The Safety of Soya

The VVF examines the latest science on soya. We give you the facts on the wealth of health benefits and the supposed risks of the humble soya bean.

By Dr Justine Butler
VVF Senior Health Campaigner

Over the last few years we have heard how soya is a very good source of nutrients and can protect against heart disease, certain cancers and may reduce the risk of osteoporosis and menopausal symptoms – it might even help boost brain power. However, not all the reports on soya are favourable and the health benefits have been questioned by some while others have gone even further, launching a vigorous anti-soya crusade. The result is confusion – people don't know what to believe. The VVF has looked at the research in its entirety and this fact sheet sets the record straight.

The history of soya consumption

There is a long history of people safely consuming soya beans, dating back to the 11th century BC (3,000 years ago) in the eastern part of Northern China. The period from the first century AD to the 15th-16th century saw the introduction of soya beans in many parts of Asia, including Japan and India, and in 1765 the soya bean was introduced to the USA (JHCI, 2002). Since then, it has become an important part of the diets of many populations and in more recent years has found favour with vegetarians and vegans because of its many nutrients and health benefits. However, as the popularity of soya has grown, so has the number of critics questioning the benefits of this humble bean.

Nutritional value

Soya (Glycine max) is a particularly good source of protein as it contains the eight essential amino acids which the human body needs. Soya milk and other soya products provide a rich source of polyunsaturated fatty acids (including the 'good' fats – omega-3) and are free of cholesterol. Compared to cow's milk, soya milk contains lower levels of saturated fat and higher levels of unsaturated essential fatty acids, which can lower cholesterol levels.

Soya products provide an excellent source of disease-busting antioxidants, B vitamins (including folate) and iron. Calcium-fortified soya products such as soya milk and tofu provide a valuable source of this important mineral without the saturated animal fat, animal protein (casein) and cholesterol found in dairy products. One serving of 200ml (7 fl oz) of Alpro soya with added calcium and vitamins (blue pack) contains 30 per cent of the recommended daily amount (RDA) of calcium – equivalent to cow's milk. It is also fortified with vitamin B12 and 200ml provides 100 per cent of the RDA of this important nutrient.

Many soya foods also contain valuable fibre which is important for good bowel health and can also lower cholesterol. Soya foods, particularly those made from whole soya beans, offer a wide range of nutritional and health benefits.

Health benefits

Heart health

Scientists agree that soya protein can promote heart health – a fact supported by dozens of controlled clinical trials. In 1995, a review published in the *New England Journal of Medicine* investigated the effect of soya protein on cholesterol levels (Anderson *et al*., 1995). In 34 of the 38 studies reviewed, replacing animal protein with soya protein decreased cholesterol levels (in the remaining four trials the subjects had low cholesterol levels to start with). The role of soya protein in heart health has since been widely accepted and approved by many different health bodies.

The UK government's Joint Health Claims Initiative (JHCI) offers market advice and a code of practice for both the UK food industry and consumers to ensure that health claims on foods are both scientifically truthful and legally acceptable. In 2002 the JHCI approved the health claim: "the inclusion of at least 25 grams soya protein per day as part of a diet low in saturated fat can help reduce blood cholesterol" (JHCI, 2002a).

Exactly how soya protein does this is not yet clear. In 2005, a review of 23 trials, published in the *American Journal of Clinical Nutrition*, examined the cholesterol-lowering effects of soya protein containing isoflavones (a phytoestrogen or plant hormone – see below). It confirmed that soya protein significantly lowers cholesterol levels but suggested that isoflavones alone did not (Zhan and Ho, 2005).

Another study looked at the cholesterol-lowering effects of soya proteins in healthy young men, a sub-group that has been somewhat overlooked. It showed that soya protein, regardless of its isoflavone content, reduces cholesterol (McVeigh *et al*., 2006).

These studies suggest that this effect involves a combination of factors in soya, including: isoflavones, soya protein peptides (small chains of amino acids – the building blocks of protein) and its amino acid content (the sequence of amino acids that make up soya protein and which may differ significantly to that of animal protein). These factors appear to work together to lower cholesterol and so reduce the risk of heart attack and stroke.

Menopausal symptoms

In Japan, where soya consumption is higher than most other places in the world, the incidence of menopausal hot flushes is much lower than in the West. However, within Japan there are variations. A six-year study of over 1,000 Japanese women showed that those who consumed the most soya foods had less than half the number of hot flushes compared to women consuming the least amount of soya (Nagata, 2001).

There are also many studies showing that supplementing the diet with soya foods or soya protein isolates can substantially reduce the frequency or severity of hot flushes and other menopausal symptoms in some women.

It was shown in 1995 that the incidence of hot flushes was reduced by 40 per cent in women consuming 45 grams of soya flour for 12 weeks compared to a 25 per cent reduction among those consuming wheat flour (Murkies *et al*., 1995). In 1997, another study found that hot flushes were reduced by 54 per cent in women consuming tofu, soya milk and miso, compared to a 35 per cent reduction in the control group (Brzezinski *et al*., 1997). A third study, in 1998, showed that 60 grams of an isolated soya

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protein supplement containing 76mg total isoflavones significantly reduced hot flushes by 45 per cent compared to a 35 per cent reduction in the control group (Albertazzi *et al*., 1998).

More recently, in 2002, Faure *et al*. showed that a soya isoflavone extract reduced the incidence of hot flushes by 61 per cent after 12 weeks compared to a 21 per cent reduction in the control group (Faure *et al*., 2002). Not surprisingly, some of these researchers suggest that soya protein may provide an alternative to hormone replacement therapy (HRT) for reducing menopausal symptoms.

The safety of specific amounts of isoflavones has not yet been established and so it is better to obtain isoflavones from whole soya foods rather than as isolates extracted from soya.

