Soy Toxins
There's plenty yet that you didn't know about soy!

By William Jarvis, Ph.D.

Soy contains several naturally occurring compounds that are toxic to humans and animals. The soy industry frequently refers to these toxins as anti-nutrients, which implies that they somehow act to prevent the body getting the complete nutrition it needs from a food. The soy toxins (such as phytic acid) can certainly act in this manner, but they also have the ability to target specific organs, cells and enzyme pathways and their effects can be devastating.

The soy toxins that Soy Online Service have concerns about are protease inhibitors, phytic acid, soy lectins (or haemagglutins), nitrosamines, manganese concentrations and the mysterious soyatoxin. Nitrosamines are not naturally occurring in soybeans but form during the processing of products such as isolated soy protein (ISP).

As with any toxin there will be a dose at which negative effects are not observed. Soy Online Services have examined the scientific data on the soy toxins and have uncovered several alarming truths:

♦ There is no legislation to protect consumers from soy toxins in raw soy products.
♦ With the possible exception of soy lecithin, all soy products, no matter how well treated, contain low to moderate levels of soy toxins; processing cannot remove them all or many of them.
♦ The soy industry has little in the way of quality control to protect consumers from exposure to inadequately treated soy products.

Protease Inhibitors

Perhaps the best known of the soy toxins are the protease inhibitors (also referred to as trypsin inhibitors) which, as the name suggests, are able to inhibit the action of proteases (including trypsin) which are enzymes that are involved in the process of dismantling proteins for use by the body. In the rat, high levels of exposure to protease inhibitors (such as that found in raw soy flour) cause pancreatic cancer whereas moderate levels cause the rat pancreas to be more susceptible to cancer-causing agents. The validity of the rat model to humans has been questioned and the USFDA have examined the effects of protease inhibitors on the Cebus monkey (JP Harwood et al., Adv Exp Med Biol 1986 199: 223-37).

The parameters of the Cebus Monkey study were as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of monkeys</th>
<th>Dietary Protein</th>
<th>Trypsin Inhibitor (mg/g of diet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>Lactalbumin</td>
<td>0.12</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>Soy Isolate</td>
<td>0.54</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>Casein</td>
<td>0.08</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Soy Concentrate</td>
<td>2.41</td>
</tr>
</tbody>
</table>

After five years of chronic ingestion to low levels of trypsin inhibitors, there was no discernible pancreatic damage effect in monkeys from groups 1-3. However, one monkey in group 4 exhibited moderate diffuse acinar atrophy, moderate diffuse interstitial fibrosis and moderate chronic pancreatitis in all three sections of tissue examined. Minimal lymphoid hyperplasia was noted in the other group 4 monkey.

Therefore, there is good reason to question claims that low levels of soy protease inhibitors pose no
threat to human health. Such a statement has even been made by the USFDA in response to a health claim petition by Protein Technologies. The USFDA reported that:

‘Concerns have been raised in the past about exposure to trypsin inhibitors contained in soybeans because these compounds had been found to stimulate pancreatic hyperplasia and hypertrophy in animals. These concerns have been allayed because heat treatment removes most of the activity of these proteases. In addition, recent studies have questioned the applicability of the animal models, which differ from humans in the type of diet, sensitivity of the pancreas to trypsin inhibitors, and the anatomic sites of pancreatic cell proliferation and have found low rates of cancer in populations with dietary patterns that include soy foods’ (FR 63, 217:62977-63015, 1998).

This statement brought an angry response from Professor Irvin Leiner, the foremost expert on protease inhibitors. In his reply to the FDA Liener wrote:

‘The impression one gets from reading this section is that there is little cause for concern as far as the human exposure to soybean trypsin inhibitors is concerned.... In the interests of a balanced treatment of the subject, I trust you will give due consideration to the opposing view that the soybean trypsin inhibitors do in fact pose a potential risk to humans when soy protein is incorporated into the diet.’

So, if there is valid concern about low levels of protease inhibitors in soy foods, what about exposures to levels higher than those in the Cebus monkey study? Is there any chance that such exposures could occur in human diets?

Soy Online Service has noted that there is considerable variability in the levels of protease inhibitors in commercially available foods and that there is little to protect consumers from exposure to high levels of protease inhibitors. For example, a study entitled ‘Trypsin inhibitor levels in soy-based infant formulas and commercial soy protein isolates and concentrates (RW Peace et al., 1992, Food Res Int, 25: 137-141) found that trypsin inhibitor levels were as high as 2.72 mg/g in ready to feed soy formulas and 7.30 mg/g in soy protein concentrate.

Since there is no established acceptable levels of protease inhibitors in foods and no protection from short-term high level (acute) exposures or long term low level (chronic) exposures, Soy Online Service offer the following advice:

♦ Don’t feed your baby or infant a soy formula; there are alternatives!

