroneous. The market for these products has been extrapolated from existing data and discussions with industry participants. It is believed that ginseng represents the largest single crop in this category, with about CAD$20 million produced in each of Ontario and BC. The largest areas of herb production are believed to be Ontario, BC, and the Prairies, though all regions have the capacity to produce herbs. A report for the Food Industry Branch of the BC Ministry of Agriculture, Food and Fisheries suggests that the BC herb and botanical industry represents approximately CAD$30 million in 2000.

Table 7. Canadian primary food production for 2000 (CAD$ millions)

Region	Dairy & Poultry	Meats	Fruit & Vegetables	Grain & Oilseed	Pulse & Legume	Herb & Botanical*	Total
Maritimes	414.2	165.3	375.6	12.1	0	10	977.2
Quebec	2021.8	1264.1	442.1	383.7	3.6	10	4125.3
Ontario	2066.2	1617.6	844.1	1112.4	29.5	40	5709.8
Prairies	950.2	5504.6	353.7	5583.3	597.6	20	13009.4
BC	679.4	310.6	435.7	33.8	0.4	30	1489.9
Canada	6131.8	8862.1	2451.2	7125.3	631.1	110	25311.6

* Herb & Botanical data estimated from ginseng production plus a portion of the "other crops" category
source: Canada Grains Council 2001 Statistical Handbook

Table 8. Canadian primary functional food production for 2000 (CAD$ millions)

Region	Dairy & Poultry	Meats	Fruit & Vegetables	Grain & Oilseed	Pulse & Legume	Herb & Botanical	Total
% functional	2.8%	0.1%	5.4%	5.2%	2.0%	90%	3.1%
Maritimes	11.6	0.2	20.3	0.6	0	9	41.7
Quebec	56.6	1.3	23.9	20.0	0.1	9	110.9
Ontario	57.8	1.6	45.6	57.8	0.6	36	199.4
Prairies	26.6	5.5	19.1	290.3	12.0	18	371.5
BC	19.0	0.3	23.5	1.8	0	27	71.6
Canada	171.7	8.8	132.4	370.5	12.7	99	795.1

Table 9. Canadian Total Manufactured Food Exports 1996 – 2000 (CAD$ millions)

Region	1996	1997	1998	1999	2000
Maritimes	1,661	1,813	2,083	2,555	2,667
Quebec	1,511	1,780	1,813	1,877	2,215
Ontario	3,189	3,476	3,800	4,124	4,273
Prairies	2,302	2,788	3,322	3,366	3,925
BC	1,034	1,087	1,032	1,061	1,138
Canada	9,699	10,944	12,049	12,983	14,218
Growth Rate		12.8%	10.1%	7.7%	9.5%
Production Growth rate		2.1%	-2.5%	-1.4%	10.6%

source: Statistica Canada website: www.statcan.ca

In order to estimate the proportion of Canadian production that is used in functional foods and nutraceuticals, food consumption data from the U.S. in Appendix B (Tables B3 and B4) are used.

Table B4 establishes the proportion of various food categories that were functional in the U.S. for 1999 and estimated for 2010. For the dairy & poultry category, 3.6% of dairy products in the U.S. are functional, but none of the poultry market is functional. An estimated 5% of the egg market is functional. Based on the relative proportions of production of these categories in Canada, the category Dairy & Poultry would be expected to be about 2.8% functional. Approximately half of grains and oilseeds production goes to producing feed for livestock, suggesting that only half is available for functional foods. U.S. breads and bakery sales suggest that this category is about 10.4% functional, making half that, or 5.2%, of Canadian raw materials for functional foods. Fruits and vegetables present a larger challenge as many of the processed foods and functional juices are based on fruits or vegetables as functional ingredients. Raw fruits and vegetables, represent approximately half the category, and are not marketed as functional. Therefore, half the functional beverages category (10.8% functional) is credited for fruits and vegetables, making this category 5.4% functional. Legumes and pulses represent an infrequent functional ingredient, allowing only 2% functionality for meat replacement proteins, and meats are not considered functional, with only rare exceptions, allowing 0.1% functionality. Herbs and botanicals include both medicinal and culinary herbs, though the medicinal herbs are believed to represent the bulk of this category. It has been estimated that 90% of this category would be used as functional ingredients or nutraceuticals.

Table 8 above presents the estimated functional components of each food category by Canadian region. The functional percentages have been applied to all Canadian regions equally. These data are dominated by the Grains & Oilseeds Prairie region, which contains over 35% of the total functional production of approximately CAD$800 million. Dairy, fruits & vegetables, and herbs & botanicals also represent functional opportunities of approximately CAD$100 million or more overall in Canada. These figures should be viewed as indicative data, and serve to suggest opportunities rather than be taken strictly as fact. The overall percentage of primary production estimated to be used for functional food production is 3.1%, which is very close to the 1999 functional penetration rate of food manufacturing of 3.4% (see Table B4).

The data in Table 8 does suggest specific regional opportunities for functional foods. The Maritimes region is the lowest producer of all regions, but has a comparative advantage in the fruits & vegetables category in particular, but also could in dairy & poultry. Quebec has a strong opportunity in dairy & poultry, with possibilities for fruits & vegetables. Ontario production could support functional ingredient development in dairy & poultry and fruits & vegetables. In the Prairies, the clear emphasis should be on grains and oilseeds, with some efforts on developing pulses and legumes for functional foods. BC is strong in fruits and vegetables, with some emphasis on dairy & poultry. All regions should evaluate their herb and botanical opportunities, as these products are extremely regional in nature and are primarily functional.

Food manufacturing data in Canada was obtained from Industry Canada and is presented in Appendix B, Tables B1 and B2. This data was not regionalized, but serves to indicate the level of overall production in the various food categories. Industry Canada divides food manufacturing into 20 main categories and beverages into 4 more. Table B1 presents 1990 and 1998 figures along with average annual growth rates for this time period and a projection to 2002 based on these annual growth rates. These 24 categories do not fit nicely into the six categories used for this study and some are not useful for evaluating functional food possibilities. Table B2 includes those categories that can be placed into the six categories used above and presents total for these categories for 1990 and

1998. Also included are investment figures for these categories for the same time period. Investment is believed to represent the amount of innovation and product development that is occurring within an industry; for the food industry, investment would lead to greater development of functional foods. Most categories showed flat to decreasing investment trends between 1990 and 1998, and only the grain and oilseed category showed significant increases in investment, driven by the 12.2% increases in the vegetable oil (except corn oil) category. These numbers suggest that Canadian food manufacturers are not spending more money on new equipment and product development than they were a decade ago, with the exception of a few categories. As functional foods and nutraceutical products are driven by investments in product research and technology development, these data do not suggest that Canadian manufacturers on the whole are moving in this direction.

Table 9 presents yearly Canadian food export data by region. These figures represent food manufacturing rather than primary production. The data here indicate that exports are growing faster than production, suggesting that Canadian food manufacturers must be more aware of trends in foreign markets in order to maximize the value of their production.

Approximately 300 Canadian companies have been identified that are believed to be involved in the development and production of functional ingredients or functional foods. Table A1 in Appendix A lists these companies by region and product category as above. At the end of the list many multinational companies are added that are also involved in the Canadian functional food industry. This appendix highlights the differences between regions in terms of number of companies associated with a particular product category. It is not certain whether all of the companies on the list are currently producing functional products.

From this table, current regional emphases can be drawn. In the Maritimes, ten of the 24 companies that fit the categories are in the fruit & vegetable category. This matches the region’s calculated advantage from Table 8 above. Eight more represent herbs & botanicals, though four are associated with seaweed or kelp products. The two grain & oilseed companies are involved at the end of the processing chain, and do not appear to be involved in primary production.

In Quebec, nine companies are in the herbs & botanicals and dairy & poultry categories each, and eight are involved with fruits and vegetables. This also corresponds to the region’s strength in terms of production.

Ontario has many companies in each of the grain & oilseed, fruit & vegetable, and herb & botanical categories, but has fewer companies in the dairy & poultry category than would be expected by its production. Ontario also represents the only region with a strong presence in the meat category, though it is uncertain how many functional products are being produced by the large meat companies such as J.M. Schneider and Maple Leaf.

The Prairie region is dominated by grain & oilseed and herb & botanical companies, with only a few from the dairy & poultry, legume, and fruit & vegetable categories. The only surprise here is the absence of companies involved in legume processing or manufacturing. Pulse Canada officials have stated that legumes are among the best opportunities for Prairie farmers and processors, though for them to be considered functional, more research on protein and lipid profiling must be done.

BC is dominated by herb & botanical companies, with a few companies in the fruit & vegetable and grain & oilseed markets. Surprising is the lack of fruit & vegetable-based companies, given the province's supportive climate for fruit growing.

Generally, the Canadian companies involved in nutraceuticals and functional foods are located in the region where the production opportunities are the greatest. This is representative of the fast-growing cottage industry for healthy ingredients, and the propensity for regions to utilize their strengths.

Overall, the production data suggests that Canada's greatest opportunity for functional food development lies in grains & oilseeds, as this category represents the largest contribution to functional foods and nutraceuticals, though regional opportunities exist in other areas. As Canadian exports continue to grow, demand trends from foreign markets must be carefully monitored.

Research Activities

Feeding the supply of functional ingredients for the world's growing appetite for healthy foods are technological advances in the areas of identification, extraction, and processing of functional ingredients. Researchers both from industry and within public research institutes and universities have recently increased their focus on bioactive ingredients found in plants (phytochemicals) in particular and have developed improved processes for extracting, testing, and processing these ingredients for use in foods. The result of this heightened research activity has been the introduction of many small technology-based companies involved in the functional foods and nutraceuticals industry. A 1998 report of the Manitoba market for nutraceuticals and functional foods estimated that 55% of the food, 36% of the pharmaceutical, and 90% of the biotechnology industries are actively researching phytochemicals (Manitoba Phytochemical Nutraceutical Market Study, 1998).

Table 10 presents data on the amount of research being committed by various industries related to functional foods and nutraceuticals. Interestingly, both agricultural and food manufacturing research have been somewhat stagnant, and have lost ground relative to the growth in total industrial R&D. Table 11 suggests that the bulk of the growth in industrial R&D expenditures has occurred in Ontario, with some growth in British Columbia and Quebec. The Maritimes region and the Prairie Provinces did not exhibit growth in industrial R&D between 1997 and 1999.

Table 10. Industrial Research and Development Expenditures in Canada (CAD$ millions)

Category	1997	1998	1999	2000	2001
Agriculture	42	51	43	45	45
Food Manufacturing	84	87	95	92	98
Pharmaceuticals and Medicine	502	548	625	665	731
Total Industrial R&D	8781	9623	9820	10,862	11,656

Source: Statistics Canada GERD Report 2000

Table 11. Total Industrial Research by Region 1997-1999 (CAD$ millions)

Region	1997	1998	1999
Maritimes	108	122	107
Quebec	2534	2801	2987
Ontario	4845	5317	5444
Prairies	720	781	635
Canada	8207	9021	9175

source: Statistics Canada Science Statistics Service Bulletin

Table 12. Estimated Total Canadian Research Activities 1998 (CAD$ millions)

Region	Industrial	Health Sciences	Natural Sciences and Engineering	Social Sciences and Humanities	Higher Education	Total
Maritimes	122	75	198	51	325	517
Quebec	2801	490	960	204	1653	4028
Ontario	5317	685	1293	286	2264	7224
Prairies	781	221	473	113	807	1614
BC	602	106	283	79	468	1007
Canada	9623	1577	3208	732	5517	14,390

source: Statistics Canada reports: GERD 2000, Science Statistics Service Bulletin, Estimations of R&D Expenditures in the Higher Education Sector

Numerous research facilities have been established over the past five years across Canada to address the opportunities provided by the nutraceutical industry. Table A2 of Appendix A lists many of the centers in Canada involved in research on nutraceuticals and functional foods. In addition, many associations have also been established to help companies and researchers coordinate their activities. Many of these associations are listed in Table A3 of Appendix A.

Coordination of this research would appear to be a key factor for the nutraceutical and functional food industry in Canada. Research is being undertaken in medical and pharmaceutical facilities in addition to food science, plant science, and human ecology departments. For example, the recently funded National Centre for Applied Research in Medicine (NCARM) at the St. Boniface Hospital in Winnipeg will be expected to carry out clinical trials for products or compounds that may be developed elsewhere. Officials at the University of Manitoba, which is closely involved with the St. Boniface Centre, believe that NCARM will support the University's proposed new Nutraceuticals and Functional Foods Centre. This center will research all aspects of nutraceutical production and processing. That includes determining whether certain plants contain compounds that actually have health benefits, discovering what those compounds are, developing methods for extracting them without affecting their activity, developing crop varieties that contain these compounds, and determining how these crops should be grown in various prairie conditions.

While each of the research centers are focused on specific areas of agriculture that are local to the center, it is believed that these facilities must coordinate their efforts nationally in order to achieve maximum gain. For example, discoveries that are occurring at the Functional Foods and Nutraceuticals Research Institute in Laval on dairy milk may have significant impact on prairie agriculture, and the development of livestock feed, and so should be shared with the facilities in the prairie region.

Despite the growing emphasis on research exhibited by governments, universities, and industry, most industry participants believe that much more must be done. Most believe that more science is needed in support of health benefits of food products.

Among the challenges faced by the industry is the frequent negative publicity due to health risks of certain products. This publicity arises from the misuse of products or from the lack of available information regarding the use of certain products. In many of these cases, the proper therapeutic dose of phytochemicals or biologicals has not been clinically determined, and problems have occurred. The industry has shown a desire to deal with these incidents by calling for more research in support of product development. Almost all industry participants interviewed expressed their belief in the need for scientific evidence for product use and health claims.

Despite the recognized need for scientific research, consumers have become more cautious with respect to the contents, health claims, and effects of combinations of nutraceuticals because of a few well-publicized incidents. This has had a direct impact on demand for many products unrelated to the incidents. With increased research into the activity of biological compounds, delivery instructions can be improved, health risk minimized, and industry demand will increase.

Some industry participants believe that high levels of required research simply places unnecessary barriers on the industry, rendering it accessible only to the larger food and pharmaceutical companies. Others argue that because the purpose of nutraceuticals and functional foods is to help prevent disease rather than to cure it, placing the same regulations on nutraceutical ingredients as is placed on drugs (i.e. clinical trials) is not appropriate. It is argued that for preventative therapies, clinical trials on disease prevention therapies could require perhaps decades of observation. While it may be true that smaller and mid-sized companies cannot afford clinical trials, particularly on products that cannot be patented, researchers firmly believe that additional research is necessary to develop a strong nutraceutical and functional food industry in Canada.

A prime area for research is in the testing of combinations of nutraceuticals. Many compounds are believed to be healthy on their own, but effects may be reduced or multiplied through the addition of another functional compound.

Appendix A Table A4 lists many of the bioactive compounds currently being investigated for use in nutraceuticals and functional foods by researchers.