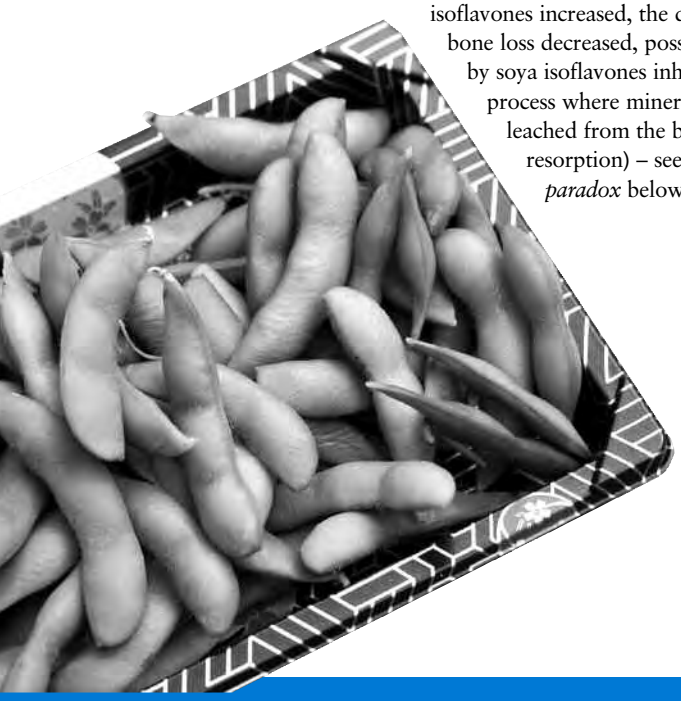
Bone health

The first published human trial investigating the effects of soya foods on bone health and osteoporosis indicated that soya protein may be effective in reducing the risk of this debilitating disease (Potter *et al*., 1998). It was found that supplementing the diet of postmenopausal women with 40 grams of soya protein a day (containing 90mg of isoflavones) for six months significantly increased both the bone mineral content and density of the lumbar spine.

These findings were supported by a later study that looked at the effect of 80mg of soya isoflavones a day on bone density (Alekel *et al*., 2000). This also showed that isoflavones reduced bone loss from the lumbar spine of women who may otherwise be expected to lose two to three per cent of bone per year. In 2003, a review of the published research concluded that diets rich in phytoestrogens (and therefore isoflavones) were likely to benefit bone health (Setchell and Lydeking-Olsen, 2003).

Studies from Japan and China show that postmenopausal women with the highest intake of isoflavone-rich soya foods have the highest bone mineral density in the lumbar spine compared with women with low intakes of soya (Somekawa *et al*., 2001; Mei *et al*., 2001). A more recent study of Chinese women, published in the *European Journal of Nutrition*, confirmed a strong link between soya isoflavones and a reduction of bone loss in postmenopausal women who were not obese (Ye *et al*., 2006).

In this study, a total of 90 women aged 45-60 years were randomly assigned to one of three treatment groups – taking daily doses of 0 (placebo), 84 and 126mg of isoflavones for six months. Bone mineral density of the spine and hip was measured at the start of the trial and when it ended after six months. It showed that as the intake of soya isoflavones increased, the degree of bone loss decreased, possibly caused by soya isoflavones inhibiting the process where minerals are leached from the bone (bone resorption) – see *The calcium paradox* below.



The calcium paradox

As food is digested, acids are released into the blood in varying proportions, depending upon the food. The body tries to neutralise this acid by drawing calcium from the bones and the calcium is then excreted in the urine (the calciuric response). Animal protein from cow's milk and dairy products, as well as meat, fish and eggs, has a particularly strong acidic effect compared to plant protein because of the sulphur-containing amino acids it contains. As increasing amounts of animal products are eaten, the sulphur content of the diet increases and so does the level of calcium in the urine. This increases calcium loss and may be a risk factor for the development of osteoporosis.

This so-called calciuric response is well-documented in the scientific literature – the more cow's milk, meat, fish and eggs you eat, the more calcium is lost from the body. The irony is that cow's milk is promoted as the best source of calcium but it is also a powerful source of calcium loss. The World Health Organisation (WHO) calls this the 'calcium paradox', where the damaging effects of animal (but not vegetable) protein may outweigh the positive effects of the calcium it contains (WHO, 2004). In other words, you're better off getting calcium from plant foods such as cereals, nuts, seeds and pulses, which don't cause such huge losses of calcium from the bones (See VVF fact sheet, *Boning up on Calcium*).

The evidence indicates that soya isoflavones are good for bone health. Importantly, some researchers suggest that soya foods could provide an alternative treatment to HRT for women at risk of osteoporosis and this may offer a cheap, drug-free prevention for this debilitating condition (Lydeking-Olsen *et al*., 2004).

Cancer risk

The low rates of breast and prostate cancers seen in Asian countries have encouraged scientists to investigate the role of soya foods on these and other hormone-related cancers.

Breast cancer

There is some evidence that soya intake during adolescence may reduce the risk of breast cancer later in life. The Shanghai Breast Cancer Study investigated 1,400 breast cancer cases in China (Shu *et al*., 2001) and found that women who consumed the most soya as teenagers had half the risk of breast cancer as adults.

A year later, scientists investigated the link between adolescent soya intake and breast cancer in Asian-American women (Wu *et al*., 2002). They found that women who consumed soya at least once a week during adolescence had a significantly reduced risk of breast cancer. Over 1,000 women, including 501 breast cancer patients, were asked how often they ate soya foods such as tofu, soya milk and miso.

Results showed that those who were high soya consumers as both adolescents and adults had a 47 per cent reduction in risk of breast cancer. Those who ate little soya as adults but had eaten it regularly during adolescence showed a 23 per cent reduction in risk. Women who were low consumers during adolescence and high consumers during adulthood showed little reduction in risk.

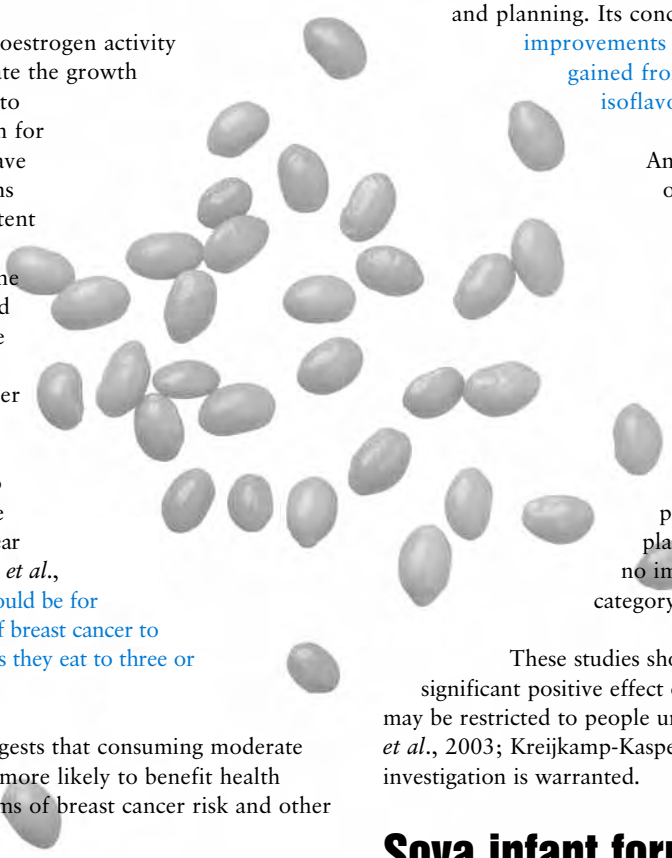
These studies suggest that high soya intake during adolescence reduces breast cancer risk and the risk continues to fall if people continue to eat soya as an adult.

