Flaxseed Lignans  
Phytochemicals for the New Millennium  
by Bernard M. Collett, PhD

Flaxseed, from the Linaceae family (Linum usitatissimum) is emerging as the powerhouse source of both nutritive and non-nutritive health-benefitting plant substances. The increasing body of scientific research aimed at deciphering the role of these naturally occurring plant substances found in this remarkable seed, is yielding results. To understand the role these factors contribute to preventative health care, we must first look at the flaxseed itself.

Flaxseed's Health-Benefiting Factors
The flaxseed "power-house" consists of a three-pronged delivery of the omega-3 essential fatty acid (alpha-linolenic acid), soluble and insoluble fiber, and the lignans. Eighty percent of the oil fraction is found in the embryo/endosperm. Both the fiber and lignans originate in the 5-layer seed coat (Figure 1).

People are becoming familiar with the health benefits of dietary fiber, and the FDA has included three fiber-related claims on their list of approved health claims for cancer and coronary heart disease. Flaxseed delivers a wonderful fiber package. Table 1 is a comparison of the fiber content of familiar plant seeds, grains and their brans.

Flaxseed yields a generous amount of insoluble fiber, but the important soluble fraction is among the most concentrated. Soluble fiber slows the rate at which the stomach empties thereby slowing the rate that food is broken down and absorbed into the bloodstream. This promotes better nutrient absorption, helps keep blood sugar levels steady, and plays an important role in weight control by curbing the appetite. Insoluble fiber, conversely, speeds up body waste transit time, promoting detoxification, binding cholesterol and bile acids, thereby leading to the overall health of our digestive system, and indeed, our body. Lorenzani has written a clear and succinct overview of the function, mechanisms and protective health benefits of fiber.

Americans are beginning to become much more aware of the importance of the essential fatty acids (EFAs), as is, finally, the FDA (at this time there is a "qualified" coronary heart disease claim for EPA and DHA). There are two EFA families, omega 6, the parent being linoleic acid, and omega 3, with the alpha-linolenic acid parent. The word "essential" means, in dietary terms, that the body cannot manufacture these two EFAs, and therefore they must be specifically obtained from our daily diet. EPA and DHA are derivatives of the omega 3 parent EFA that are "synthesized" in the body (in vivo).

These derivatives, in turn, give rise in vivo to hormone-like molecules called eicosanoids. Eicosanoids are produced from both the omega 3 and omega 6 EFAs and have opposing functions that can have profound positive (omega 3) or negative (omega 6) influence on health. Since the early 1960's, we Americans have been deluged with omega 6 as a result of the belief that at that time that diets high in saturated fats raised cholesterol and that their consumption should be reduced with the substitution of omega 6 polyunsaturated oils. Later and extending to our current time, the fat-free "craze" has further contributed to our most misunderstood nutrient group, the fats. The omega 3 EFA has all but disappeared from our 21st century, Western diet. omega 3, to retain its disease-preventive properties, must be processed and handled like a perishable food. Dr. Simopoulos book is an excellent and readable source for those seeking more information and knowledge about the omega 3 EFAs and the "right fats."

Phytoestrogens
Americans are currently hearing more about phytoestrogens. "Phyto" means plant and estrogen is the sex hormone that is predominately in females. People are hearing about phytoestrogens because of the increasing popularity of soy-based

Table 1

<table>
<thead>
<tr>
<th>Fiber Component %</th>
<th>Flax Seed</th>
<th>Oat Bran</th>
<th>Oatmeal</th>
<th>Wheat Bran</th>
<th>Corn Bran</th>
<th>Rice Bran</th>
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<tr>
<td>Total Dietary Fiber</td>
<td>40</td>
<td>17</td>
<td>11</td>
<td>49</td>
<td>78</td>
<td>75</td>
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<tr>
<td>Soluble Fiber</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Insoluble Fiber</td>
<td>30</td>
<td>8</td>
<td>6</td>
<td>43</td>
<td>76</td>
<td>71</td>
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A growing body of scientific research is now pointing to another exciting and promising class of phytoestrogens. These are the lignans. We now know that there are two major phytoestrogen groups; the isoflavones that are found in greatest concentration in the soybean (a legume), and the lignans, found in greatest concentration in flaxseed. It has only been in the last 12 years that the startling finding was made that flaxseed contains by far the most concentrated source of lignans. The research of Dr. Lillian Thompson of the University of Toronto reported on the study of 66 plant food sources with the finding that flaxseed contains 75 to 800 times the amount of lignans of any other of these likely plant sources. Indeed, the discovery of lignans in the human body and the method of their isolation from flaxseed have only been known for about two decades.

To understand how phytoestrogens arrive in the human body one must understand their origin in the plant and their subsequent metabolism. Reference to Figure 2 helps in this understanding. Both the isoflavones and flaxseed lignans occur naturally as plant phytoestrogen precursors. In the soybean or flaxseed plant they are glycosidically linked to carbohydrates (a chemical link to a sugar moiety). When ingested, the plant phytoestrogens are converted to mammalian derivatives by bacterial metabolism in the colon. These are then absorbed from the intestine, transported to the liver and then excreted in the bile (enterohepatic circulation). At this point, they are partially reabsorbed and appear in relatively high concentrations in blood plasma and are finally eliminated from the body, in part, by renal clearance in the urine. With this understanding of phytoestrogen source and metabolism, we can turn more specifically to consideration of the flaxseed lignans and the emerging implications for their impact on health and on disease prevention.