Regulatory Environment

Labeling continues to be a significant issue for this industry. Health Canada historically has not allowed any foods to make health claims on their labels. Health claims have been allowed for drugs that have a registered drug identification number (DIN). The rationale for this legislation has been that foods primarily have nutritive value and are not expected to undergo the rigorous efficacy testing required of drugs. With the advent of nutraceuticals and functional foods, the clear distinction between food and drugs no longer exists. In the U.S., the FDA has allowed claims on foods containing sufficient amounts of any of twelve functional compounds recognized by that body to confer specific health benefits (see Table 4 above). Health Canada has recently begun reviewing the twelve U.S. claims, and has proposed support for five claims:

- sodium and hypertension,
- calcium and osteoporosis,
- saturated and *trans* fat and cholesterol and coronary heart disease,
- fruits & vegetables and cancer, and
- sugar alcohols and dental caries.

Three other claims are also expected to receive support by the end of the year:

- folate and neural tube defects,
- fibre-containing grain products, fruits and vegetables and cancer, and
- fruits, vegetables and grain products that contain fibre, particularly soluble fibre and risk of coronary heart disease.

The delay in allowing health claims has led to varying decisions regarding commercialization of functional foods. Companies interested in developing or producing functional foods may have been dissuaded from doing so because they would not be able to make health claims on their packaging. Without marketing the specific health benefits, it is believed by these companies that consumers would be less likely to pay a premium for these products.

III. POTENTIAL BENEFITS TO CANADIAN FARMERS

Value to Canadian Farmers

The analysis presented in the preceding section suggests that there is in the order of CAD$800 million production value in nutraceuticals and functional foods annually in Canada. In order to verify this number, a second approach will be used.

Using an economic value chain model, the value of the nutraceuticals and functional foods industry to farmers can be estimated. According to Statistics Canada, the apparent domestic market for food manufacturing in 2000 was CAD$49.7 billion. Adding the exports of $14.3 billion, and subtracting the imports of $11.0 billion, approximately $53 billion of food manufacturing occurred in Canada in 2000. The U.S. functional penetration data provided in Table B4 in Appendix B suggests that in the U.S., 3.4% of food is considered functional. Assuming that the functional penetration rate would be similar in Canada, the manufacturing numbers above suggest that $1.8 billion of the total manufacturing food is functional. It is estimated in the value chain analysis below that the value of the primary production represents from 20% to 50% of the manufacturing value of a functional food product, suggesting that the value of functional foods to Canadian farmers is between $360 million and $900 million. This range includes the previous estimate of $800 million, suggesting that this figure is realistic.

Of the greater than $50 billion of food manufacturing that occurs in Canada, imported inputs represent $5.4 billion. A further $11 billion in crop and animal production inputs were exported, some of which would be used in functional foods. If a 3% anticipated penetration rate were applied to the production trade difference of $5.6 billion, approximately $150 million could be added to the range above.

A third way to estimate the value of functional foods and nutraceuticals to farmers would be to apply the value chain model to the Canadian demand estimates. From Table 5 above, the value of the Canadian nutraceuticals and functional food industry is approximately US$1 billion, or CAD$1.6 billion. Applying the 5-25% range estimate for the value to primary producers from Figure 2 below, the Canadian nutraceuticals and functional foods market carries a value of $80 - $400 million to farmers. The food manufacturing trade balance of $3.32 billion would contribute another $50 million, assuming a functional penetration of 3.4% and a contribution of producers of 50% to the value of manufacturers output. The production trade balance of $5.6 billion would contribute another $150 million, assuming a functional penetration of approximately 3%. The total value using this rationale ranges from $280 to $600 million.

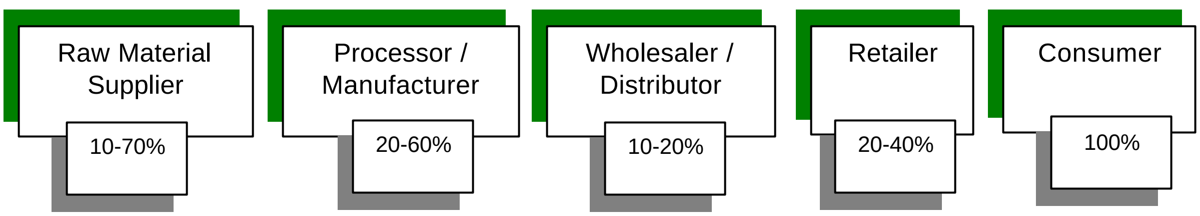
All three methods provide a value for the nutraceutical and functional food industry to Canadian farmers of between $280 million and $1 billion. The remainder of the value from the functional food and nutraceuticals industry is shared by retailers, distribution, processors, concept marketers and product commercialization, primary producers, research and technology development and feed processors.

Economic Value Chain Analysis

The value chain consists of a number of firms and the relationships between those firms that govern the flow of a product from the production of the raw material to processing to manufacturing and distribution to the consumer.

A traditional food industry value chain consists of the Farmer, Processor, Wholesaler, Retailer and Consumer, and is presented in Figure 1 below.

Figure 1. Economic Value Chain Model for the Food Industry.



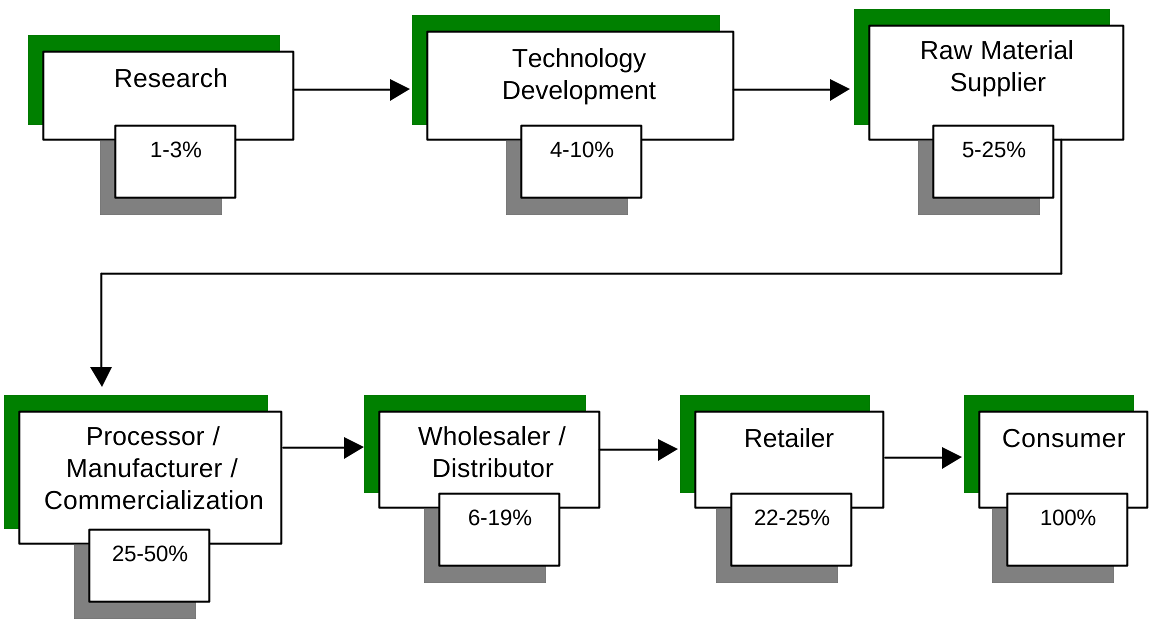
Note: The % indicated represents the estimated % of the consumer dollar that is extracted at that link of the chain.

The ranges in the model indicate the amount of processing that is involved in the manufacture of various foods. The more processing required, the greater the percentage in the processor/manufacturer box, and the less available for the raw material supplier. The range for the wholesaler/distributor depends on the transportation and storage requirements of the products. Frozen storage and transport would require a greater contribution to wholesalers, distributors, and retailers than would bulk dry goods. The value extracted by retailers would also be driven by the perishable nature of the product. To illustrate the variability in the food value chain, meat products will be compared with breads and bakery items. The value chain for unprocessed meat products would include 23% for retailers, 11% for wholesalers, and 14% for manufacturers, leaving 52% for raw materials producers. The bread and bakery products value chain would provide 40% for retailers, 18% for wholesalers, 17% for manufacturers, 5% for grain processors leaving only 20% for raw materials suppliers.

The value chain for functional foods and nutraceuticals is believed to more closely resemble that for highly processed foods. Because nutraceutical and functional food products have higher value than conventional foods, it is expected that the contribution to the suppliers of raw materials would decrease. Furthermore, this value chain has some important additional components such as research, technology development and technology commercialization. The value chain for this industry is illustrated in Figure 2. Ranges in this figure reflect the differences in the amount of operational activity at each stage as well as the differences in the types of food products being manufactured. The greater the activity required, the higher the percentage.

The industry is characterized by considerable research activities assessing the impacts of foods and food components on human health. Technology development is critical to finding new ways and methods to process food and food ingredients. The end user must ultimately pay for both of these links in the value chain through the cost of goods or through government taxes. Research and development activities for nutraceuticals and functional foods are resource intensive and require large amounts of financial resources as well as time for research and technology development. An additional link in the value chain is the commercialization activities required before the production and marketing stages. The value chain is sustainable only if all stages can extract sufficient value to cover all costs and earn a reasonable profit on its investments.

Figure 2. Economic Value Chain Model for Functional Food and Nutraceutical Industry



Note: The % indicated represents the estimated % of the consumer dollar that is extracted at that link of the chain.

The reduced percentage received by raw material suppliers reflects the other value added components in the value chain. Despite the fact that most functional food or nutraceutical products have higher prices than conventional foods, there may be no more value in the chain for suppliers of raw materials than there is under the conventional food model.

Both the pharmaceutical and food processing and retailing sectors are highly concentrated, meaning that very few firms control the majority of the market. This concentration of the processing, manufacturing and distribution industries affects market access. The concentrated industries are usually able to maintain market power because of barriers to entry such as technology or economies of scale.

Functional Foods Value Chain: Functional foods are linked to food processor's and retailer's food product line and compete with conventional foods for market share and shelf space.

Nutraceutical Value Chain: Nutraceuticals compete in the vitamin and pharmaceutical markets and therefore compete in these markets for distribution and shelf space.

These industry structures affect the ability of smaller processors and farm producers to extract value from new food products. Unless the new companies are target niche markets or have control of patented technology, it is difficult to produce competitive products. The economies of scale of large firms and their influence in the supply chain create significant barriers of entry into the mainstream food markets.

Alternative Value Chain Structures

There are many alternative structures of the value chain that could facilitate the necessary transactions between the functions. Independent firms could carry out each value chain function. They would interact with other steps in the value chain using production contracts. Alternatively, one firm could vertically integrate and perform all of the functions.

In order to assess the value chain, three case studies with alternative structures were evaluated:

- a consortium of researchers;
- a small to mid-sized processing organization, recently established, focused within the functional foods and nutraceutical industry sector; and,
- a egg processing organization, which has evolved its business to include functional food initiatives.

The following pages describe the case studies and illustrate the variations in the value chain for each structure. The estimated percentages illustrated in the charts below are considered midpoints of ranges. The value chain will vary considerably even under the same business structure based on the nature of the food product and the level of processing required.

Case Studies

1. The Flax Consortium

Flax has long been known for its health implications outside of its simple nutritive benefits. The health benefits of flax have made it an attractive ingredient in functional foods. In addition, the opportunity exists to develop processes to extract the biologically active compounds from the flaxseed for combating various human and animal diseases. The Saskatchewan based Flax Consortium was established to develop this opportunity.

The Flax Consortium was established in 1995 as a research collaboration between the Saskatoon Research Centre of Agriculture and Agri-food Canada (AAFC), University of Saskatchewan Technologies Inc., and the University of Western Ontario and the London Health Sciences Centre. The objective of the consortium was to extract, purify, and study the use of flax lignans for the prevention and treatment of certain diseases. Flax lignans are phytochemicals that are believed to have the potential to reduce the risk of several diseases in humans and animals including diabetes mellitus, hypertension, hypercholesterolemic atherosclerosis, and lupus nephritis. The principal active component in flax is the lignan secoisolariciresinol diglucoside (SDG), which has been shown to have a beneficial effect on many diseases. In addition, SDG has been found to be a potent antioxidant and is a known precursor of the mammalian lignans, enterolactone and enterodiol. These compounds have other pharmacological properties including phytoestrogen properties similar to isoflavones. Flaxseed has proven to be the most abundant source for this plant lignan. The Consortium has spent seven years refining the research, applying for patents and searching for strategic partners.

Technologies developed and patented by the Flax Consortium can generate products that complement and extend the nutraceutical properties ascribed to ground flaxseed, while eliminating many of the drawbacks associated with the consumption of whole flaxseed such as the high caloric content (flaxseed is greater than 40 per cent oil) and its laxative effect. The processing of flaxseed generally produces linseed oil and linseed meal for human and animal consumption. During the past five years, the Consortium's research has resulted in a number of process and use patents and patent applications.

The Flax Consortium has entered into an agreement with Archer Daniels Midland (ADM), a world leader in the processing of flax. ADM, with annual net sales of $18.6 billion, is the world's largest processor of soybeans, corn, wheat and cocoa and a leader in soy meal and oil, ethanol, high fructose corn syrup and flour. In the agreement, ADM carries the exclusive licensing for flax lignan technology developed by the Consortium. The license gives ADM an exclusive worldwide right to produce and sell a flax lignan complex or purified flax lignan for use as an active ingredient in functional foods, nutraceuticals, pharmaceuticals, animal feed products, and veterinary products. The patents and patent applications owned by the Flax Consortium have been licensed to ADM under the agreement.

Patents Issued:
- Process for Extracting Lignans from Flaxseed
- Purified SDG as an Antioxidant
- Method for Treatment of Lupus Nephritis

Patents Pending:
- Process for Extracting and Purifying Lignans and Cinnamic Acid Derivatives from Flaxseed - International PCT filing pending.
- Purified SDG as an Antioxidant - Canadian patent pending.
- Method for Treatment of Lupus Nephritis - Canadian patent pending.
- A Complex Containing Lignan, Phenolic and Aliphatic Substances from Flax and Process for Preparing - US patent pending.

G. Allen Andreas, Chairman and Chief Executive of Archer Daniels Midland has stated that “we are committed to unlocking the potential of nature, and believe our prudent approach to technology investment will deliver attractive returns over the long term."

The Flax Consortium technology is a process for extracting from flax meal, a complex that contains SDG, phenolic acids - including cinnamic acid derivatives, and hydroxy-methyl glutaric acid (HMGA). The complex can be produced either in the form of a liquid concentrate or a dried powder. The dried powder contains approximately 50% SDG, 25% phenolic acids, and up to 10% HMGA. This process isolates SDG in its native form, reducing processing costs. Another technology is a process for the extraction, concentration, and purification of SDG from flax. This process can be used to produce a powdered isolate containing SDG in a purity greater than 95%. Both of these technologies can be directly applied to oil-free flax meal available from flaxseed crushers.