Drawing the evidence together, Trock *et al*. performed a review of 18 studies on soya exposure and breast cancer risk published between 1978 and 2004 (Trock *et al*., 2006). Results show a

modest association between a high soya intake and a reduced breast cancer risk. However, the authors warn that this result should be interpreted with caution and that recommendations for high-dose isoflavone supplementation to prevent breast cancer or prevent its recurrence would be premature. In other words, the research looks promising but more evidence is needed.

The low rate of breast cancer in Japan and the high rate of survival amongst those who are affected is often used to promote soya foods as being beneficial – or at least, not being harmful – for breast cancer patients. Some researchers, however, are cautious and think that even the small oestrogen-like effect of soya foods may be detrimental for women who have gone through the menopause, whose natural oestrogen levels have dropped and who have been diagnosed with oestrogen-receptor positive (hormone-sensitive) breast cancer (PCRM, 2002).

Their concern is that the weak oestrogen activity of soya isoflavones may stimulate the growth of tumours which are sensitive to oestrogen. This is not a concern for premenopausal women, who have much higher levels of oestrogens which are many times more potent than phytoestrogens. These concerns are based largely on the results of *in vitro* (test tube) and animal studies but as these have produced mixed results their relevance to human breast cancer patients remains unclear.



To date there have only been two human studies on this subject, the findings of which were also unclear (Petrakis *et al*., 1996; Hargreaves *et al*., 1999). The cautious approach would be for postmenopausal women at risk of breast cancer to limit the amount of soya products they eat to three or four a week.

On the whole, the evidence suggests that consuming moderate amounts of soya foods is much more likely to benefit health rather than harm it, both in terms of breast cancer risk and other chronic diseases.

Prostate cancer

Prostate cancer rates also vary widely around the world, tending to peak in developed, wealthy countries. Japan is the exception, where prostate cancer rates are surprisingly low, despite its high standard of living, and some evidence suggests that soya may be responsible.

There are a limited number of studies investigating the role of soya in prostate cancer but in 1998 a large-scale study in 59 countries found that, overall, soya products were significantly protective (Hebert *et al*., 1998). It showed that death from prostate cancer increases with an affluent diet, specifically dairy milk, meat and poultry, while a diet based on cereals, soya beans, nuts and oilseeds reduces the death risk. The authors of this review believe that their findings are strong enough to warrant more work on the potential use of soya products in preventing prostate cancer.

In summary, there are no human studies that show an increased risk of cancer due to soya consumption but plenty of evidence suggesting that it provides protection.

Cognitive effects

Several studies indicate that soya intake may improve both short-term and long-term memory, mental flexibility and planning.

Researchers at the Centre for Neuroscience at King's College, London, investigated the effects of a high soya diet (100mg isoflavones per day) compared to a low soya diet (0.5mg isoflavones per day) in student volunteers (File *et al*., 2001). After just 10 weeks, those receiving the high soya diet exhibited significant improvements in short-term and long-term memory and in mental flexibility.

A second study investigated the effects of soya isoflavones (60mg per day) in the cognitive ability of a group of postmenopausal women aged between 50 and 65 years of age (Duffy *et al*., 2003). After 12 weeks, significant improvements were seen in the soya group, including their recall of pictures and in a sustained attention task. Although the groups did not differ in their ability to learn rules, the soya group showed significantly greater improvements in tests learning rule reversals and planning. Its conclusion was that significant cognitive improvements in postmenopausal women can be gained from 12 weeks of consumption of soya isoflavones.

Another study investigated the effects of soya supplements (60mg isoflavones per day) on postmenopausal women and found that after just six weeks, the soya group showed a greater improvement of nonverbal (identifying objects, for example) short-term memory than the placebo group (File *et al*., 2005). What's more, those on soya produced significantly better performances in mental flexibility and planning ability. There were, however, no improvements in long-term memory, category generation or sustained attention.

These studies show that soya isoflavones can have a significant positive effect on cognitive ability but the benefits may be restricted to people under the age of 65 (Kritz-Silverstein *et al*., 2003; Kreijkamp-Kaspers *et al*., 2004). Certainly, further investigation is warranted.

Soya infant formula

Nutritional adequacy

The VVF supports the World Health Organisation's recommendation that babies should be fed only breast milk for their first six months of life. However, some mothers are unable to, or choose not to, breast feed and in these circumstances specially formulated milks are recommended until the child is one year old. Soya-based infant formulas can provide all the nutrients required by a growing infant.

A number of studies confirm that infants fed soya-based formulas show normal growth and development. One study compared weight, length and head circumference of healthy, full-term infants up to one year old who were fed either soya-based formula or who were fed only breast milk for at least two months and were then weaned on to cow's milk formula. Both groups showed similar growth rates in the first year of life (Lasekan *et al*., 1999).