**Flaxseed Lignans**

A little over two decades ago the principal flaxseed lignan phytoestrogens were isolated and their biological pathways and metabolic conversion in vivo were elucidated. By far the most prevalent plant lignan was determined to be secoisolariciresinol diglycoside (SDG). A second plant lignan, matairesinol, was found but in concentrations many times less than SDG. Plant lignan precursors, as discussed above, are converted by colonic bacteria to the mammalian (animal) lignans enterodiol (ED) from SDG, and enterolactone (EL) from matairesinol, respectively (Figure 2). However, SDG is the significant plant lignan because it can be oxidized in vivo from ED to EL and is present in potentially significant quantities. ED occurs in concentrations up to 7 times greater than EL, indicating the substantial conversion by in vivo oxidation of ED to EL.

ED and EL exhibit hormone-like properties, mimicking the endogenous (natural occurring) estrogens. They
have similar molecular weights and structures to those of steroids such as the estrogens (see Figure 3). Their peculiar level of biological activity functions to antagonize the body’s estrogen cycle due to their ability to act either as a weak estrogen or as an antiestrogen. Current scientific research indicates it is through this dual mechanism that the mammalian lignans play a protective role in hormone-related cancer of the breast, ovary and prostate.3,4,7-9

**Potential Health Benefits**

As we have seen, the mammalian lignans function to modulate hormone-related cancer through estrogenic mechanisms. When acting as an estrogen, they function biologically in the same way but with 100 to 1000 times less potency. Because they are “weak” when compared to the body’s own estrogens, they attenuate the estrogen carcinogenic effect, of particular importance in postmenopausal women. When acting as an anti-estrogen, they compete with the body’s endogenous estrogens for receptor sites, thus reducing access to pathways that can lead to potentially adverse pathogenesis.4,12,14,17,30

**Flaxseed Lignans**

Since the development of methods for isolating SDG in the 1990’s,33,31 scientific studies, particularly by Thompson et al.,23,7-9,32 have shown convincingly that hormonal cancer protection is due to the lignan component of the flaxseed through their estrogen-like bioactivity. Science has also convincingly shown that the omega 3 oil fraction of flaxseed is the basis of cardiovascular protection through the mechanism of conversion in vivo to the hormone-like cell “regulator” eicosanoids. “Eicosan” signifies twenty in Greek, and the 20-carbon plus omega 3 derivative group of prostaglandins E2, leukotrienes B5 and thromboxanes A3 positively impact inflammation, vascular constriction, thrombosis and platelet aggregation.2

Research conducted and published since the mid-90’s is slowly unlocking the health benefiting “secrets” of the three-fold disease fighting factors that are found in the remarkable flaxseed “storehouse.” Curiously, this recent work also indicates that much of the earlier research using flaxseed and attributing protective effects to the omega 3 oil faction, and to a lesser extent, to the dietary fiber fraction, are actually a “health synergy” emanating from all three! Figure 4 summarizes the

**Figure 3**


**Figure 4**

Cardiovascular Disease

<table>
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<tr>
<td>Cancer</td>
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<td>Digestive Health</td>
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<tr>
<td>Other Degenerative Disease</td>
</tr>
<tr>
<td>Cellular Health</td>
</tr>
<tr>
<td>Diabetes</td>
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</table>
Flaxseed Lignans

many health benefits of flaxseed and/or its components cited in the scientific research over the years.

One of the many examples of this “health synergy” is cardiovascular protection. The omega 3 oil derivatives regulate platelet aggregation, thrombosis (blood clotting), and vascular constriction.22,23 Soluble fiber slows down and regulates the nutrient, sugar, and fat absorption into the bloodstream and contributes to weight control, while insoluble fiber binds and reduces cholesterol in the colon where it is synthesized enterohenepatically (in the liver),1 the mammalian lignans antagonize low density lipoprotein (LDL) receptor sites and inhibit the rate-limiting enzyme function in cholesterol formation.2,4,17

Phytochemicals for the New Millennium

Taking into consideration the above discussed “health synergy”; Table 3 summarizes the health-benefiting factors attributed to flaxseed fiber, the omega 3 EFA, and, in part or exclusively, to the flaxseed lignans by published scientific research.

Flaxseed Components and Health Benefits

Most of the studies at this current stage involve animal models. There are several promising human epidemiological studies and clinical trials.4,17,20 However, much remains to be done in the study of the flaxseed lignans. Can they be the “Phytochemicals of the New Millennium”? There is good reason to believe they can significantly live up to this “billing.”

In April of 2001, the world’s largest supplier of food ingredients licensed the worldwide rights to the method and process patents for commercial production of SDG, the principal plant phytosterol in flaxseed.25,26 Archer Daniels Midland (ADM) signed an exclusive agreement for flax lignan technology with The Flax Consortium, a research collaboration between Agriculture and Agri-Food Canada, the Saskatoon Research Centre, the University of Saskatchewan Technologies Inc., and Dr. William Clark of the University of Western Ontario and the London Health Sciences Centre.

The mission of The Flax Consortium, formed in 1995, has been to extract, purify and study the use of flax lignans for the prevention and treatment of diseases. The license gives ADM the 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 additives and veterinary products.33-35 ADM has committed substantial research dollars to the task of completing toxicology studies and clinical trials, anticipating a three to five year period before these purified lignan phytochemicals will be commercially available.29

In the meantime, we can take advantage of the fact that these “phytochemicals for the new millennium” are provided for us by Mother Nature in flaxseed’s amazing “storehouse.”

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References

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<td>Weight Management</td>
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Table 3
Flaxseed Components and Health Benefits

Key:
CVD = Cardiovascular Disease
C = Cancer
CH = Cellular Health
Dbs = Diabetes
Dig = Digestive Health
Deg = Degenerative Disease
(IBD) = Irritable Bowel Disease (IBD)
Bowel Syndrome (IBS), Other Autoimmune and “itis” Diseases
All = All Categories


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