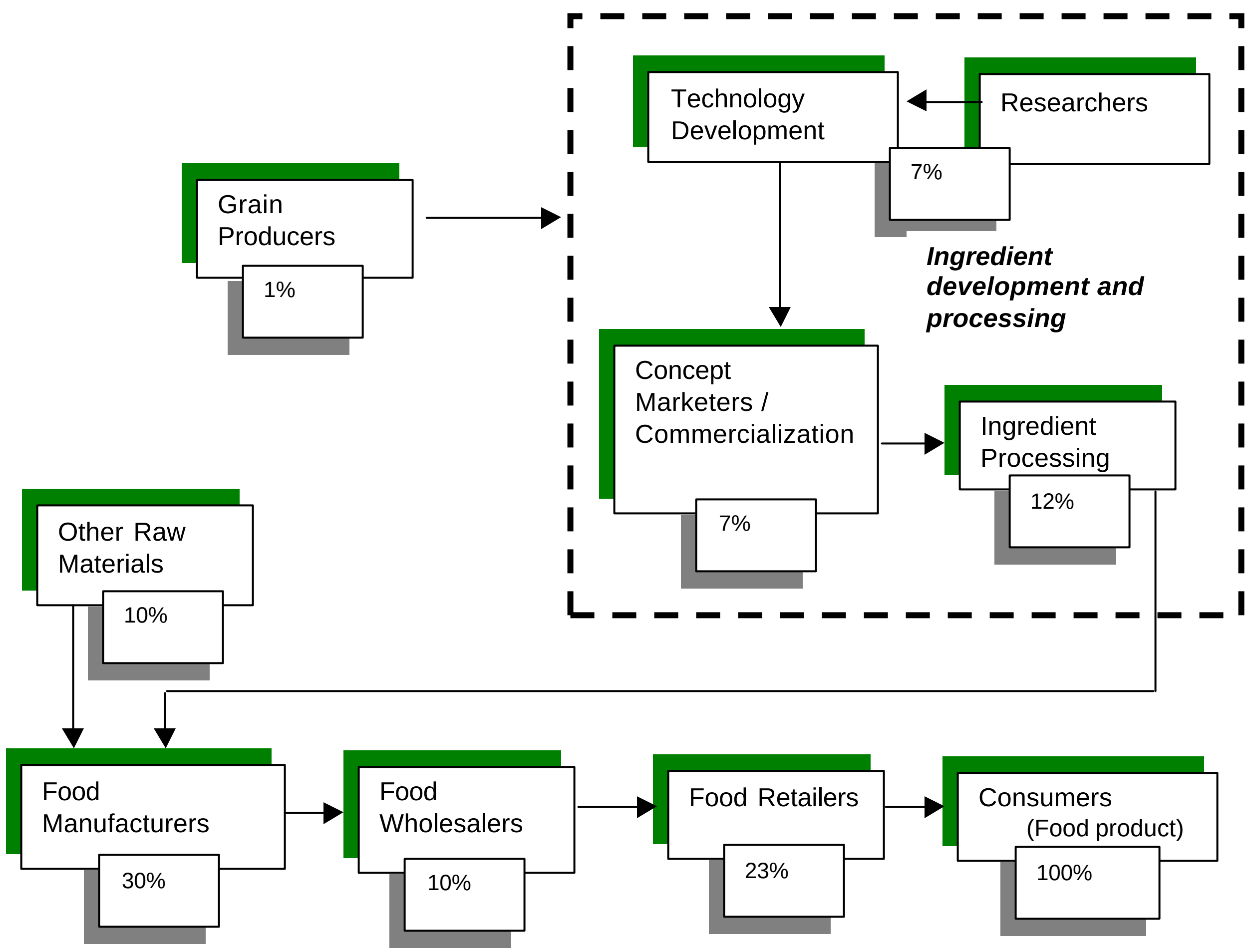
Canadian government officials have stated that this new commercial use for flax meal should help stabilize the market for flax growers (Human Resources Development Canada website). Dr. Neil Westcott, head of BioProducts and Processing at the Saskatoon Research Centre, stated that a new commercial use for flax meal could lead to more stable prices and markets for growers. A consistent demand for the product would also provide for a steadier flax market by leveling out the swings commonly seen in commodity flax.

In the context of the value chain models presented previously in this report, the Flax Consortium has positioned itself as a technologically capable organization for production and processing development of a highly functional ingredient for foods and nutraceuticals. While the consortium is not involved in the traditional value chain of grower – processor – manufacturer – wholesaler – retailer – consumer, potential value has been added to the processing of flax. The consortium will be compensated for this value by receiving royalties from ADM. As development into specific varieties of flax continues, growers may have a chance to receive some of the added value through contract premiums for producing the specific varieties with desirable characteristics.

The Flax Consortium is a good example of coordination across jurisdictions resulting in the commercialization of new technologies.

Figure 3 illustrates the value extracted by companies like the Flax Consortium and its partner ADM (enclosed box), as well as the value for other participants in the value chain. In this case, raw materials suppliers receive value near the low end of the range from Figure 2, as do wholesalers. The value added in this model goes primarily to technology development, commercialization, and ingredient processing for flax lignan, which may be sold as an ingredient to an existing food product. This value will flow through the food manufacturer who would be adding the lignan to its other food products. The food manufacturer would also realize a higher value than a traditional food product.

Figure 3. Value Chain for a New Food Ingredient



Note: all figures represent consultant's estimates

The price paid for the other raw products and processing would not change. In fact, the percent of value to the raw material and processor would drop. This incremental value is also distributed through the end of the value chain simply through the sale of a higher priced product. The raw material producers, including flax growers, are not likely to participate in the added value unless contract growing is initiated. They would realize a marginal value from the flax component used by the flax consortium. The commercialization component of the chain includes the cost of clinical trials and other efficacy experimentation.

2. Bioriginal Food & Science Corp.

Bioriginal Food & Science Corp., formed in 1993 in Saskatoon, Saskatchewan, claims to be a world leading supplier of essential fatty acids (EFA). Bioriginal has over 50 employees and is focused on the development, production, and marketing of natural plant products with therapeutic benefits. Bioriginal is a vertically integrated company that is involved in research, sourcing, processing, and distribution activities related to EFAs.

Bioriginal's core product line is oils high in essential fatty acids. These oils are processed from a variety of sources, including borage, evening primrose, black currant, flax, pumpkin, hemp and fish. Its products are sold in soft gel capsules, bottles or as bulk oils. They can be formulated or custom-packaged to meet the specific needs of customers.

Research with EFA supplementation has shown potential in a number of disease conditions, including rheumatoid arthritis, skin conditions, high blood cholesterol, coronary heart disease, diabetic neuropathy, high blood pressure, high blood triglycerides, and cancer. Bioriginal is currently participating in a number of clinical trials across Canada to determine the therapeutic benefit of flax-based products. Studies have also been conducted using flax in animal feed to increase the levels of omega-3 fatty acids in eggs and meat.

Bioriginal serves wholesale customers in five key product areas:
- Nutritional Supplements
- Cosmetics
- Pet and Veterinary
- Over-the-Counter Pharmaceuticals
- Functional Foods

Bioriginal’s essential fatty acid oil products include:
- borage oil (containing up to 24% GLA);
- evening primrose oil (containing up to 10% GLA);
- flaxseed oil (containing up to 55% ALA);
- fish oils (containing varying amounts of EPA and DHA); and,
- other specialty nutritional oils.

Research is a key component linked closely to Bioriginal's processing operations. Bioriginal employs several scientists that are to the University of Saskatchewan and Innovation Place, a research centre for agricultural biotechnology; Agriculture and Agri-Food Canada; the National Research Council / Plant Biotechnology Institute; the Saskatchewan Research Council; and the Protein Oil & Starch Pilot Plant.

All oils are GMO free and independently tested for pesticides, herbicides, heavy metals, and PCBs. Seed oils are expeller pressed without hexane or other harsh chemicals. All products are manufactured to Canadian pharmaceutical grade GMP (Good Manufacturing Practices) and WHO (World Health Organization) Codex standards for edible oil safety.

Because of the multiple packaging of its products and the variety of customers, Bioriginal finds itself in a number of locations in the value chain. By marketing its oil products as a functional ingredient, Bioriginal occupies a spot as a primary processor in the production of functional foods containing its ingredients. In this spot, Bioriginal adds value through the extraction and processing of a valuable compound found in a variety of primarily agricultural sources.

A second important value chain relevant to this study that Bioriginal employs is that of nutraceuticals. Bioriginal acts as a manufacturer of nutraceutical products that sells to companies that market these products under their own brand names.

Key success factors include:

- focus on quality EFAs, herbs, and other nutritional supplements;
- establishment of long-term relationships with growers dedicated to producing top quality inputs. The company’s ability to contract with hundreds of carefully selected farmers, primarily in Western Canada, is viewed as one of its natural and major advantages. In 1999, Bioriginal had almost 400 farmers producing borage, flax, and herbal crops;
- active in research and development, creating new products to meet the specific needs of their various customers; and,
- development of relationships with companies throughout the world. Bioriginal is sourcing from various regions around the globe and has a manufacturing presence in Asia and Europe. These relationships also provide Bioriginal with international marketing information.

Bioriginal’s goal is to become the sourcing leader of EFA and herbal products world-wide and the primary source of all EFA products in North America. Bioriginal has recognized the need to market the benefits of EFAs to doctors and other members of the medical profession. Studies suggest that in North America, only 40% of the population believes that they need vitamin supplements, 67% would take them if recommended by pharmacists, and 84% if recommended by doctors.

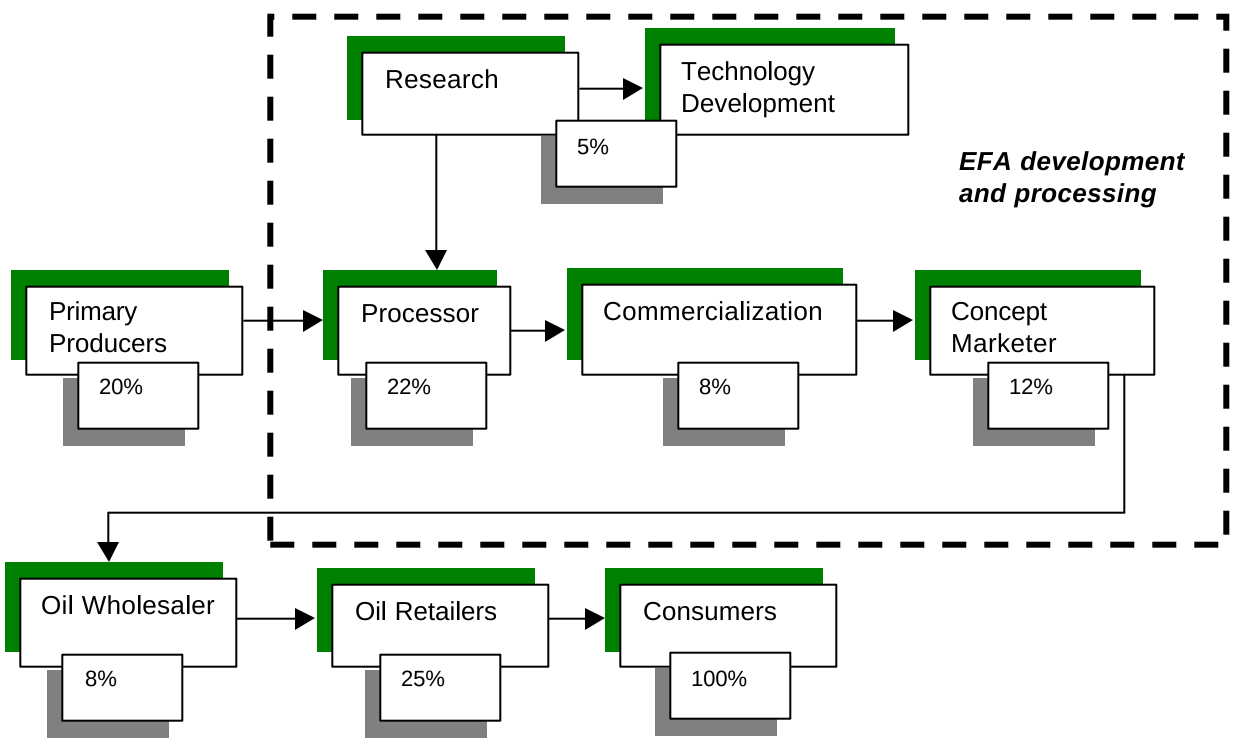
Bioriginal grew at a rate in excess of 25% in 1998 according to CFO Joe Vidal. This compares very favourably to the EFA market growth for the same period of less than 10%. The growth has come as a result of $9.2 million in investment from employees and external sources in 1999. The new investment has allowed Bioriginal to expand their internal R&D activities, thereby expanding their technical capabilities.

Bioriginal is selling a new health product to the consumer. This means that they are extracting additional dollars of value from the consumer that was previously not being received from consumers.

Figure 4 illustrates the value chain for EFA oil products. Activities undertaken by companies such as Bioriginal are included in the enclosed box. Over 50% of the value is extracted by these companies, and only 15% is passed back to the primary producers, despite the emphasis on contract production. As the product is highly processed, most of the value occurs after the product has left the producer's hands. The value passed to the producer is lower for the commodity products such as flax and higher for less common crops that are more difficult to grow such as borage.

This model does not apply to the use of EFA products as a functional ingredient in foods. Such a model would include a food manufacturer stage and other raw materials suppliers, similar to Figure 3 above.

Figure 4. Value Chain for EFA Products



Note: all figures represent consultant's estimates

3. Burnbrae Farms

Burnbrae Farms is a family owned and operated group of companies dedicated to the production, processing and distribution of quality table eggs and egg products throughout Canada. Incorporated in 1959, with its head office in Lyn, Ontario, Burnbrae is involved in egg production, grading, processing, packaging, and distribution. It employs approximately 400 people and sells eggs and egg products to many of the major grocery chains and large bakery customers in Ontario, Quebec and Manitoba. It continues to be privately owned and operated by the Hudson family.

Burnbrae has focused on new product development, and has increased research and development expenditures. In existence since 1893, Burnbrae has evolved into one of Canada's leading producers of eggs. In 1973, Burnbrae entered the "further processing" market by establishing a plant in Lyn to break, pasteurize and package eggs that are surplus to the table egg market and sold to the bakery, hotel, restaurant and industrial trade. Since that time, Burnbrae has undergone vertical integration through the purchase of processing plants in Quebec and grading facilities in Quebec, Ontario, and Manitoba. Burnbrae does not produce eggs for all its grading and processing facilities, but purchases eggs from farms throughout Canada. Burnbrae Farms has become a leader in Canadian Agribusiness through its award winning new product innovation. Four years in a row Burnbrae has been nominated for a Canadian Grand Prix New Product Award by the Canadian Council of Grocery Distributors and Canadian Grocer Magazine. Grand Prix products include Naturegg Omega 3 (winner 1997), Naturegg Simply Egg Whites (nominated 1997), Naturegg Break Free (winner in 2 categories 1999 including All-Canadian new product of the year) and Naturegg Omega Pro (winner 2000). Burnbrae's products also carry the Health Check logo, having been accepted into the Heart and Stroke Health Check program.

Burnbrae Farms' products fall under two general categories: shell eggs and liquid eggs, both that contain functional products. All of the functional products are marketed under the Naturegg brand. Liquid products include Simply Egg Whites, a fat and cholesterol free product, Break Free, a low fat and cholesterol product, and Omega Pro, which contains 40% of the recommended daily allowance of omega-3 polyunsaturated fatty acids in a reduced fat and cholesterol product. Functional shell egg products under the Naturegg brand include Omega 3, with 20% the RDA of omega-3 fatty acids, Free Run, eggs produced by free range chickens fed without medications, additives, preservatives, antibiotics, or hormones, Organic Eggs, similar to Free Run, VitaPlus, eggs enriched in Vitamin E and B12 as well as Folic Acid, and Prestige top quality eggs. Enrichment in the eggs in each product comes as a result of additions to the hen feed.