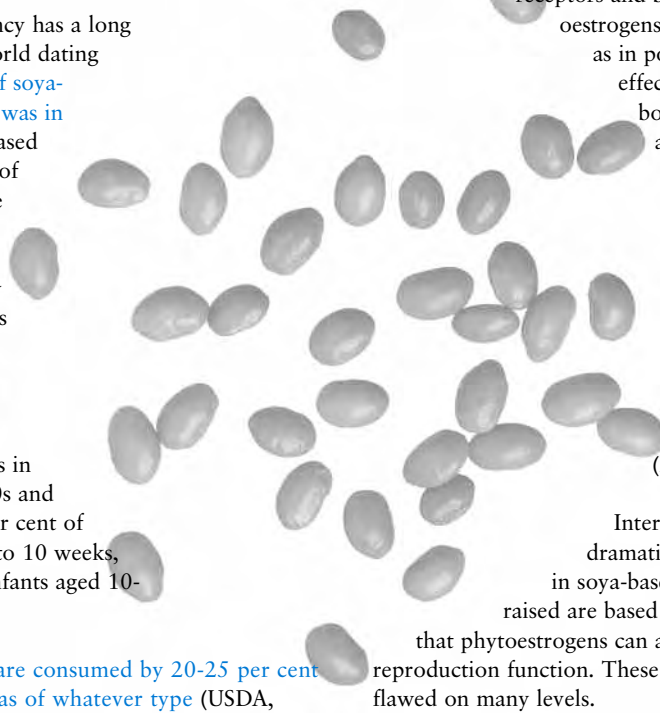
Another, more recent study compared the nutritional status and growth of 168 infants who were allergic to cow's milk and were fed either soya-based infant formula or hydrolysed whey formula. In both groups, nutrient intake and growth were 'within reference values' – in other words, they grew normally (Seppo *et al*., 2005).

There is currently only one vegan infant soya formula on the UK market: Farley's Soya Formula, produced by Heinz. This dairy-free infant formula is nutritionally complete and can be used from birth. It contains no animal products so it is suitable for both vegetarians and vegans and infants who require a diet free from lactose or casein.

In summary, soya-based infant formulas continue to provide a safe feeding option for infants. They meet all a baby's nutritional requirements but have none of the detrimental effects associated with cow's milk formulas. For more information on the health consequences of consuming cow's milk, see the VVF's *White Lies* report online at www.vegetarian.org.uk/campaigns/whitelies or order a copy by telephoning the VVF on 0117 970 5190 Mon-Fri 9am-6pm. For more information on soya infant formulas see the VVF fact sheet *Soya-Based Infant Formula*.

Is soya safe for babies?

Soya-based nutrition during infancy has a long history of safe use around the world dating back centuries. The first report of soya-based infant formula in the West was in 1909 (Ruhrah, 1909) and soya-based infant formula was used in cases of infantile eczema as early as in the 1920s (Hill and Stuart, 1929). Since these early days, formulas have come a long way. They now contain all the necessary nutrients and can be used as a safe alternative to breast milk or as a supplement to it.



Use of soya-based infant formulas in the UK has grown since the 1960s and are currently fed to about one per cent of all formula-fed babies aged four to 10 weeks, rising to about two per cent of infants aged 10-14 weeks (Hamlyn *et al*., 2002).

In the US, soya infant formulas are consumed by 20-25 per cent of all babies who are fed formulas of whatever type (USDA, 2006). Despite this, the UK Food Standards Agency's (FSA) advice is that you should only give your baby soya-based infant formula if your GP or health visitor advises it (FSA, 2007). It also says that in almost all cases, breast-feeding or another type of formula will be a better choice and that if you are currently feeding your baby soya-based formula, talk to your GP or health visitor about changing it (FSA, 2007). This highly-cautious approach is based largely on unfounded anecdotal evidence and animal-based experiments.

This controversial issue has yet to be resolved (see Phytoestrogens below). The FSA says that, until a full review of the evidence both for and against soya formula has been completed, there is no reason to stop your baby having a soya formula – but only if it has been suggested by a health professional.

This is an extremely cautious approach given that literally millions of infants have been raised on soya formulas in the UK and US, many of whom are now well into their late 30s and early 40s. What's more, there are no reports from Japan and China that the use of soya has affected fertility rates. In fact, the absence of any reported ill effects on millions of babies would suggest there are no adverse effects, either biological or clinical (Klein, 1998).

Phytoestrogens

Phytoestrogens are natural substances found in many fruits, vegetables, dried beans, peas, and wholegrains. Isoflavones are a type of phytoestrogen found in soya beans and include genistein and daidzein. Each gram of soya protein in traditional soya foods provides about three to four milligrams (mg) of isoflavones (Messina and Redmond, 2006).

Many of the beneficial effects – and supposed health risks – of soya foods are thought to be related to the presence of phytoestrogens. Phytoestrogens can act in a similar way to the hormone oestrogen, although they are far less potent (Coldham *et al*., 1997). Some phytoestrogens (isoflavones) are estimated to be between 100 and 100,000 times weaker than the oestrogens that occur naturally in humans (Messina *et al*., 2006).

It is thought that phytoestrogens can have a normalising effect on the body's natural oestrogen levels (Kurzer, 2000) – if a woman has a high oestrogen level, perhaps from taking the contraceptive pill or HRT, phytoestrogens may reduce it by binding to oestrogen receptors and blocking access from the stronger oestrogens. When oestrogen levels are low, such as in postmenopausal women, the weak effect of phytoestrogens can return the body's oestrogen to more normal levels and so relieve menopausal symptoms.

Soya isoflavones have been a part of the diet of millions of adults and children in Asia for centuries and are generally regarded as healthy. A recent review came to the conclusion that the current scientific literature, taken as a whole, shows that isoflavones from soya foods are quite safe (Munro *et al*., 2003).

Interest in phytoestrogens has increased dramatically over the last decade, particularly in soya-based infant formulas. The concerns raised are based on animal experiments which suggest that phytoestrogens can affect sexual development and reproduction function. These experiments are fundamentally flawed on many levels.

Firstly, isoflavones behave differently in different species so animal studies bear little relevance to humans. Secondly, the intestines act as a barrier to isoflavones so artificially boosting levels in animals by injection has no relevance. Finally, many of these experiments have exposed animals to isoflavones at levels many, many times higher than those absorbed by infants fed with infant formula. More and more scientists and doctors are acknowledging that the results of animal experiments should not form the basis of a public health policy. Dr Kenneth Setchell, Professor of Pediatrics at Cincinnati Children's Hospital Medical Centre, states that mice, rats and monkeys all metabolise soya isoflavones differently from humans and that the only appropriate model for examining human reproductive development is the human infant (Setchel, 2006).