♦ Avoid the direct consumption of raw or partially processed soy products such as soy flour or soy protein concentrate. Traditionally fermented soy foods are relatively free of protease inhibitors.

♦ When preparing your own soy foods, such as boiled or roasted soybeans or soy milk, ensure that they are adequately heated. The traditional Chinese method for preparing soybeans was a time consuming job that was left to monks. It involved soaking the beans first and then boiling them twice over ‘the full length of an incense’.

Phytates

The term phytate refers to several compounds that are based on phytic acid (inositol hexaphosphate). It is the presence of multiple phosphates in phytates that makes them effective chelating agents, i.e. they have the ability to bind to certain metal ions. Obviously if metals are bound up in a phytate-complex, they are less available to the body (i.e. less bioavailable) for nutritive purposes.

Phytates are particularly adept at binding metals in their so-called divalent state, metal ions such as calcium (Ca^{2+}), copper (Cu^{2+}), iron (Fe^{2+}), manganese (Mn^{2+}) and zinc (Zn^{2+}).
Soybeans contain very high levels of phytate and there are numerous reports of reduced bioavailability of various metals from foods containing soy; this has particular significance for vegetarians and infants fed soy-formulas.

Vegetarians, particularly young women vegetarians, need to be aware that soy products affect their iron and zinc requirements and it has been recommended that they utilise strategies that minimise the intake of dietary phytate.

The effects of phytate in soy-formulas are a great concern. The iron and zinc requirements of developing infants are well documented, particularly those that relate to cognitive function. There is no question that infants fed soy-formulas are at greater risk of reduced uptake of various essential minerals compared with breast-fed infants or infants fed other formulas.

♦ Copper bioavailability is significantly lower in rhesus monkeys fed low-phytate soy formula from 2 to 4 months.

♦ Iron absorption in infants is approximately doubled by the removal of phytate from soy formula; a similar effect is observed by doubling the ascorbic acid content of a soy formula.

♦ Manganese absorption is also doubled by the removal of phytate from soy formula, but increasing the ascorbic acid content of a soy formula containing the native amount of phytic acid did not improve manganese absorption.

♦ Zinc bioavailability from soy formulas is also reduced by phytate. In rhesus monkeys, zinc absorption was 2.0 times greater from monkey milk compared with soy formula, 2.2 times greater from whey-predominant formula compared with soy formula and 1.7 times greater from casein-predominant formula compared with soy formula. Zinc absorption from dephytinized soy formula was approximately the same as that from casein-predominant formula.

Soy formulas are typically over-supplemented with minerals and vitamins to account for the deficiencies caused by phytate, but it is evident that this does not take care of the problems. Removal of phytate from soy formulas is altogether a better solution but manufactures have not shown any inclination do this. Why not? Phytate removal will cost $$$ and it seems to us that soy formula manufacturers consider economics to be more important than the well being of infants.

Manganese

The soybean plant has the ability to absorb manganese from the soil and concentrate it to an extent that soy-based infant formulas can contain as much as 200 times the level of manganese found in natural breast milk. In babies, excess manganese that cannot be metabolised is stored in body organs. Around eight percent of the excess manganese in the diet is stored in the brain in close proximity to the dopamine-bearing neurons responsible, in part, for adolescent neurological development.

The implications are that the one in eight infants raised on soy formula during the first six months of life may be at risk of brain and behavioural disorders that do not become evident until adolescence.

Vitamin B12 Deficiency

Vitamin B 12 deficiency has been recognised as a serious result of soy consumption for many years. For instance JJ Rackis discusses it in January 1974 in "Biological and Physiological Factors in Soybeans' in the J. Am. Oil Chemists Soc, pp 161", and Irvin E Liener examines it in 1994 in "Implications of Anti-Nutritional Components in Soybean Foods in Soybean" in Critical Reviews in Food Science and Nutrition.
There is a simple explanation of some of the physical effects that can result from a deficiency of this important nutrient at. "Vegans Deficient in Nutrients".

If the Moorhead trial judge had known this, would these people now be serving a jail term for the death of their child?

Other Toxins

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The FDA Consumer article on soy spoke of the possible risks of plant estrogens, but made no mention of the carcinogenic effects of protease inhibitors found in soy. McGuinness et al. report rats fed raw soya flour develop cancer of the pancreas ("The effects of long-term feeding of soya flour on the rat pancreas," Scandinavian Journal of Gastroenterology, 1980; 15:497-502). They say that preheating the flour protected the animals, but others have said that the high heat required (130 degrees Celsius) to deactivate the carcinogenic trypsin inhibitors in soya flour denatures the soy proteins to the point that they become virtually useless. If this is so, one either chooses less heating, resulting in more surviving trypsin inhibitors, or more heating, resulting in useless protein.

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