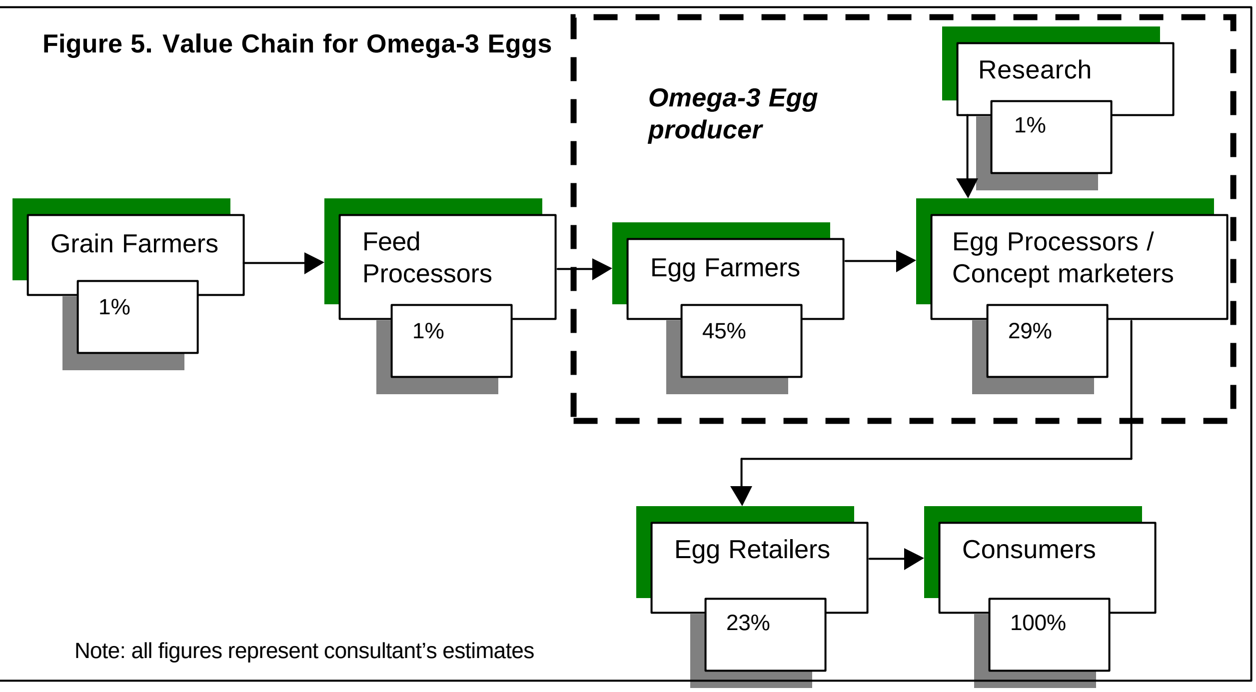
In terms of the value chain analysis, Burnbrae encompasses the farmer, processor, manufacturer, and distributor roles for its consumer products, and the farmer and processor roles as a supplier of functional ingredients. Because the functional products produced by Burnbrae Farms are a result of specific ingredients in the feed, a whole new set of value chain levels are required before the production of the eggs. This additional value chain must include the farmer, processors, and manufacturers of the feed products used in Burnbrae's functional foods.

Added value in the value ranges from $1.00 - $1.50 per dozen eggs. This added value is shared with retailers and wholesalers because they continue to extract a percentage of the retail and wholesale price. In addition, the processor who coordinates and markets this concept of high omega eggs is able to extract value for their efforts and market development.

The feed processors may receive a small amount for adding flaxseed to the feed ration. There is a new market for flaxseed albeit currently small, therefore strengthening the market for a Canadian crop. As the market develops further there may be a need for specialized flaxseed with characteristics that provide more of the beneficial EFA's. In the future, flaxseed contracts with higher value than commodity flaxseed could be offered to grain farmers willing and able to grow the specialized flaxseed. Of greater significance is the potential for egg farmers to participate directly in a new functional food market. By changing the feed rations for their chickens, Omega-3 enriched eggs are being produced and consumers are willing to pay a higher amount. This additional value is then shared along the value chain including a portion for primary producers.

A value-chain model for omega-3 eggs is illustrated in Figure 5. The majority of the added value is extracted by egg farmers and concept marketers. While these processes are both part of the involvement of egg producers like Burnbrae (see enclosed box), omega-3 eggs are also purchased from independent egg farmers.

Figure 5. Value Chain for Omega-3 Eggs



Note: all figures represent consultant's estimates

Opportunities for Canadian Agriculture

Farmers continue to experiment with alternatives to diversify from production of low-priced bulk commodities into higher value crops and livestock. Many have also explored opportunities for adding more value to what they grow. At the same time, there is a concerted effort by federal, provincial and municipal governments and community groups to promote and foster industries that will help restore our rural communities.

As the case studies clearly demonstrate, farmers often stand to gain very little from the value chain for nutraceuticals and functional foods. In the case of Bioriginal, however, significantly more of the value is provided to the farmer. The primary reason for the difference between this case and the others is that Bioriginal forms contracts with carefully selected farmers for its oils. Because of the farmers' involvement in and commitment to the process, more value is extracted. Most industry participants believe that agriculture does not stand to gain much from the growing nutraceutical and functional food market because farmers produce commodities whose price is largely dictated by the worldwide marketplace.

The nutraceuticals and functional foods markets will certainly impact farmers in a number of positive ways.

- Nutraceuticals are creating and developing markets for products that were previously unfavourable. In Canada, many wild herbs and berries are believed to have medicinal value, and markets for these products are developing rapidly. Ginseng cultivation is an example of this. Ginseng grows naturally in BC, but until recently, was rarely considered a useful crop. As the market for Canadian ginseng developed, prices rose, and farmers were rewarded. By growing a product that has a growing market, farmers are more certain of their ability to sell their product at a good price. However, market saturation and oversupply often limits the opportunities to the farming sector.

- The growing demand for nutraceuticals and functional foods also has the effect of expanding the market for certain commodities (e.g. flax, oats) or preventing a market from receding. Product commodity prices will continue to fluctuate, but the stronger the demand, the more stable the prices will be for the product. Through the development of many markets for flax, primarily by processors and manufacturers, flax producers can expect to benefit. The same would apply for any commodity.

- Price stability due to expanded markets for product or to the ability to develop production contracts with processors or manufacturers will benefit farmers greatly by providing them with a more certain estimate of revenue. This will allow them to better match costs of inputs with expected revenues from production.

- Another potential market expansion occurs when value is identified in a waste product. For example, Burcon NutraScience has developed a process to make canola meal into a high protein source for human consumption. This processing would generate a high value market for canola meal where previously only a low value market (protein supplement for livestock feed) existed.

- There are also more active ways to increase value for farmers. Through participation in the development of functional food markets for their products, farmers could add good value. Three specific opportunities have been identified for farmers to add value. They will be discussed individually below.

    1. Develop contractual arrangements with processors or manufacturers as is the case with Bioriginal. Contractual agreements would ensure a market for farmers product, and would guarantee a price. Assuming that the product will be of greater value than a non-functional product, the farmer would receive a premium for producing to the processor's or manufacturer's specifications. These types of agreements are expected to increase in popularity as the functional foods markets develop. Farmers must become aware of their capabilities and seek out appropriate partners.

    2. Expand operations to include first-level processing, for example, milling or active compound extraction. A farmer looking to vertically integrate down the value chain must be aware of the specific active compounds in the product, and must have the capability to develop methods for processing the raw materials in such a way as to add value. Generally, this vertical integration would involve a partnership among farmers to spread the risk, though this is certainly not necessary.

    3. Form associations with technology-based companies. The purpose of this activity would be to generate associations and networks with industry players who may be in need of the services of a farmer.

Regional Opportunities By Product Category

Dairy:

Dairy products represent a large opportunity for Canada. Probiotic and prebiotic products generally take the form of dairy drinks and yogurts. Milk also produces such functional ingredients as kefir, whey and colostrom. Margarines and oleo spreads are frequently produced with omega-3 fatty acids, or some other cholesterol-reducing agent in Europe and Japan, though these products have yet to take a strong hold in North America.

The functional dairy market is considered much larger in Japan and Europe than North America.

There are no regional exclusions for dairy in Canada, as products are produced and manufactured in all of Canada's regions.

Dairy is considered to be 3.6% functional, with $1.9B sold in the U.S. in 1999.

Dairy is also threatened by functional foods such as soy milk and other milk alternatives.

Poultry:

Poultry products, with the exception of eggs, are generally not considered functional. Eggs enriched in omega-3 fatty acids or some other bioactive compound are functional, and are being produced by companies throughout Canada.

Meats:

Meats generally resist functionality and so may represent the food category most threatened by the increased emphasis on healthier foods. Even extra lean meats would not be considered functional except by the broadest of definitions. Meats are not marketed as functional in their unprocessed forms. Red meats in particular stand to lose ground to high-protein alternatives such as soy products. Possible functional components of meats include amino acids, animal pigments, and extracts from specific animal species such as chondroitin, an extract from bovine trachea being used for arthritis therapy.

As meats represent the largest category in Canada in terms of production value, it is reasonable that Canada's overall functional penetration of production is somewhat less than the US demand of 3.4%.

Fruits and vegetables:

Many fruits and vegetables are considered functional by the Health Canada definition, though most would not be considered functional in industry reports. For example, no raw fruits and vegetables are considered functional by the NBJ annual reports, though if fortified as fruit juice they are included. These products are not normally included in the nutraceuticals and functional foods category as they are not packaged or marketed as functional. It can be difficult to gauge an accurate assessment of the functional market for functional fruits and vegetables because of their presence in many of the food manufacturing categories.

Many fruits and vegetables contain significant levels of soluble fibres, suggesting that health claims for products containing sufficient levels of fruits or vegetables could make specific health claims in the U.S. Functional fruits and vegetable products include extracts from these crops as well as juices and wines. Examples are:

- beta carotene, found in many vegetables,
- fruit juices are often fortified with calcium or vitamins making them functional,
- cranberries have been shown to have positive effects on urinary tract activities
- broccoli is believed to be associated with cancer risk reduction.

Many wild berries found in the Maritimes and BC are also believed to contain significant health benefits, though little scientific evidence exists to back these claims.

Ontario and Quebec are significant producers of vegetables, and BC and Ontario are primary fruit producers in Canada.

Legumes & pulses:

Most well known pulses are not considered functional at this time as the protein and lipid profiles have not yet been identified. Many believe that pulses may represent similar advantages to those found in soy protein, though this claim is not verified. Fenugreek protein has been marketed as a functional food. Among the many research opportunities is the development of research initiatives to uncover functional derivatives based on other pulse crops.

Legumes and pulses are primarily grown in the Prairies, with some grown in Ontario. The development of research initiatives around pulse crops and their specific health benefits may represent a strong opportunity for Prairie farmers.

The demand for pulses is not well known, as this category is included with fruits and vegetables for most food manufacturing and consumption data.

Grains and oilseeds:

Grains and oilseeds represent a plethora of possible functional ingredients. Much research has been done on products like wheat, barley, oats, canola, and corn. Several peripheral grains and oilseeds are known to have functional qualities. Examples are:

- Oats – beta-glucans from oat bran for heart health
- Flax – omega-3 fatty acids, lignans (ALA), phytoestrogens
- Hemp – omega-3 and omega-6 fatty acids
- Canola – high protein meal
- Barley – glutamine-rich protein, hemicellulose-rich fibre
- Wheat – prebiotic foods based on cold-pressed wheat germ
- Soy protein - is recognized as a heart health agent by the U.S. FDA. Functional nutrition bars, sports powders, frozen prepared foods, and meat substitute products are using soy protein.

- Buckwheat
- Breads, flour, and cereals that are fortified.

Breads & Grains are considered 10.5% functional, with US$6 billion in consumer sales. Opportunities in this area are primarily in the Prairies, though soybeans are grown primarily in Ontario.

Herbs and Botanicals

Herbs and botanicals have been used for millennia for their medicinal activities, though the recent attention they are receiving is unprecedented in the West. Eastern and Native American medical practices have long been associated with herb use, and Western naturopaths have been using this tradition as well. Recently, the medical community is becoming more accepting of herb and botanical use in treating disease, though it remains an alternative medicine rather than a supplementary one.

Identification and development of functional herb extracts may provide Canadian producers and manufacturers with terrific market opportunities. Many of these plants grow wild in Canada and are in high demand in the world markets as functional ingredients and supplements. Herbs and botanicals affect the teas market, ice cream and yogurt, cereals, nutrition bars, and energy drinks in addition to their significant impact on the nutraceutical supplements market. While this category represents perhaps the best opportunities, it also is the area most fraught with negative publicity. It seems that for every news item outlining a new health benefit for herbs or botanicals, there is another indicating negative health effects. Better research is needed for these products in order for the public to truly accept them as a medical alternative.

A list of potential herbs and botanicals for the functional food and nutraceuticals industry is included in Table A5 of Appendix A. Among the products grown in Canada are:

- Echinacea is packaged in various products as an immune system booster.
- Ginseng has been used as an energy enhancer.
- Garlic is believed to be have powerful effects on preventing high blood pressure, treating diabetes, curing diarrhea, lowering the risk of heart attacks and killing cancer cells.
- Amino acids to fight neurodegenerative diseases and omega-3 fatty acids for cholesterol management extracted from algae.
- Mushrooms and fungal extracts may help fight cancers.
- Plant sterols extracted from wood pulp for cholesterol reduction.

Most regions in Canada have some herb production, though the value of this production is difficult to assess. BC is believed to produce CAD$30 million annually. Data for the other regions is estimated from Ginseng production and other crops. This category represents the greatest concentration of the development of cottage industry companies in the industry.

U.S. data suggests an herb and botanical market of US$4.2 billion in 2000. Large markets for these products also exist in Asia and Europe.

IV. AREAS REQUIRING ADDITIONAL STUDY

Support from the Medical Profession

Many industry participants observed that in order for the nutraceutical and functional food industry to reach its potential in Canada, support is needed from the medical profession and from Health Canada. All indications are that this type of support is increasing, though there have been no studies looking at this. By determining the level of interest physicians and pharmacists are taking in these products, suggestions could be made regarding marketing to these bodies. Among the challenges of the industry will be to convince the medical community that the benefits to a healthy diet can have a tremendous impact on disease prevention.

Distribution Channels

Health food stores and dedicated retailers will continue to be the largest distribution channel for a period of time, but will eventually be overtaken by conventional retail outlets, especially as larger manufacturers enter the business. As Internet providers improve their technologies, direct selling through e-commerce is becoming much more prevalent for Canadian consumers. Internet sales also provide companies with a means for passing on the particular health message they wish to send. Mail order has been a primary source of distribution for small cottage industry companies. The effectiveness of different distribution channels and the ones that would best support Canadian producers should be investigated further.

GMOs

Genetically modified organisms (GMOs) would appear to be a good fit for the nutraceuticals and functional foods industry as agricultural inputs could be scientifically designed for optimum health benefit. This does not appear to be the case yet, however, due largely to the negative public sentiment to GMOs. It is expected that in the future, 5 to 10 years out, GMOs will be an important part of this industry. The possibilities offered by modern molecular science should be further investigated both from the perspective of scientific abilities and public opinion.

Value added through development of functional food and nutraceutical industry.