In 1998, a review of isoflavones, soya-based infant formulas and hormone function in those who had soya formulas as infants, reported that growth was normal and no changes in timing of puberty or in infertility rates were reported (Klein, 1998). The author concluded that soya-based infant formulas continue to be a safe, nutritionally complete feeding option for most infants. They would not, of course, be suitable for infants with a soya allergy (see *Allergies* below).

Just one single human study has specifically examined the effect of soya-based formula on sexual development and fertility (Strom *et al*.,

2001). It looked for links between the feeding of soya-based infant formula and reproductive health in adulthood. There was no evidence of adverse effects on either sexual development or reproductive health of either males or females. The authors said that their findings were reassuring about the safety of soya-based infant formula.

In 2003, in response to concerns about phytoestrogens, the UK Department of Health's committee of independent experts, the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) reviewed the health implications of phytoestrogens and other naturally-occurring chemicals (COT, 2003). It tried to assess, on the basis of current evidence, if soya-based infant formulas pose any risk for babies.

The COT report compared isoflavone intakes in Western and Eastern populations and found that Eastern populations have a significantly higher intake. In the UK, the US, Australia and New Zealand, intakes tend to range from around 0.8mg per day to 17mg per day, while in Japan, China and Korea they range from 18mg per day to 200mg per day. These figures do not include data collected from a group of vegans in New Zealand whose intake was found to be 140mg per day.

The average UK consumer, the COT report states, consumes around 1mg of isoflavones per day, while vegetarians who eat soya-based meat and dairy replacement foods, consume around 3mg a day. They concede that these figures may be underestimated given the increasing amount of soya used in processed foods.

More recently, the isoflavone intake of a small group of vegetarians and omnivores was estimated using a new isoflavone database which lists the isoflavone content of 6,000 foods (Ritchie, 2006). Vegetarians were found to consume around 7.4mg per day compared to an estimated 1.2mg for omnivores (Ritchie *et al*., 2006). The main source for each group were soya milks and yogurts, soya and textured vegetable protein foods, breads and dried fruit.

Previous work showed that a group of UK vegetarians consumed an average of 10.5mg of isoflavones per day (Clarke *et al*., 2003). Only one report has measured the isoflavone intake of vegans (11 breast-feeding UK vegan mothers) which was estimated to be 75mg a day (MAFF, 1998). This is above the average Western intake but well within the range of Eastern countries. The table below shows the isoflavone content of a range of soya-based foods.

Food	Isoflavone (mg/100g)	Isoflavone (mg in average portion size)
Miso	43-60	4-16
Soya cheese	6-31	1-24
Soya milk	5-10	3-53
TVP	68.3*	29-67
Soya yoghurt	16	5-85
Soya sauce	0.1-1.6	-
Tempeh	29-53	4-38
Tofu	13.5-67	19

Source: COT, 2003. *Ritchie *et al*., 2006.

COT estimated that the daily isoflavone intake of infants fed soya-based infant formula is approximately 40mg per day. Again, above the average Western intake but well within the range of intakes seen in Eastern countries. The COT report acknowledged that there is no evidence that populations which regularly eat high quantities of soya, such as the Chinese and Japanese, have altered sexual development or impaired fertility. China is the world's most populous nation, with over 1.3 billion citizens.

Despite this, they recommended that research should be undertaken as a matter of high priority to determine whether consumption of soya-based formulas can affect infant reproductive development in any way. Interestingly, the UK and New Zealand are the only countries to have issued such advice on phytoestrogens and soya-based formulas.

Oestrogen in cow's milk

The hormonal content of cow's milk has not been widely discussed amongst scientists and very little research has been published on it. Cow's milk has been shown to contain over 35 different hormones and 11 growth factors (Grosvenor *et al*., 1992).

Some scientists are particularly concerned about the oestrogen content of cow's milk, suggesting that it is one of the main ways we are exposed to it (Ganmaa and Sato, 2005). What concerns them is that cow's milk has changed drastically over the last 100 years. For most of the time that a cow is milked, she is also pregnant and therefore secreting hormones into the milk. Hormone levels increase markedly during pregnancy and have been linked to a wide range of illnesses and diseases, including certain hormone-dependent cancers such as ovarian and breast cancer.

These hormones and growth factors act as signalling molecules, carrying important messages from the mother to the infant animal that encourage rapid growth and development. Cow's milk is designed to turn a small calf into a big cow in just one year.

In summary, a cow's milk contains many hormones and growth factors and often in concentrations much higher than those found naturally in her blood (Grosvenor *et al*., 1992). In other words, powerful hormones and growth factors are synthesised in the cow's mammary gland and excreted into her milk – milk which humans then drink. Considering the main complaint about soya is that it contains phytoestrogens, many thousand times weaker than animal oestrogens, it begs the question: what is the real motivation behind the anti-soya crusade?

When considering the health benefits and/or risks of soya versus cow's milk, think about which is the more natural drink? Plant 'milk', produced from a bean, consumed by millions for centuries, or animal milk, taken from another species and one which is generally pregnant? Humans are the only mammal to consume milk after weaning and then from another species. Over three-quarters of the world's population do not drink cow's milk at all; they are lactose intolerant and cannot digest the sugar in milk after weaning. It is clear that for most humans, cow's milk isn't and never has been 'natural'.

Soya and thyroid function

The thyroid is a small gland found in the front of the neck. It produces the important hormone thyroxine, which helps control how fast the body makes and uses the energy it obtains from food. The thyroid gland needs iodine from food to function and a lack of it can make the gland enlarge, forming a goitre. It can happen whether the thyroid is overactive or underactive. An overactive thyroid causes an illness called hyperthyroidism while an underactive gland causes hypothyroidism. The concerns about soya and thyroid focus on two components – goitrogens and isoflavones.

Goitrogens are found naturally in soya, broccoli, kale, cabbage, turnips, millet, peanuts and pine nuts. They can interfere with the uptake of iodine and lead to a goitre. However, this is not a problem if the diet provides enough iodine.

A limited number of studies have suggested that isoflavones may affect thyroid function by lowering free thyroxine concentrations. In a cautionary statement, COT advises physicians and other health care workers to be aware of possible links between isoflavones in soya-based infant formulas and thyroid function, particularly in cases of congenital hypothyroidism (COT, 2003).