Through the development of the nutraceutical and functional food industry, new value chain components have emerged and are growing. In many cases, these components are required to support the growing industry and new companies. These components include:

- Research
- Technology development
- Primary Production
- Commercialization
- Management support

- Quality control and monitoring
- Health consultants
- GMO development
- Third Party certification

The emergence of these new components into the food industry could be evaluated to identify areas of specific capability or capacity within Canadian companies.

Fish and Seafood

Marine products were not considered in this report, though they deserve consideration within the functional foods and nutraceuticals industry. Many fish are high in omega-3 fatty acid content, and as such would constitute a functional ingredient in some cases. Chitin from seafood also has functional implications. Table A1 includes companies that work in the functional fish and seafood industry, and provide a starting point for further study.

Coordination of Provincial Research Efforts

Among the challenges of the many new research centers focusing on nutraceutical and functional food research will be to understand what has been and is being done at other centers to avoid duplication of efforts. It is believed that research centers in Quebec are ahead of the rest of the country in terms of research process development. Those issues that have been resolved there must be shared with the other provinces in order to streamline processes and to recognize strategic fit.

Data Capture in Canada

Statistics Canada does not currently measure any indicators for the nutraceuticals and functional foods industry. As previously mentioned, defining the industry is a challenge, but methods will be necessary in order to help this industry mature.

Determination of Products that can be grown in various regions across Canada

In 1998, a study was performed identifying the various opportunities that exist in Manitoba in terms of growing crops with nutraceutical or functional value. Crops that have value in the nutraceutical and functional food industry were determined and ranked along a number of criteria, including their ability to be grown in Manitoba. Studies similar to this one should be performed across Canada to better understand the opportunities that are practical given the particular environment in each region.

APPENDIX A

Table A1. Canadian and Multinational Functional Food and Nutraceutical Companies

	Company	website	product(s)	brand(s)
Maritimes				
Dairy & Poultry				
	ACA Co-operative	None	omega-3 eggs	EdenValley Farms
	Fortius Natural Nutrition	www.fortius.ca/	nutritional and sports supplements from whey and colostrum	DynaWhet Protein, Pure Creatine Monohydrate, EstroSoy, MenoSoy, others
	Ganong Bros. Ltd.	www.ganong.com/	chocolatier	
	Scotsburn Dairy Group	www.scotsburn.com/	dairy products	Scotsburn
Meats				
Fruit & Vegetables				
	Cavendish Farms	www.cavendishfarms.com/	frozen potato products	Cavendish
	Cobi Foods Inc.	http://home.istar.ca/~cobifood/main.html	frozen vegetables	
	Big 8 Beverages Ltd.	None	juices & sodas	
	Dark Tickle Company	www.darktickle.com/	jams, sauces, berry beverages	Dark Tickle
	Nova Agri Associates	None	potatoes & berries	
	Nova Scotia Farm Fresh	www.novascotiafarmfresh.com/	farm products	
	Oxford Frozen Food	None	frozen berries, vegetables	
	Rodrigues Winery	www.rodrigueswinery.com/	fruit drinks & wines	Rodrigues
	Sarsfield Foods Ltd.	None	fruit pies	
	Vaccinium Technologies	www.vacciniumtechnologies.nb.ca/	wild blueberries & other fruit	
Grains & Oilseeds				
	Belleisle Foods Ltd.	www.belleislefoods.com/	oriental foods, oatmeal	Belleisle
	Purity Factories Ltd.	www.purity.nf.ca/	breads, cookies, crackers, jams, syrups, teas	Purity
Pulses & Legumes				
Herbs & Botanicals				
	Acadian Seaplants	www.acadianseaplants.com/	cytokinins from seaweed extract	Hana-Nori
	Ampikelp Products	None	kelp products	
	Diagnostic Chemicals Ltd.	www.dclchem.com/	enzymes, minerals e.g. creatine, amylase, calcium	
	Efamol Research Inc./Scotia Pharmaceutical Ltd.	None	EFA research	
	Kori Farms Ltd.	None	medicinal herbs	

	Company	website	product(s)	brand(s)
	Naturally Nova Scotia health Products Ltd.	www.naturallynovascotia.com/	herbal remedies	Naturally Nova Scotia
	Newfoundland Aqua Products Inc.	www.nfkelp.com/	nutritional supplements from kelp	Sea Vite
	Ocean Produce International	www.oceanproduce.com/	algae production	Opika
Fish & Seafood				
	Atlantic Marine Products Inc.	None	harp seal products for omega 3 fatty acids, fishery by-products for nutraceuticals, e.g. chitin, glucosamine	
	Connors Bros. Ltd.	None	sardines & salmon	
	High Liner Foods Inc.	www.highlinerfoods.com/	frozen fish products	High Liner
	National Sea Products Ltd.	None	seafood products	
	Ocean Nutrition Canada Ltd.	www.ocean-nutrition.com/	dietary supplements (fish oil, glucosamine)	
	Terra Nova Fishery Co. Ltd.	None	harp seal products with omega 3 fatty acids	
Research Companies				
	Acta-Med Inc.	www.actamed.net/	contract R&D	
	BioVectra	www.biovectra.com/	contract R&D	
Quebec				
Dairy & Poultry				
	Advitech Solutions Inc.	www.advitech.com/	milk protein supplements for diet and sport	Prodiet
	Agropur	None	dairy co-operative	Danesbourg
	Bio-K+ International Inc.	www.biokplus.com/	probiotics in milk products	Bio-K+
	Harmonium International	www.harmonium-intl.com/	probiotics in yogurt, kefir and other formulations	
	Les Oeufs Avibro	None	omega-3 eggs	Eggs Soleil
	Natrel Inc.	None	dairy products	Sealtest, Natrel
	Nexia Biotechnologies	www.nexiabiotech.com/	recombinant goat milk proteins	BELE goats
	Nutri-Oeuf Inc.	None	omega-3 eggs	Nutri-oeuf
	Ultima Foods Inc.	None	fresh dairy products	Yoplait
Meats				
	Charcuterie La Tour Eiffel Inc.	None	pork products	Tour Eiffel, La Sicilia, Volksmund, Bilopage
	Maxi Poultry Company Ltd.	None	poultry products	
Fruit & Vegetables				
	A. Lassonde Inc.	www.lassonde.com/	fruit juice with lycopene, folic acid, vitamin C, calcium, beta carotene	Oasis Health Break
	Aliments Carriere Inc.	www.carrierefoods.com/	canned & frozen fruits & vegetables, soups	
	FBI Foods Ltd.	None	fresh fruits	

	Company	website	product(s)	brand(s)
	Ouimet Cordon Bleu Inc.	None	canned & frozen foods	
	Quadra Chemicals Ltd.	www.quadrachemicals.com/	minerals, ingredients	
	Usine de Congelation de St. Bruno	None	fruits & vegetables	
	Wong Wing Foods Inc.	www.wongwing.com/	Chinese foods with emphasis on nutritive value	
Grains & Oilseeds				
	Artel Cuisifrance Inc.	www.artel.ca/	food manufacturing	Del Maestro, Yin Yang, Quick Meals
	Canolio	www.canolio.com/	organic hemp coffee	Organic Hemp Coffee
	Les Aliments Dainty Foods	None	rice	
	Pablo & Pepe	None	organic tacos	Pablo & Pepe
	V-H Foods	None	gluten-free sauces	
Pulses & Legumes				
	Internova Inc.	None	soy products	Yu, Earthshake
Herbs & Botanicals				
	Atrium Biotechnologies Inc.	www.atriumbio.com/	nutritional supplements	CarTCell, NatCell
	Gourmet Nutrition F.B. Inc.	www.gourmetfb.com/	herbal products	Phytovie, Herb Xtra
	Institut Rosell-Lallemand/Lallemend Inc.	www.lallemand.com/	Probiotics, dairy cultures, baking yeasts	Rosell, Fermipan
	Laboratoire Riva Ltd.	None	nutritional supplements	
	Medicago Inc.	www.ulaval.ca/vrr/rech/Proj/org010155.html	recombinant proteins using alfalfa	
	Odan Laboratories Ltd.	www.odanlab.com/	OTC drugs, supplements	Nu Cal, Odan
	Pharmascience Inc.	www.pharmascience.com/	OTC drugs, supplements	
	Pharmetics Inc.	None	nutritional supplements, vitamins	
	Rolmex International Inc.	None	vitamins, mineral products	Nutrol
Fish & Seafood				
	Blue Water Seafoods	None	frozen fish products	Blue Water
Research Companies				
	AETerna Laboratories	www.aeterna.com/	anti-angiogenic, cancer therapies	Neovastat
	Biozymes Inc.	None	enzymes ingredients from animal and plant materials	
Ontario				
Dairy & Poultry				
	Ault Foods	None	dairy products	Ault Foods, Royal Oak Dairy
	Burnbrae Farms Ltd.	www.burnbraefarms.com	omega-3 eggs	Naturegg Omega Pro

	Company	website	product(s)	brand(s)
	Gelda Scientific Inc.	www.gelda.com/	lactose-free milk products, cheeses	Lacteeze
	Gray Ridge Egg Farms	www.grayridge.com	omega-3 eggs	Omega 3
	Parmalat Canada	www.parmalat.ca	dairy products	Parmalat, Beatrice, Balderson, others
	Stella Pharmaceutical Canada Inc.	www.nutribar.com/client/stella	meal replacements/bars	Nutribar
	Storck Canada Inc.	None	confectionery	Toffifee, Milkfuls, Werthers
Meats				
	J.M. Schneider Inc.	www.schneiders.ca/	meats	Schneiders
	Maple Leaf Foods	www.mapleleaf.ca/	meats, bakery, agribusiness	Maple Leaf
	Marsan Foods Ltd.	None	poultry processing	
	Morrison Lamothe Inc.	None	frozen meat pies, desserts, and other products	Savarin, Holiday Farms
	The Coming Home Foods Co.	None	meat pies, frozen meats	
	Transcontinental Gourmet Foods Inc.	None	meat & fish processors	
Fruit & Vegetables				
	Canadian Home Products Ltd.	None	gluten-free sauces, other products	Chef Boyardee, Jiffy Pop
	E.D. Smith & Sons Ltd.	www.edsmith.com/	gluten free pie fillings, jams, tomatoes, toppings, syrups	E.D. Smith
	Fairlee Fruit Juice Ltd.	www.fairlee.com/	fruit juices	Fairlee, Tropical Grove
	Family Tradition Foods Inc.	www.familytradition.com	vegetable manufacturer	John O's brand
	Golden Town Apple Products	None	apple products	Golden Town Apple brand
	Imperial Flavours Inc.	None	fruit juice manufacturer	
	Janes Family Foods Ltd.	www.janesfamilyfoods.com/	fresh & frozen vegetables, fish, chicken products	Janes Family Foods brand
	KGK Synergize Inc.	www.kgksynergize.com/	citrus extracts, testing of bioactives	
	McCain Foods Ltd.	www.mccain.com	fruit juice, potato products, desserts, pizzas	McCain brand
	Nation Wide Canning Ltd.	None	tomato processors	
	Performance Plant Inc.	None	genetically modified low-light plants	
	Produce Processors Ltd.	None	unknown	
	Reinhart Foods	www.reinhartfoods.com	dried fruits, fillings, baking products, vinegars	Reinhart, Daltons, Jaffa, orchard Fresh brands
	Strathroy Foods Ltd.	None	vegetable processors	

	Company	website	product(s)	brand(s)
	Strub Brothers Ltd.	None	pickled products	Strub's brand
	Sun-Brite Canning	None	tomato processors	
	SweetRipe Drinks Inc.	None	fruit juices	Allen's Ecological
	Thomas Canning (Maidstone) Ltd.	None	tomato processors	Utopia brand
	Unifine Richardson B.V.	None	sauces, dressings	
	Weil's Food Processing Ltd.	None	tomato processors	
	W.T. Lynch Foods Ltd.	www.lynchfoods.com	fillings, sauces, dressings, juices, desserts	Lynch, Olde Style, Swiss Treat, Lifestyle brands
Grains & Oilseeds				
	Beta Brands Ltd.	None	crackers and confectionery	Bitelife, Country Harvest
	Cool Hemp Company	www.coolhemp.com/	hemp desserts, cookies	Cool Hemp brand
	Corporate Foods Ltd.	None	breads	
	Daminco	www.daminco.com	soy products, ingredients	Lesoy, Vegetol, others
	Dare Foods Ltd.	www.darefoodsinc.com/	cookies, crackers, confectionery	Dare, Bremner, Vinta
	Dimpflmeier Bakery Ltd.	None	linseed, flax, rye breads	Dimpflmeier
	Hempola	www.hempola.com/	hemp dressings & flour	Hempola
	Kenex Ltd.	www.kenex.com/	hemp products	
	Natural Emphasis Ltd.	www.fastfuelup.com	energy bars & snacks	Fast Fuel, Fun Fuel
	Oshawa Foods Ltd.	None	breads/bakery products	
	R&D Hemp Inc.	www.thenaturalorder.com/	hemp products	
	Robin Hood Multifoods Inc.	www.robinhood.ca	wheat milling, processing & marketing	Robin Hood, Red River brands
	Ruth's Foods	www.ruthsfoods.ca	hemp products (oil, dressings, bars, chips, pasta)	Ruth's brand
	Stickling's Landhaus Bakery	none	breads	Sunflax Gourmet brand breads
	St. Lawrence Technologies Inc.	none	canola products (oil & cake)	
	Sunny Crunch Foods Ltd.	www.sunnycrunch.com	nutritional bars, ginseng bars	Sunny Crunch brand
	Tasty Selections Inc.	none	bakery	
	Voortman Cookies Ltd.	none	cookies	Voortman brand
Pulses & Legumes				
	Lifemax Natural Foods Distribution Inc.	none	development of functional foods	

	Company	website	product(s)	brand(s)
Herbs & Botanicals				
	Ashbury Biologicals	none	botanical medicines & ingredients	
	Boehringer Ingleheim / Quest Vitamins	www.questvitamins.com	vitamins, nutritional supplements	Quest brand
	Food-Nutrition Inc.	www.foodnutrition.com	vitamins, minerals, phytonutrients	Pros-tect energy bar
	HoneyBar Products International Inc.	www.honeybar.ca	nutrition bars	HoneyBar brand nutrition bars
	Jamieson Laboratories Ltd.	www.jamiesonvitamins.com	supplements	Jamieson brand supplements
	Kicx Nutrition Inc.	www.kicxnutrition.com	marketing & product development services	
	Martin Health Group	www.martinhealth.com	pine bark extract	Dr. Martin brand
	McCormick Canada	www.mccormick.com	herb & spice manufacturing	Club House
	Mother Parker's Tea & Coffee Inc.	www.mother-parkers.com	herbal teas	Mother Parker's brand
	Nu-Life Corp.	None	nutritional supplements, herbal remedies, vitamins	Nu-Life brand
	Nutri-Chem Pharmacy	www.nutrichem.com	supplement testing, retail	
	Platinum Naturals	www.platinumnaturals.com	supplements, teas	SD's tea
	Puresource Natural Products	www.puresource.ca	distribution of many products	many brands
	Quinte Botanicals	None	equine echinacea	Echi-Fend
	Sierra Health and Nutrition	None	unknown	Nature's Health Rx, Nutura
	Swiss Herbal Remedies Ltd.	www.swissherbal.ca	nutritional supplements/vitamins	
	Tetley Canada Inc.	www.tetley.ca	teas	Tetley brand herbal & green teas
	The Herb Works	www.theherbworks.com	herbal products	The Herb Works brand
	Vita Pharm Canada Inc.	None	nutritional supplements/vitamins	
	Wampole Canada Inc.	None	nutritional supplements/vitamins	Wampole brand
Fish & Seafood				
	Clover Leaf Seafoods Inc.	www.cloverleaf.ca	canned & packaged seafoods	Clover Leaf brand
Research Companies				
	D.C. Labs Ltd.	None	dosage facility	
	Genpharm Inc. Pharmaceuticals	www.genpharm.ca/	generic pharmaceuticals and nutraceuticals	
	Innovus Research Inc.	www.innovus.com	research services	
	Lipid Analytical Laboratories Inc.	None	testing of foods, biological materials	

	Company	website	product(s)	brand(s)
Prairies				
Dairy & Poultry				
	Fortius Canada Inc.	www.fortius.com	nutritional supplements from colostrum and whey for private labels and own brand	Fortius
	Lilydale Egg Company	www.lilydale.com	omega-3 eggs	Formula 3
	Lucerne Foods Ltd.	None	dairy products	Lucerne brand
	Maple Ridge Farms	www.mapleridgefarms.com	chocolate and confectionery	Maple Ridge Farms brand
	The Saskatoon Colostrum Company Ltd.	None	colostrum for health assurance for neonatal calves	
	Villetard's Eggs (AB)	None	omega-3 eggs	Dr. Sims Designer Eggs
Meats				
	UFL Foods Inc.	None	food coatings, microingredients	
Fruit & Vegetables				
	Northern Wild Harvest	None	berry wildcrafting	
	Prairie Natural Processing	none	black currant	
	Prairie Plant Systems Inc.	www.prairieplant.com	fruit trees and nutraceuticals propagation and research	
Grains & Oilseeds				
	API Grain Processors	www.apigrainprocessors.com	wheat processing	
	Agricore United / United Grain Growers	www.ugg.com	grain marketing/processing	
	Aurora Farms Ltd.	None	producer & processor of functional food ingredients from grains	
	BioHemp Technologies Ltd.	None	Hemp products	
	CanAmera Foods	www.canamera.com	oilseed-based products	CanAmera brand
	Can-Oat Milling Products	www.can-oat.com	oat milling	
	Cargill Inc.	www.cargill.com	functional food division	
	Ceapro Inc.	www.ceapro.com	oat beta glucan and colloidal oat extracts	
	Country Lane Organic Grain & Milling	None	flax milling & cereal production	7 Grain Cereal
	Dow AgroSciences Canada Inc.	www.dowagro.ca/	EFA canola oil	
	ECO Farms	www.ecofarms.ca	sunflower seeds	Eco-farms
	Emerson Milling Inc.	www.oatgroats.com	milling of oats	
	Enquce Biochemicals Inc./Northern Quinoa Corp	www.quinoa.com	quinoa and other grains	
	Fresh Hemp Foods Ltd. / Manitoba Harvest	www.hemperor.com	Hemp seed products	Manitoba Harvest
	Gen-X Research Inc.	www.gen-xresearch.com	Hemp products	
	Hemp Oil Canada Inc.	www.hempoilcan.com	hemp products	

	Company	website	product(s)	brand(s)
	InfraReady Products Ltd.	www.infrareadyproducts.com	pulses, grains & oilseeds	Infraready brand
	Integrity Foods	None	Organic whole grains	
	Kinnikinnick Foods	www.kinnikinnick.com	gluten-free breads	
	Nutris Inc.	None	hemp	
	Pizzey's Milling & Baking Co.	www.pizzeys.com/	flax milling	Flax 'N Bran, Canadian Flax, Flax Pancake & Waffle Mix
	Prairie Sun Grains 2000 Inc./The Camrose Milling Company Ltd.	None	flour milling, cereals	Sunny Boy, Prairie Sun Certified Flax
	Quality Assured Seeds Inc.	None	seed science & technology	
	R&D Hemp	www.thenaturalorder.com/rdhemp.htm	hemp breeding/processing	
	Rocky Mountain Grain Products	www.rockymountaingrainproducts.com/	hemp oil production	
	Saskatchewan Wheat Pool	www.swp.com	grain marketing/processing	
	SemBioSys Genetics Inc.	www.sembiosys.ca	molecular farming with oilseeds	
	The Flax Consortium	None	Flax processing technology	
	Weisbrod Farms	None	mixed farming	cereals/pulses/meats/berries/echinacea
Pulses & Legumes				
	Emerald Seed Products	www.emeraldseedproducts.com	fenugreek processing	FenuLife ingredients
	Parrheim Foods	www.parheim.mb.ca	pulse & poultry processing, grain handling, flour milling	Propulse, Accu-Gel, Centara, Hi Fi Lite, Uptake brands
Herbs & Botanicals				
	Advanced Nutri-Tech Systems Inc./New Era Nutrition	www.nutritech.com	functional food bar & nutraceutical bar technology with botanicals	
	Bioriginal Food & Science Corp.	www.bioriginal.com/	functional oils	
	Blue Hills Herb Farm	None	echinacea production	
	Coulee Pickings Ltd.	None	milling/processing of botanicals	
	CV Technologies Inc.	www.herbtech.com/	proprietary technology, herb extraction	Herb Tech O
	Extropian Agro Forestry Ventures	None	energy bars	Heartbar, Extropian Lifestyle Cardio bar
	From the Earth Narutally Ltd.	www.peacecountryproduct.net	functional herb products	
	Fytokem Products Inc.	www.fytokem.com	herb, grain extractions	

	Company	website	product(s)	brand(s)
	Helga's Herbs	None	Herb processing	
	Interlake Forage Seeds	www.interlakeforageseeds.com	Agronomic technology for herb growing etc	
	Lone Wolf Native Plants and Herb Farm	None	Herb growing	
	Mekiwin Corp.	www.mekiwin.com	horseradish supplement, herbal production and processing	Mekiwin brand
	Mid Northern Growers Ltd.	www3.sk.sympatico.ca/machd/	medicinal herbs, grains	
	Natural Plantation Inc.	None	purslane products	SuperD-Master
	New Era Nutrition Inc.	www.nutritech.com	Functional technologies, non-capsule nutritional supplements	
	Norac Technologies Inc.	www.noractech.com	extraction technologies	
	Nutravim Nutraceutical Inc.	www.nutravim.com	gel capsule manufacturing	
	Sangster's Health Centre	www.sangsters.com	vitamins/supplements	Sangster's brand
	Specialty Distributing Ltd.	None	herbs/specialty crops	
	Sundance Health Products Inc.	www.geocities.com/elkvelvet	elk antler velvet	
	Taiga Bioactives Inc.	www.taigabioactives.com	plant extracts with medicinal properties	
	Velvet Independent Processors Inc.	None	elk antler velvet	
	Vita Health Products	www.vitahealth.ca	nutritional supplements/vitamins	
	WateResearch Corp.	None	algae products (EPA, astaxanthin)	
	Wise Owl Herbs	www.wiseowlherbs.com	echinacea	
Research Companies				
	Ben-Don Innovations	www.bdi.sk.ca	food technology consulting	
	Enviro-Test Laboratories	www.envirotest.com/	biological testing	
	PharmaChem Technologies Inc.	www.gko.com/	pilot facilities, packaging	
	POS Plant Pilot Corp.	www.pos.ca	pilot plant testing	
British Columbia				
Dairy & Poultry				
	Born 3 Marketing Corp.	www.born3.com	omega-3 eggs	Born 3
	Canadian Inovatech Inc.	www.inovatech.ca	milk and egg fractionation	many
	Golden Valley Foods Ltd.	www.goldenvalley.com/	omega-3 eggs	Born 3, Canadian Harvest eggs
	PVL Nutrients Ltd.	None	whey protein meal replacements	PVL Nutrients brand
Meats				
Fruit & Vegetables				
	Fraser Valley Foods	None	fruit and vegetable processing	

	Company	website	product(s)	brand(s)
	Kelley Valley Dried Fruit	None		
	Pride Beverages Ltd.	None	fruit beverages	
	Snowcrest Packers Ltd.	None	vegetable packaging	
	Sun-Rype Products Inc.	None	fruit juices/fruit snacks	Sun-Rype brand
Grains & Oilseeds				
	Burcon NutraScience Corp.	www.burcon.ca/	canola protein processing	Puratein
	CHII Chi Hemp Industries Inc.	www.chii.ca/	hemp products	
	Echo Oils Inc.	www.echo-oils.com	hemp products	Echo Organics products
	Grantham Foods Ltd.	www.granthamfoods.com	various	Tosca safflower oil
	Nature's Path	www.naturespath.com/	cereals, breads, waffles	Nature's Path, Lifestream brands
	Northern Lights Flax	www.nlflax.com	flax seed	Northern Lights brand
	Nunweiler's Flour Co.	www.nunweilersflour.com	flours, pancake mixes	Grandma Nunweiler's
	Omega Nutrition Canada Inc.	www.omeganutrition.com/	EFA oil processing, proprietary manufacturing process	
	Rogers Foods Ltd.	www.rogersfoods.com	wheat & oat milling	Rogers brand flours, oats, brans, granolas
	Sepp's Gourmet Foods	www.seppsfoods.com	pastries & processed foods	Sepp's, McIntosh of Dyce, Summersweet)
Pulses & Legumes				
	Yves Veggie Cuisine	www.yvesveggie.com	produces soy-based vegetarian products	Yves Veggie Cuisine brand
Herbs & Botanicals				
	Alta Natural Herbs & Supplements Ltd.	www.alta-natural.com	nutritional supplements	Alta Natural brand
	Altex Processing Inc.	www.altexprocessing.com/	herb processing, supplement manufacturing	
	Canadian Phytopharmaceuticals Corp.	www.canphyto.com/	herl processing, nutritional supplements	
	Canadian Seabuckthorn Enterprises Ltd.	www.seabuckthorn.com/	seabuckthorn products	
	Canadian Emu Oil Ltd.	www.emu.ca/	emu oil	Songlines
	Canadian Kelp Resources Ltd.	None	Kelp products	
	Canadian Phytopharmaceuticals Corp.	www.canphyto.com	herbal extracts	
	Chai-Na-Ta Corp.	www.chainata.com	vertically integrated ginseng company	
	Eclectic Echinacea	None	Echinacea	Prairie Doctor brand

	Company	website	product(s)	brand(s)
	Flora Manufacturing & Distributing Ltd.	www.florahealth.com	herbal remedies	Udo's Choice, Flor*Essence brands
	Forbes Medi-Tech Inc.	www.forbesmedi.com/	phytosterols from wood pulp	Phytrol
	Fraser Valley Mushroom Growers	None	Fungi and mushroom products	
	Holista Health Canada Inc.	www.holistahealth.com	herbal supplements	Holista brand supplements
	Hypex Technologies Inc.	None	extraction and fractionation of bioactive materials from herbs, spices, algae, and other bio-feedstock	
	Jamp Pharma Corp.	None		
	Natural Factors Nutritional Products Ltd.	www.naturalfactors.com	herbal supplements, remedies, vitamins	Natural Factors brand
	Nature's Formulae Health Products Ltd.	None	herbal products	Master Formulae
	Nutravite Pharmaceuticals Inc.	www.nutravite.com	nutritional, herbal supplements	
	Okanagan Ginseng Laboratories Inc.	www.forthrt.com/~roland/okginseng.html	herb production, processing, manufacturing	
	Organika Health Products	www.organika.com	nutritional supplements	Organika brand
	Pharmanutrients Botanical Corp.	None	bulk raw materials	
	Phytogen Life Sciences Inc.	www.phytogen.com	ginseng cultivation	
	PurePlus Extracts Inc.	None		
	Rhema Industries	www.rhemaindustries.com		
	Sisu Enterprises Co. Inc.	www.sisuhealth.com	vitamins/supplements/botanicals/homeopathics/sports nutrition	Sisu brand
	Soma Health Products Canada Ltd.	www.somalife.net	dietary supplements	Soma brand (Soma MVP, Somalife gHP, SomaPet)
	Sunmore Healthtech Ltd.	None	ginseng manufacturing	unknown
	Tai-Can Biotechnologies Inc.	None	identification/extraction of bioactive compounds	
	Trophic Canada	www.trophic.net	nutritional supplements	Trophic brand
	Viva Pharmaceutical Inc.	www.vivapharm.com	softgel capsules	
	Webber Naturals	www.webbernaturals.com	herbal supplements	Webber brand; EchinaMax
	White's Ginseng and Medical Herbs	None	ginseng/other herbs	
	WN Pharmaceutical Ltd.	None		
	Xymega Corp.	www.xymega.com	plant stanols, food ingredients	

	Company	website	product(s)	brand(s)
Fish & Seafood				
	International Chitin Production	None	chitin from shrimp and other seafood sources	
Research Companies				
	Axelson BioPharma Research Inc.	www.axelson.net	biological testing	
	Biopharmaceutical Research Inc.	www.bripharm.com/	biological testing	
	Biotech Holdings Ltd.	www.biotechltd.com/	pharmaceutical & health products	
	Cantest Ltd.	www.cantest.com	biological testing	
	JR Laboratories Inc.	www.jrlabs.ca	biological testing	
	Northern Lipids Inc.	www.northernlipids.com	R&D support	
	S.G.S. Canada Inc.	www.sgs.ca	biological testing	
Multinational Companies				
	Abbott Laboratories/Ross Products Division			
	Archer Daniels Midland			
	Aventis Crop Science			
	BASF Canada			
	Bayer Consumer Care Division			
	Bertolli Canada Inc.			
	Bristol-Myers Squibb Consumer Products Group			
	Burns Philp Food Ltd./Fleishmann's Yeast			
	Cadbury Beverages Canada Inc.			
	Campbell Soup Co. Ltd.			
	Cargill, Inc.			
	Coca-Cola Ltd.			
	Colgate-Palmolive Canada Inc.			
	ConAgra Inc.			
	Danone Inc.			
	Dole Foods Canada Ltd.			
	Effem Inc.			
	Everfresh Beverages			
	Ferrero Canada Ltd.			
	Fishery Products International Ltd.			
	General Mills Canada Inc.			
	George Weston Foods Ltd.			
	GlaxoSmithKline Consumer Products			
	Good Humor - Breyers Ice Cream			
	Griffith Laboratories Ltd.			
	H.J. Heinz Company of Canada Ltd.			
	Hershey Canada Inc.			
	Hoffmann-La Roche Ltd.			
	J.M. Smucker Inc.			
	Kellogg Canada Inc.			
	Kraft General Foods Canada Inc.			
	Lindt & Sprungli			