However, a recent review of 14 trials which investigated the effects of soya on thyroid function concluded that there was little evidence that it had an adverse effect in people whose thyroid function is normal and whose diet contains adequate iodine (Messina and Redmond, 2006). The authors raise the possibility that soya foods may interfere with absorption of medications containing synthetic thyroid hormone taken by hypothyroid patients, but say that hypothyroid adults need not avoid soya foods.

There is a theoretical concern that in individuals with compromised thyroid function and/or whose iodine intake is marginal, soya foods may increase risk of developing hypothyroidism. The general consensus is that all people, whether soya consumers or not, should ensure their intake of iodine is adequate.

The Department of Health recommends that toddlers aged one to three should get 70 micrograms of iodine per day and adults 140 micrograms (Department of Health, 1991). You should be able to get all the iodine you need by eating a varied and balanced diet (FSA, 2007a). Good sources of iodine include seaweed such as nori and kelp and Vecon vegetable stock. Adults can supplement their diet with kelp tablets but these are not suitable for children.

Iodine is also be found in cereals and grains, such as whole wheat and rye, but levels vary depending on the amount of iodine in the soil where the plants are grown.

It is important not to take too much iodine as this can be harmful. The FSA consider that 500 micrograms or less a day is unlikely to cause any harm (FSA, 2007a).

Allergies

Although severe reactions to food are rare, approximately six per cent of children under three years old are thought to be affected by food allergy, the most common culprits being cow's milk and eggs. The number of people affected by food allergies tends to decline with age, with around four per cent of adults being affected, with shellfish and nuts being the most common causes (Department of Health, 2006).

Just a small number of foods are responsible for 90 per cent of all allergic food reactions and include: cow's milk and dairy products, eggs, peanuts, tree nuts (including Brazil nuts, hazelnuts, almonds and walnuts), fish, shellfish, including mussels, crab and shrimps, wheat and soya (FSA, 2007b). The symptoms of soya allergy are similar to those of cow's milk allergy and include rashes, diarrhoea, vomiting, stomach cramps and breathing difficulties. Very rarely, soya can cause anaphylaxis (FSA, 2007c) – a severe and potentially fatal 'toxic shock'. Since November 2005, food labelling rules require pre-packed food sold in the UK to show clearly on the label if it contains soya (FSA, 2007c).

There are concerns that genetically modified (GM) soya may be more likely to cause an allergic reaction than non-GM soya (Soil Association, 2007). These concerns have been met by biotechnology companies producing even more GM soya, but with the specific proteins thought to cause the allergic reactions removed. GM products, especially soya and maize, are now in so many foods that it can be difficult to avoid them. If you want to avoid GM foods then choose foods that are certified organic.

Environmental impact of soya

Some people attempt to condemn soya by citing the environmental impact soya farming is having on the Amazonian rainforest. They are right to be concerned but people eating soya are not the problem – 80 per cent of the world's soya production is fed to livestock so that people can eat meat and dairy foods (Greenpeace, 2006). Much of the remainder is used as padding in a wide range of mainstream food products such as meat pies and pasties. Both the rainforests and our health would benefit tremendously if more people became vegetarian or vegan, even if they ate more soya.

Soya production

Long-established soya foods such as soya sauce, tamari, miso, tempeh, tofu and soya milk were originally developed in Asia using traditional fermentation or precipitation methods. Many of these foods use the whole bean and the foods made from them differ from soya protein isolates, which are extracts from soya beans and include textured vegetable protein (TVP) and other meat substitutes.

As with all processed foods, the nutrient content is partly determined by the processing method. The VVF does not recommend over-consumption of any highly-processed foods as they tend to contain high levels of fat – sometimes including hydrogenated fats – salt, sugar and artificial additives, which have all been linked to health problems. However, many of the 'mock meats' do provide a valuable low-fat and cholesterol-free source of good protein and increasingly they do not contain hydrogenated

fats (check the label!). This makes them a healthier option than their meaty milky equivalents, which contain saturated animal fat, animal protein, cholesterol and hormones.

The key to good health is to eat a wide range of foods including plenty of wholegrains such as wholemeal bread, brown pasta and brown rice, pulses (peas, beans – including soya – and lentils), fruit and vegetables and nuts and seeds.

Summary

- Soya beans are cholesterol-free and are a good source of protein, polyunsaturated fatty acids, antioxidants, B vitamins and iron.
- Calcium-fortified soya products such as soya milk and tofu provide a valuable source of this important mineral.
- Vitamin B12-fortified products such as soya milk provide a vital source of this nutrient.
- Soya protein lowers cholesterol and can protect heart health.
- Soya foods can reduce menopausal symptoms.
- Soya protein can protect bone health and reduce the risk of osteoporosis.
- Soya foods may reduce the risk of breast cancer, with the possible exception of postmenopausal women.
- Soya foods may reduce the risk of prostate cancer.
- Soya foods can help improve cognitive skills.
- Millions of people have been safely consuming soya foods for thousands of years.
- Phytoestrogens (plant hormones) are much weaker than the natural oestrogens consumed in dairy products and red meat and may have a normalising effect on hormone levels.
- Soya-based infant formula can be used as a safe alternative or supplement to breast milk as it meets the nutritional requirements of the child.
- Millions of healthy infants have been safely raised on soya-based infant formulas.
- There is no evidence that soya adversely affects the sexual development or reproductive health of humans.
- Intakes of phytoestrogens in the UK are no greater than those consumed in Eastern countries for thousands of years.
- There is no evidence that soya foods cause impaired fertility or alter sexual development in humans.
- For the vast majority of people, soya does not disrupt thyroid function.
- Although soya may be responsible for some food allergies, it is not the main culprit.
- Soya 'mock meats' provide a valuable source of protein.
- Cow's milk contains over 35 different hormones and 11 growth factors, several of which have been linked to cancer.
- 80 per cent of the world's soya production is fed to livestock.