Multinational Companies	
	Mead Johnson Nutritionals
	Melitta Canada Inc.
	Monsanto Canada Inc.
	Morgan Foods Inc.
	Motts Canada
	Nabisco Ltd.
	Nestle Canada Inc.
	Novartis Consumer Health Care
	Nutrinova Nutrition Specialties & Food Ingredients
	Ocean Spray International Ltd.
	Oetker Canada Ltd.
	Park Tonks Ltd.
	Parmalat
	Pasta Kitchen
	Pepsi-Cola Canada Inc.
	Pfizer Canada Inc.
	Pharmacia Consumer Healthcare Canada
	Pillsbury Canada Ltd.
	Proctor & Gamble Pharm Canada Inc.
	Quest Vitamins
	Ralston Purina Canada Inc.
	RBD Technologies Inc.
	Sara Lee Bakery Canada
	S.C. Johnson and Son Ltd.
	SoBe Beverages
	The Clorox Company of Canada Ltd.
	The Dial Corp.
	The Hostess Frito-Lay Company
	The Ingredient Company Ltd.
	The Minute Maid Company Canada Inc.
	The Perrier Group of Canada Ltd.
	The Quaker Oats Company of Canada Ltd.
	Tropicana Canada
	Unico Inc.
	Unilever Canada Ltd.
	Vlasic Foods Canada, Inc.
	Wrigley Canada
	Yakult Honsha
	Zeneca Agro / Syngenta

Table A2. Research Centres in Canada with Functional Food and Nutraceutical Initiatives

Maritimes	AAFC Atlantic Food and Horticultural Research Centre
	Acadia University
	Memorial University - Centre for Aquaculture and Seafood Development
	NRC Institute for Marine Biosciences
	PEI Food Technology Centre
	University of Moncton, Food Research Centre
Quebec	AAFC Food Research & Development Centre
	Functional Foods and Nutraceuticals Research Institute
	Laval University
	McGill University - Phytochemical Metabolism Group
	St. Hyacinthe Agri-Food Technology Park
Ontario	AAFC Eastern Cereal & Oilseed Research Centre
	AAFC Food Research Program
	AAFC Greenhouse & Processing Crops Research Centre
	AAFC Research Branch
	AAFC Southern Crop Protection & Food Research Centre
	Carleton University
	Guelph Food Technology Centre
	Lawson Health Research Institute
	Lipid Analytical Laboratories Inc.
	London Health Sciences Centre
	Ontario Agri-Food Technologies
	Ontario Veterinary College
	Robarts Research Institute
	St. Clair College of Applied Arts
	University of Guelph - Guelph Centre for Functional Foods
	University of Guelph - Human Nutraceutical Research Unit
	University of Guelph - Natural Health Products Technology Cluster
	University of Ottawa
	University of Toronto - Dep't of Nutritional Science
	University of Western Ontario
Prairies	AAFC Saskatoon Research Centre
	Alberta Research Council
	Ben-Don Innovations
	Enviro-Test Laboratories
	Manitoba Food Development Centre
	National Agri-Food Technology Centre
	Olds College
	PharmaChem Technologies Inc.
	POS Plant Pilot Corp.
	Saskatchewan Drug Research Institute
	Saskatchewan Research Council - Fermentation Branch
	St. Boniface Research Centre - National Centre for Applied Research in Medicine
	University of Alberta - Functional Foods Alberta Centre of Excellence
	University of Manitoba
	University of Saskatchewan - Herb Research Centre

	University of Saskatchewan - College of Pharmacy & Nutrition
British Columbia	AAFC Pacific Agri-Food Research Centre
	ABR Axelson BioPharma Research Inc.
	BC Institute of Technology -
	BRI Biopharmaceutical Research Inc.
	Cantest Ltd.
	JR Laboratories Inc.
	Northern Lipids Inc.
	S.G.S. Canada Inc.
	Tzu Chi Institute
	University of British Columbia - Food Science Dep't

Table A3. Canadian Associations with Nutraceutical and Functional Food Related Initiatives			
	Association	Website	
Maritimes			
	Nova Scotia Fruit Growers Association	www.nsapples.com	
	The Nova Scotia Biotechnology and Life Sciences Industry Association	www.randburg.com/ca/bionova.html	
Quebec			
Ontario			
	Canadian Health Food Association	www.chfa.ca/	represents health food industry stakeholders
	Canadian Soybean Exporters Association	www.soybean.on.ca/csea.htm	
	Natural Sciences and Engineering Research Council	www.nserc.ca/	
	Ontario Processing Vegetable Growers	www.opvg.org/default.htm	contracting between growers and processors
	Ontario Soybean Growers Marketing Board	www.soybean.on.ca	
	Ontario Tender Fruit Producers	www.ontariotenderfruit.com/	
Prairies			
	Canola Council of Canada	www.canola-council.org/	expand production and use of Canadian canola
	Flax Council of Canada	www.flaxcouncil.ca/	promote the use of flax and flax products
	Health Care Products Association of Manitoba	www.hcpam.com/	development of Biotech/Pharma Medical Device Industry
	Northern Lights Herbs Inc.	None	
	Pulse Canada	www.pulsecanada.com	
	Saskatchewan Agriculture and Food	www.agr.gov.sk.ca/	
	Saskatchewan Canola Development Commission	www.scdc.sk.ca/	
	Saskatchewan Elk Breeders Association	www.elkbreeders.sk.ca/	
	Saskatchewan Flax Development Commission	www.saskflax.com/	
	Saskatchewan Food Processors Association	www.sfpa.sk.ca	
	Saskatchewan Fruit Growers' Association	www.saskfruit.com/	
	Saskatchewan Hemp Association	www.saskhemp.com	
	Saskatchewan Herb and Spice Association	www.saskherbspice.org/	
	Saskatchewan Nutraceutical Network	www.nutranet.org	
British Columbia			
	British Columbia Functional Food & Nutraceutical Network	www.bcfn2.com	
	British Columbia Health Industries Network	www.hinetbc.org/	
	Science Council of British Columbia	www.scbc.org	

Table A4. Selected compounds under investigation for bioactivity

Amino Acids
Amoniacetic acid
Creatine
DL-Cysteine
DL-Methionine
DL-Phenylalanine
L-Alanine
L-Arginine
L-Asparagine
L-Aspartic acid
L-Carnitine
L-Citrulline
L-Cysteine
L-Cystine
L-Glutamic acid
L-Glutamine
L-Histadine
L-Homocystine
L-Isoleucine
L-Leucine
L-Lysine
L-Methionine
L-Norvaline
L-Ornithine
L-Phenylalanine
L-Proline
L-Pyroglutamate
L-Serine
L-Taurine
L-Threonine
L-Tryptophan
L-Tyrosine
L-Valine
N-Acetylcysteine

Dairy based Ingredients
Bioactive peptides
Bovine casein
Caseins & casienates
Lactose
Milk minerals
Milk proteins
Nutritional blends & compounds
Whey fractions

Antioxidants
2,4,5-trihydroxybutyrophenone (THBP)
4-hydroxymethyl-2,6-di-tert-butylphenol
Allysl sulfides
Alpha acid glutarate
Alpha-lipoic acud
Ascorbate-sodium
Ascorbate-calcium
Bioflavinoids
Biotin
Botanical & herbal extracts
Butylated hydroyxtoluene (BHT)
Butylated hydroxyanisole
Carotenoids
Chelated Minerals
Chlorophyllins
Citrates
Citric Acid
Coenzyme Q10 (ubiquinone)
Dilauryl thiopropionate (DLTDP)
Dodecyl gallate stearyl
Enzymes
Ethoxyquin
Gluconates
Gluconic acid
Lactates
Mineral aspartates
N-acetylcysteine (CNAC)
Nitrates
Nordihydroguaiaretic acid (NDGA)
Paba
Phosphoric acid
Potassium bisulfite
Proanthocyanidins (OPC)
Propyl gallate
Quercetin
Selenium
Sodium compounds
Soy isoflavone
Tea compounds
Tertiary butylhydroquinone (TBHQ)
Thiodipropionic acid
Vitamins

Fatty Acids
Arachidonic acid (AA)
Alpha-linoleic acid (ALA)
Behenic acid
Conjugated linoleic acid (CLA)
Conjugated fatty acids
Docosahexaneoic acid (DHA)
Eicosadienoic acid
Eicosenoic acid
Elaidic acid
Eicosapentaenoic acid (EPA)
Gammer linoleic acid (GLA)
Lauric acid
Low density lipoprotein (LDL)
Linoleic acid
Myristic acid
Oleic acid
Omega-3 alphalinoleic acid
Omega-3 fatty acids
Omega-6 PUFA
Palmitic acid
Palmitoleic acid
Stearic acid
Veccenic acid

Vitamins
Beta-carotene
Biotin
Carotenoids
Choline
Folic acid
Inositol
L-carnitine
Niacin
Vitamin A (acetate)
Vitamin A (palmitate)
Vitamin A (retinol)
Vitamin B1 (thiamine)
Vitamin B2 (riboflavin)
Vitamin B5 (pantothenic acid)
Vitamin B6 (hydrochloride)
Vitamin B6 (pyridoxine)
Vitamin B12 (cyanocobalamin)
Vitamin C (ascorbic acid)
Vitamin D2 (calciferol)
Vitamin D3
Vitamin E (tocopherol/tocotrienol)
Vitamin F
Vitamin K

Nutritional Oils and Lipids
Blackcurrant oil
Borage oil
Canola oil
Citrus oil
Cocoa butter
Coconut oil
Corn oil
Cottonseed oil
Evening primrose oil
Flax seed oil
Gamma oryzanol
Hemp oil
Linseed oil
Liquid oils
Menhaden oil
Mosqueta oil
Olive oil
Omega-3 fish oil
Palm oil
Peanut oil
Rapeseed oil
Ricebran oil
Rose hip oil
Safflower oil
Sesame oil
Soybean oil
Sunflower oil
Teetree oil
Wheat germ oil
Triaglycerols

Fibres
Cereal fibres
Chitosan
Fructo-oligosaccharides
Fruit fibres
Inulin
Plant fibres
Vegetable fibres

Plant Extracts
Botanical extracts
Essential oils
Fruit extracts
Herbal extracts
Oleoresins
Spice extracts
Vegetable extracts

Minerals and Mineral Elements
Calcium
Iron
Magnesium
Manganese
Potassium
Sodium
Zinc

Other Health Ingredients
Algae based products
Bacterial cultures
Bee products
Caffeine
Catechin
Creatine
Egg based products
Enzyme and co-enzyme based products
Fruit ingredients (blueberry, cranberry, avocado, grape)
Fungi based products
Gelatine
Glutamine
Glutamine peptide
Gum acacia
L-carnitine
Lactoferrin
Natural immune components
Nut based products
Oltipraz
Protease inhibitors
Shark cartilage
Spirulina
Sugar alcohols
Theamflavin
Tryptophan
Wine extracts

Non-Dairy Proteins
Bonito
Gelatin
Sardine muscle
Tuna muscle
Meat proteins
Soybean protein concentrates, isolates, and hydrolysates

Phytochemicals
Allysl sulfides
Betaglucans
Carotenoids
Catechins
Chlorophyllins
Ellagic acid
Flavinoids
Thioallyl compounds and garlic
Indoles
Isoflavonoids
Isoprenoids
Isothoicyanates
Lecithin
Lignans
Lignins
Limonoids
Phytases
Phythalides
Phytoestrogens
Phytosterols
Polyacetylenes
Polyphenols
Saponins
Sulforaphanes
Terpenes
Tocotrienols

Probiotics
Bifidobacterium infantis
Bifidobacterium lactis
Bifidobacterium longum
Lactobacillus acidophilus
Lactobacillus delbrueckii ssp. Bulgaricus
Lactobacillus gasseri
Lactobacillus paracasei ssp. Paracasei
Lactobacillus plantarum
Lactobacillus reuteri
Lactobacillus rhamnosus
Pediococcus acidlactici
Saccharomyces
Streptococcus thermophilus

Prebiotics
Fructo-oligosaccharides
Inulin
Other dietary fibres
Resistant starches

Source: NutraIngredients.com

Table A5. Selected Herbal Remedies

Agnus-castus
Alfalfa
Aloe vera
Althea
American ginseng
American skullcap
Angelica sinensis
Artichoke
Asian ginseng
Ashwagandha
Astralagus
Avena sativa
Ayurvedic herbs
Bahupatra
Baikal skullcap
Barberry
Bearberry
Bedstraw
Bee pollen
Beta-sitosterol
Bhuiamla
Bilberry
Bitter melon
Black cohosh
Black currant oil
Black elder
Blackberry
Blessed thistle
Bloodroot
Blue cohosh
Blue flag
Blueberry
Blue-green algae
Boldo
Boneset
Boneset (comfrey)
Borage
Boswellia
Bottlebrush
Brazilian ginseng
Bromelain
Buchu
Bugleweed
Burdock
Butcher's broom
Calendula
Capsaicin
Capsicum
Caraway
Carob
Cascara
Cat's claw
Catechin
Catnip
Cayenne
Chamomile
Chaparral
Chaste tree
Chickweed
Chinese angelica
Chinese ginseng
Chinese skullcap
Cinnamon
Cleavers
Coleus
Coltsfoot
Comfrey
Corydalis
Cranberry
Cranesbill
Creosote bush
Daidzein
Damiana
Dandelion
Desert parsley
Desert tea
Devil's claw
Dewberry
Dong quai
Echinacea
Epigallocatechin gallate
Elderberry
Elecampane
Eleuthero
Eleutherococcus
Ephedra
Eucalyptus
European blackberry
European mistletoe
European vervain
Evening primrose oil
Eyebright
False unicorn
Fennel
Fenugreek
Feverfew
Flaxseed
Flea seed
Fleur-de-lis
Forskolin
Fo-ti
Fragrant valerian
Garcinia
Garlic
Ge-gen
Genistein
Gentian
German chamomile
Ginger
Gingko bilboa
Ginseng
Globe artickoke
Gobernadora
Golden root
Goldenseal
Goose grass
Gotu kola
Grape seed extract
Greater celandine
Green tea
Guaraná
Guggul
Gugulipid
Gurmar
Gymnema
Hawthorn
Heliotrope
He-shou-wu
Hops
Horehound
Horse chestnut
Horseradish
Horsetail
Hua gu
Huang qi
Huckleberry
Hyssop
Indian ipecac
Indian mulberry
Indian tobacco
Inula
Isoflavone
Ivy leaf
Juniper
Katki
Kava kava
Kelp
Kinnikinnick
Klamath weed
Knitbone

Korean ginseng
Kudzu
Kutki
Lapacho
Lavender
Lemon balm
Licorice
Lignan
Ligustrum
Lime blossom
Lime flower
Linden
Ling chih
Ling zhi
Linseed oil
Lobelia
Lomatium
Lucerne
Ma huang
Mahonia
Maidenhair tree
Makandi
Maitake fungi
Manuka
Marigold
Marshmallow
Meadowsweet
Melaleuca
Melissa
Milfoil
Milk thistle
Milk vetch
Mistletoe
Monk's pepper
Mormon tea
Mullein
Myrrh
Nettle
Noni
Oak
Oats
Old man's beard
Olive leaf
Oregano
Oregon grape
Panax ginseng
Papain
Passiflora
Passion flower
Pau d'arco
Peppermint
Phyllanthus
Phytosterols
Picrorhiza
Pineapple enzyme
Plantago seed
Pollen
Pot marigold
Privet
Proanthocyanidins
Psyllium fiber
Pumpkin
Purple coneflower
Pycnogenol
Pygeum
Qinghao
Raspberry leaf
Red clover
Red eyebright
Red raspberry
Red yeast rice
Reishi fungi
Rosemary
Rumex
Sabal
Sacred bark
Sage
Salai guggal
Sandalwood
Sarsaparilla
Saw palmetto
Schisandra
Scouring rush
Senna
Shave grass
Shiitake fungi
Siberian ginseng
Silybum
Slippery elm
Soy
Spirulina
Spotted cranebill
St. Benedict thistle
St. John's bread
St. John's wort
Starflower
Stevia
Stining nettle
Suma
Sundew
Sweet Annie
Sweet wormwood
Sweetleaf
Taheebo
Tang kuei
Tea tree oil
Thyme
Turmeric
Tylophora
Una de gato
Usnea
Uva ursi
Valerian
Vervain
Vitex
White willow
Wild cherry
Wild clover
Wild indigo
Wild marjoram
Wild oats
Wild yam
Willow bark
Witch hazel
Wormwood
Wu-wei-zi
Yan hu so
Yarrow
Yellow dock
Yellow gentian
Yohimbe
Yucca