References

1. Alekel, D.L., St Germain, A., Peterson, C.T., Hanson, K.B., Stewart, J.W. and Toshiya, T. 2000. Isoflavone-rich soy protein isolate attenuates bone loss in the lumbar spine of perimenopausal women. *American Journal of Clinical Nutrition*. 72, 844-852.
2. Albertazzi, P., Pansini, F., Bonaccorsi, G., Zanotti, L., Forini, E. and De Aloysio, D. 1998. The effect of dietary soy supplementation on hot flushes. *Obstetrics and Gynecology*. 91 (1) 6-11.
3. Anderson, J.W., Johnstone, B.M. and Cook-Newell, M.E. 1995. Meta-analysis of the effects of soy protein intake on serum lipids. *New England Journal of Medicine*. 333, 276-282
4. Brzezinski, A., Adlercreutz, H., Shaoul, R., Rösler, A., Shmueli, A., Tanos V. and Schenker J.G. 1997. Short-term effects of phytoestrogen-rich diet on postmenopausal women. *Menopause*. 4, 89-94.
5. Clarke, D.B., Barnes, K.A., Castle, L., Rose, M., Wilson, L.A., Baxter, M.J., Price, K.R. and DuPont, M.S. 2003. Levels of phytoestrogens, inorganic trace-elements, natural toxicants and nitrate in vegetarian duplicate diets. *Food Chemistry*. 81 (2) 287-300.
6. Coldham, N.G., Dave M., Sivapathasundaram S., McDonnell D.P., Connor C. and Sauer M.J. 1997. Evaluation of a recombinant yeast cell estrogen screening assay. *Environmental Health Perspectives*. 105 (7) 734-742.
7. COT, 2003. Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment. Phytoestrogens and Health. London: The Food Standards Agency, FSA/0826/0503.
8. Department of Health, 1991. *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom, Report on Health and Social Subjects*. London: HMSO.
9. Department of Health, 2006. *An epidemiological report for the Department of Health's review of services for allergy by Professor John Newton* 28th June 2006 [online]. Available at: www.dh.gov.uk/assetRoot/04/13/73/78/04137378.pdf [Accessed October 3 2006].
10. Duffy, R., Wiseman, H. and File, S.E. 2003. Improved cognitive function in postmenopausal women after 12 weeks of consumption of a soya extract containing isoflavones. *Pharmacology Biochemistry and Behaviour*. 75 (3) 721-729.
11. Faure, E.D., Chantre, P. and Mares, P. 2002. Effects of a standardized soy extract on hot flushes: a multicentre, double-blind, randomized, placebo-controlled study. *Menopause*. 9 (5) 329-334.
12. File, S.E., Jarrett, N., Fluck, E., Duffy, R., Casey, K. and Wiseman, H. 2001. Eating soya improves human memory. *Psychopharmacology* (Berl). 157 (4) 430-436.
13. File, S.E., Hartley, D.E., Elsabagh, S., Duffy, R. and Wiseman, H. 2005. Cognitive improvement after 6 weeks of soy supplements in postmenopausal women is limited to frontal lobe function. *Menopause*. 12 (2) 193-201.
14. FSA, 2007. Eat well, be well website. *Children and babies* [online]. Available at: www.eatwell.gov.uk/asksam/agesandstages/childrenandbabies/#A219760 [Accessed January 23 2007].
15. FSA, 2007a. *Iodine* [online]. Available at: www.eatwell.gov.uk/healthydiet/nutritionessentials/vitaminsandminerals/iodine/ [Accessed January 23 2007].
16. FSA, 2007b. *Types of allergy and intolerance*. Available at: www.eatwell.gov.uk/healthissues/foodintolerance/foodintolerancetypes/ [Accessed January 23 2007].
17. FSA, 2007c. *Soya allergy*. Available at: www.eatwell.gov.uk/healthissues/foodintolerance/foodintolerancetypes/soyaallergy/ [Accessed January 23 2007].
18. Faure, E.D., Chantre, P. and Mares, P. 2002. Effects of a standardized soy extract on hot flushes: a multicenter, double-blind, randomized, placebo-controlled study. *Menopause*. 9 (5) 329-34.
19. Ganmaa, D. and Sato, A. 2005. The possible role of female sex hormones in milk from pregnant cows in the development of breast, ovarian and corpus uteri cancers. *Medical Hypotheses*. 65 (6) 1028-1037.
20. Greenpeace. 2006. *Eating up the Amazon* [online]. Available at: www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/7555.pdf [Accessed November 1 2006].
21. Grosvenor, C.E., Picciano, M.F. and Baumrucker C.R. 1992. Hormones and growth factors in milk. *Endocrine Reviews*. 14 (6) 710-728.
22. Hamlyn, B., Brooker S., Oleinikova K. and Wands S. 2002. *Infant Feeding 2000*. The Stationery Office. London, UK.
23. Hargreaves, D.F., Potten, C.S., Harding, C., Shaw, L.E., Morton, M.S., Roberts, S.A., Howell, A. and Bundred, N.J. 1999. Two-week dietary soy supplementation has an estrogenic effect on normal premenopausal breast. *Journal of Clinical Endocrinology and Metabolism*. 84, 4017–24.
24. Hebert, J.R., Hurley, T.G., Olendzki, B.C., Teas, J., Ma, Y. and Hampl, J.S. 1998. Nutritional and socioeconomic factors in relation to prostate cancer mortality: a cross-national study. *Journal of the National Cancer Institute*. 90 (21) 1637-1647.
25. Hill, L.W. and Stuart H.C. 1929. A soya bean food preparation for feeding infants with milk idiosyncrasy. *Journal of the American Medical Association*. 93, 985-987.