APPENDIX B

Table B1. Canadian Food Manufacturing by Category (CAD$ billions)

Food Category	1990	1998	Annual Growth	Projected 2002
Meat & Meat Products (except poultry)	9	11.1	2.7%	12.3
Poultry Products	2.2	3.4	5.6%	4.2
Fish Products	2.6	2.9	1.4%	3.1
Canned and Preserved Fruits and Vegetables	2.3	2.7	2.0%	2.9
Frozen Fruits and Vegetables	0.9	1.4	5.7%	1.7
Fluid Milk	3	3.7	2.7%	4.1
Other Dairy Products	4.5	4.6	0.3%	4.7
Cereal Grain Flour	0.8	1.1	4.1%	1.3
Prepared Flour Mixes and Prepared Cereal Foods	0.6	1.1	7.9%	1.5
Feed	2.8	4.5	6.1%	5.7
Vegetable Oil Mills (except Corn Oil)	0.8	2.5	15.3%	4.4
Biscuits	0.5	0.8	6.1%	1.0
Bread and other Bakery Products	1.9	2.4	3.0%	2.7
Cane and Beet Sugar	0.6	0.8	3.7%	0.9
Chewing Gum	0.3	0.4	3.7%	0.5
Sugar and Chocolate Confectionery	0.9	1.6	7.5%	2.1
Tea and Coffee	0.7	1	4.6%	1.2
Dry Pasta Products	0.2	0.3	5.2%	0.4
Potato Chips, Pretzels, and Popcorn	0.6	1	6.6%	1.3
Malt and Malt Flour and other Food Products	3.3	4.6	4.2%	5.4
Soft Drinks	1.6	2.7	6.8%	3.5
Distillery Products	0.9	0.8	-1.5%	0.8
Brewery Products	2.8	3.5	2.8%	3.9
Wine	0.3	0.4	3.7%	0.5
Total	44.1	59.3	3.8%	68.8

Source: Industry Canada, http://strategis.ic.gc.ca

Table B2. Food Production and Investment in Canada, 1990, 1998 (CAD$ billions)

	Production		Annual	Investment		Annual
	1990	1998	Increase	1990	1998	Increase
Total Meat & Meat Products	9	11.1	2.7%	250	246.6	-0.2%
Poultry Products	2.2	3.4	5.6%	62.5	75.4	2.4%
Fluid Milk	3	3.7	2.7%	84.9	81.4	-0.5%
Other Dairy Products	4.5	4.6	0.3%	125.1	101.8	-2.5%
Total Dairy and Poultry	9.7	11.7	2.4%	272.5	258.6	-0.7%
Canned & Preserved Fruit & Vegetable	2.3	2.7	2.0%	64.4	61	-0.7%
Frozen Fruit & Vegetable	0.9	1.4	5.7%	25.9	31.7	2.6%
Total Fruit, Vegetable, & Legume	3.2	4.1	3.1%	90.3	92.7	0.3%
Cereal Grain Flour	0.8	1.1	4.1%	22.1	24.5	1.3%
Prepared Flour Mixes & Prepared Cereal Foods	0.6	1.1	7.9%	17.7	24.8	4.3%
Vegetable Oil Mills (except corn oil)	0.8	2.5	15.3%	22.4	56.2	12.2%
Biscuit	0.5	0.8	6.1%	14.2	18.7	3.5%
Bread & Other Bakery	1.9	2.4	3.0%	52.9	52.7	0.0%
Dry Pasta Products	0.2	0.3	5.2%	5.2	5.5	0.7%
Total Grain & Oilseed	4.8	8.2	6.9%	134.5	182.4	3.9%
Total Fish Products	2.6	2.9	1.4%	73.8	63.7	-1.8%
Grand Total	29.3	38	3.3%	821.1	844	0.3%

Source: Industry Canada, http://strategis.ic.gc.ca

Table B3. US functional foods and nutraceuticals estimates ($US millions)

Functional Food	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
Juice	589	743	813	887	966	1,047	1,132	1,217	1,303	1,675
frozen juice	239	240	262	285	308	332	356	379	402	492
canned & bottled juice & drinks	1,107	1,275	1,397	1,527	1,663	1,806	1,953	2,102	2,253	2,906
prepared drinks (tea/coffee)	749	766	800	834	867	900	931	961	989	1,092
soft drinks*	1,677	1,862	2,193	2,562	2,971	3,414	3,888	4,384	4,895	7,198
Beverages	4,361	4,886	5,465	6,095	6,775	7,499	8,260	9,043	9,842	13,363
annual growth		12.0%	11.9%	11.5%	11.2%	10.7%	10.1%	9.5%	8.8%	6.3%
snack food	113	168	235	364	1,558	1,828	2,122	2,440	2,779	4,735
nutrition bars	500	670	860	950						
candy & gum*	30	30	31	32	33	34	34	35	36	38
Snack Foods	643	868	1,126	1,346	1,591	1,862	2,156	2,475	2,815	4,773
annual growth		35.0%	29.7%	19.5%	18.2%	17.0%	15.8%	14.8%	13.7%	11.1%
frozen prepared foods	240	252	347	470	623	810	1,031	1,284	1,565	3,030
baby food	792	803	852	902	952	1,002	1,050	1,097	1,141	1,310
canned & dry soup	190	272	292	313	333	354	374	394	413	486
Desserts	10	10	10	11	11	11	11	11	11	12
Packaged/Prepared Foods	1,232	1,337	1,501	1,696	1,919	2,177	2,466	2,786	3,130	4,838
annual growth		8.5%	12.4%	12.9%	13.2%	13.4%	13.3%	13.0%	12.4%	9.1%
milk/soymilk	250	290	350	438	480	524	569	616	663	871
canned milk	10	10	11	11	12	13	14	15	15	18
frozen dairy/ice cream	189	215	225	236	246	257	267	276	285	431
other dairy	1,065	1,215	1,310	1,387	1,520	1,660	1,806	1,954	2,103	2,762
Dairy	1,514	1,730	1,896	2,072	2,258	2,454	2,656	2,861	3,066	4,082
annual growth		14.3%	9.6%	9.3%	9.0%	8.7%	8.2%	7.7%	7.2%	5.9%
baking needs	121	121	125	128	130	133	136	138	141	149
instore bakery	360	382	388	394	399	404	409	413	417	431
frozen breads & grains	136	148	154	159	164	170	174	179	184	200
baked goods	1,199	1,222	1,234	1,245	1,257	1,267	1,278	1,288	1,297	1,332
dried breads & grains	24	25	26	27	29	30	31	32	32	36
Pasta	23	23	23	23	23	23	23	23	23	24
dry breakfast foods	3,886	3,914	4,033	4,149	4,262	4,371	4,474	4,572	4,663	4,992
Breads & Grains	5,749	5,835	5,983	6,125	6,264	6,398	6,525	6,645	6,757	7,164
annual growth		1.5%	2.5%	2.4%	2.3%	2.1%	2.0%	1.8%	1.7%	1.2%
Sweeteners*	30	29	30	30	30	31	31	31	32	33
Condiments, dressings, spreads, sauces	57	57	60	62	64	67	69	71	73	79
Condiments	87	86	90	92	94	98	100	102	105	112
annual growth		-1.1%	4.7%	2.2%	2.2%	4.3%	2.0%	2.0%	2.9%	1.3%
Total Functional Foods	13,586	14,742	16,061	17,426	18,901	20,488	22,163	23,912	25,715	34,332
annual growth		8.5%	8.9%	8.5%	8.5%	8.4%	8.2%	7.9%	7.5%	6.0%

source: Nutrition Business Journal Functional Foods Report 2001

Nutraceuticals and Supplements	1997	1998	1999	2000	2001	2002	2003	2004	2005
MultiVitamins	2,600	2,770	2,890						
Vitamin C	720	750	770						
Vitamin E	730	800	860						
B Vitamins	580	610	630						
Vitamin A/Beta Carotene	190	200	210						
Others	260	480	420						
Total Vitamins	5,320	5,610	5,780	5,900	6,018	6,132	6,261	6,386	6,514
annual growth		5.5%	3.0%	2.1%	2.0%	1.9%	2.1%	2.0%	2.0%
Ginkgo Bilboa	226	299	297						
St. John's Wort	100	308	233						
Echinacea	203	208	214						
Ginseng	227	216	191						
Garlic	215	198	176						
Saw Palmetto	86	105	117						
Kava Kava	22	44	70						
Valerian	30	42	57						
Aloe	56	46	53						
Cranberry	39	41	49						
Goldenseal	60	57	43						
Milk Thistle	21	34	42						
Bilberry	38	33	37						
Soy	-	5	36						
Cascara Sagrada	23	24	36						
Primrose	26	25	35						
Black Cohosh Root	4	11	34						
Cayenne	37	25	34						
Grape Seed Extract	31	34	31						
Mahuang	20	24	29						
Dong Quai	28	25	29						
Cat's Claw	45	29	27						
Ginger	23	21	26						
Green Tea	14	22	23						
Psyllium	18	23	23						
Chamomile	14	15	22						
All Others	240	291	407						
Total Herbs and Botanicals	3,520	3,960	4,070	4,170	4,270	4,364	4,451	4,531	4,618
annual growth		12.5%	2.8%	2.5%	2.4%	2.2%	2.0%	1.8%	1.9%
Powders/Formulas	960	1,110	1,210	1,290					
Pills	100	95	90	90					
Drinks	110	115	120	130					
Total Sports Nutrition Supplements	1,170	1,320	1,420	1,510	1,616	1,722	1,829	1,935	2,040
annual growth		12.8%	7.6%	6.3%	7.0%	6.6%	6.2%	5.8%	5.4%

Nutraceuticals and Supplements continued	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Calcium	507	567	681	742					
Magnesium	78	85	91	106					
Chromium	74	80	81	90					
Zinc	68	82	84	85					
Selenium	53	57	60	61					
Potassium	53	55	57	59					
Iron	157	162	170	175					
Others	60	52	65	72					
Total Minerals	1,050	1,140	1,290	1,390	1,523	1,639	1,750	1,862	1,974
annual growth		8.6%	13.2%	7.8%	9.6%	7.6%	6.8%	6.4%	6.0%
Meal Supplements	1,720	1,840	1,970	2,070	2,166	2,263	2,357	2,450	2,541
annual growth		7.0%	7.1%	5.1%	4.6%	4.5%	4.2%	3.9%	3.7%
Melatonin	90	80	75	71					
Probiotics	90	95	103	111					
DHEA	55	50	49	48					
Essential Fatty Acids	130	160	182	201					
Glucosamine	130	240	341	402					
Bee Products	50	55	59	62					
CoQ10	110	140	151	169					
5 HTP	30	35	39	40					
SAMe	-	12	132	170					
Homeopathics	260	295	313	325					
Others	45	48	57	70					
Total Specialty Supplements	990	1,210	1,500	1,670	1,837	2,000	2,155	2,309	2,461
annual growth		22.2%	24.0%	11.3%	10.0%	8.9%	7.8%	7.1%	6.6%
Total Nutraceuticals and Supplements	13,770	15,080	16,030	16,710	17,430	18,120	18,803	19,473	20,148
annual growth		9.5%	6.3%	4.2%	4.3%	4.0%	3.8%	3.6%	3.5%
Total Agri-food Related Nutraceuticals	7,400	8,330	8,960	9,420	9,889	10,349	10,792	11,225	11,660
annual growth		12.6%	7.6%	5.1%	5.0%	4.7%	4.3%	4.0%	3.9%
Total Nutraceuticals and Functional Foods	27,356	29,822	32,091	34,136	36,331	38,608	40,966	43,385	45,863
annual growth		9.0%	7.6%	6.4%	6.4%	6.3%	6.1%	5.9%	5.7%
Total N&FF Agri-food Related	20,986	23,072	25,021	26,846	28,790	30,837	32,955	35,137	37,375
annual growth		9.9%	8.4%	7.3%	7.2%	7.1%	6.9%	6.6%	6.4%

source: Nutrition Business Journal Supplement Business Report 2001

Table B4. U.S. Penetration Rates of Functional Foods 1999 and 2010 (US$ millions)

	Total sales	Functional sales	% Functional	Total sales	Functional sales	% Functional
		1999			2010	
Functional Food						
Juice	4,712	813	17.3%	6,183	1,675	27.1%
frozen juice	1,048	262	25.0%	1,375	492	35.8%
canned & bottled juice & drinks	7,760	1,397	18.0%	10,182	2,906	28.5%
prepared drinks (tea/coffee)	9,882	800	8.1%	12,966	1,092	8.4%
soft drinks*	27,068	2,193	8.1%	35,516	7,198	20.3%
Total Beverages	50,470	5,465	10.8%	66,222	13,363	20.2%
snack food & nutrition bars	12,883	1,095	8.5%	16,904	4,735	28.0%
candy & gum*	15,011	31	0.2%	19,696	38	0.2%
Total Snack Foods	27,894	1,126	4.0%	36,600	4,773	13.0%
frozen prepared foods	6,428	347	5.4%	8,434	3,030	35.9%
baby food	4,261	852	20.0%	5,591	1,310	23.4%
canned & dry soup	4,057	292	7.2%	5,323	486	9.1%
Desserts	813	10	1.2%	1,067	12	1.1%
Total Packaged/Prepared Foods	15,559	1,501	9.6%	20,415	4,838	23.7%
milk/soymilk & other dairy	43,904	1,660	3.8%	57,606	3,633	6.3%
canned milk	428	11	2.6%	562	18	3.2%
frozen dairy/ice cream	7,764	225	2.9%	10,187	319	3.1%
Total Dairy	52,096	1,896	3.6%	68,355	3,970	5.8%
baking needs	3,464	125	3.6%	4,545	149	3.3%
instore bakery	12,937	388	3.0%	16,974	431	2.5%
frozen breads & grains	2,560	154	6.0%	3,359	200	6.0%
baked goods	24,675	1,234	5.0%	32,376	1,332	4.1%
dried breads & grains	1,632	26	1.6%	2,141	36	1.7%
Pasta	2,256	23	1.0%	2,960	24	0.8%
dry breakfast foods	9,717	4,033	41.5%	12,750	4,992	39.2%
Total Breads & Grains	57,241	5,983	10.5%	75,105	7,164	9.5%
Sweeteners*	2,964	30	1.0%	3,889	33	0.8%
Condiments, dressings, spreads, sauces	11,950	60	0.5%	15,679	79	0.5%
Total Condiments	14,914	90	0.6%	19,568	112	0.6%
Other Food Categories	255,934	-	0.0%	335,808	-	0.0%
Total Functional Foods	474,108	16,061	3.4%	622,073	34,220	5.5%

Source: Nutrition Business Journal Functional Food Report 2001

APPENDIX C

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