26. JHCI, 2002. *Does the inclusion of 25g soya protein per day as part of a diet low in saturated fat help to reduce blood cholesterol?* A Health Claim Submission by the Soya Protein Association to the JHCI [online]. Available from: www.jhci.org.uk/approv/FINALJHCI%20Soya%20Submission.pdf [Accessed September 14 2006].
27. JHCI, 2002a. Joint Health Claims Initiative. *Generic health claim for soya protein and blood cholesterol* [online]. Available from: http://www.jhci.org.uk/approv/schol2.htm [Accessed September 14 2006].
28. Klein, K.O. 1998. Isoflavones, soy-based infant formulas, and relevance to endocrine function. *Nutrition Review*. 56 (7) 193-204.
29. Kreijkamp-Kaspers, S., Kok, L., Grobbee, D.E., de Haan, E.H., Aleman, A., Lampe, J.W. and van der Schouw, Y.T. 2004. Effect of soy protein containing isoflavones on cognitive function, bone mineral density, and plasma lipids in postmenopausal women: a randomized controlled trial. *Journal of the American Medical Association*. 292 (1) 65-74.
30. Kritz-Silverstein, D., Von Muhlen, D., Barrett-Connor, E. and Bressel, M.A. 2003. Isoflavones and cognitive function in older women: the SOy and Postmenopausal Health In Aging (SOPHIA) Study. *Menopause*. 10 (3) 196-202.
31. Kurzer, M.S. 2002. Hormonal effects of soy isoflavones: studies in premenopausal and postmenopausal women. *Journal of Nutrition*. 130 (3) 660S-661S.
32. Lasekan, J.B., Ostrom, K.M., Jacobs, J.R., Blatter, M.M., Ndife, L.I., Gooch, W.M. 3rd and Cho, S. 1999. Growth of newborn, term infants fed soy formulas for one year. *Clinical Pediatrics*. 38 (10) 563-571.
33. Lydeking-Olsen, E., Beck-Jensen, J.E., Setchell, K.D. and Holm-Jensen, T. 2004. Soymilk or progesterone for prevention of bone loss--a 2 year randomized, placebo controlled trial. *European Journal of Nutrition*. 4: 246-57.
34. MAFF, 1998. Ministry of Agriculture Fisheries and Food. *Levels of oestrogens in the diets of infants and toddlers*. University of Reading. Report FS2829.
35. McVeigh, B.L., Dillingham, B.L., Lampe, J.W. and Duncan, A.M. 2006. Effect of soy protein varying in isoflavone content on serum lipids in healthy young men. *American Journal of Clinical Nutrition*. 83 (2) 244-251.
36. Mei, J., Yeung, S.S.C. and Kung, A.W.C. 2001. High dietary phytoestrogen intake is associated with higher bone mineral density in postmenopausal but not premenopausal women. *Journal of Clinical Endocrinology and Metabolism*. 86:5217-5221.
37. Messina, M. and Redmond, G. 2006. Effects of soy protein and soybean isoflavones on thyroid function in healthy adults and hypothyroid patients: a review of the relevant literature. *Thyroid*. 16 (3) 249-258.
38. Messina, M., McCaskill-Stevens, W. and Lampe, J.W. 2006. Addressing the soy and breast cancer relationship: review, commentary, and workshop proceedings. *Journal of the National Cancer Institute*. 98 (18) 1275-1284.
39. Munro, I.C., Harwood, M., Hlywka, J.J., Stephen, A.M., Doull, J., Flamm, W.G. and Adlercreutz, H. 2003. Soy isoflavones: a safety review. *Nutrition Review*. 61 (1) 1-33.
40. Murkies, A.L., Lombard, C., Strauss, B.J.G., Wilcox, G., Burger, H.G. and Morton. M.S. 1995. Dietary flour supplementation decreases post-menopausal hot flushes: effect of soy and wheat. *Maturitas*. 21, 189-195.
41. Nagata, C., Takatsuka, N., Kawakami, N. and Shimizu, H. 2001. Soy product intake and hot flashes in Japanese women: results from a community-based prospective study. *American Journal of Epidemiology*. 153 (8) 790-793.
42. Petrakis, N.L., Barnes, S., King, E.B., Lowenstein, J., Wiencke, J., Lee, M.M., Miike, R., Kirk, M. and Coward, L. 1996. Stimulatory influence of soy protein isolate on breast secretion in pre- and postmenopausal women. *Cancer Epidemiology Biomarkers and Prevention*. 5, 785–94.
43. PCRM, 2002. *Healthy eating for life to prevent and treat cancer*. New York: John Wiley & Sons, Inc.
44. Potter, S.M., Baum, J.A., Teng, H., Stillman, R.J., Shay, N.F. and Erdman, J.W. Jr. 1998. Soy protein and isoflavones: their effects on blood lipids and bone density in postmenopausal women. *American Journal of Clinical Nutrition*. 68 (suppl) 1375S–1379S.
45. Ritchie M.R., Cummings J.H., Morton M.S., Michael Steel C., Bolton-Smith C., Riches A.C. 2006. A newly constructed and validated isoflavone database for the assessment of total genistein and daidzein intake. *British Journal of Nutrition*. 95 (1) 204-213.
46. Ritchie, 2006. *Phyto-oestrogen database* [online]. Available from: http://medicine.st-and.ac.uk/research/docs/ritchie/ [Accessed October 17 2006].
47. Ruhrah, J., 1909. The soy bean in infant feeding: preliminary report. *Archives of Pediatrics*. 26, 496-501.
48. Seppo, L., Korpela, R, Lonnerdal, B., Metsaniitty, L., Juntunen-Backman, K., Klemola, T., Paganus, A. and Vanto, T. 2005. A follow-up study of nutrient intake, nutritional status, and growth in infants with cow milk allergy fed either a soy formula or an extensively hydrolyzed whey formula. *American Journal of Clinical Nutrition*. 82 (1) 140-145.
49. Setchell, K.D. and Lydeking-Olsen, E. 2003. Dietary phytoestrogens and their effect on bone: evidence from in vitro and vivo, human observational, and dietary intervention studies. *American Journal of Clinical Nutrition*. 78 (supplement) 593S-609S.
50. Setchell, K.D. 2006. Assessing risks and benefits of genistein and soy. *Environmental Health Perspectives*. 114 (6) A332-A333.
51. Somekawa, Y., Chiguchi, M., Ishibashi, T., and Aso, T. 2001. Soy intake related to menopausal symptoms, serum lipids, and bone mineral density in postmenopausal Japanese women. *Obstetrics and Gynecology*. 97:109-115.
52. Soil Association, 2007. *GM Food: Scientific Evidence of Health Risks* [online]. Available from: www.soilassociation.org/web/sa/saweb.nsf/librarytitles/1914E.HTMl/$file/Genetic%20engineering%20the%20key%20issues.pdf [Accessed February 1 2007].
53. Shu, X.O., Jin, F., Dai, Q., Wen, W., Potter, J.D., Kushi, L.H., Ruan, Z., Gao, Y.T. and Zheng, W. 2001. Soyfood intake during adolescence and subsequent risk of breast cancer among Chinese women. *Cancer Epidemiology Biomarkers and Prevention*. 10 (5) 483-488.
54. Strom, B.L., Schinnar, R., Ziegler, E.E., Barnhart, K.T., Sammel, M.D., Macones, G.A., Stallings, V.A., Drulis, J.M., Nelson, S.E. and Hanson, S.A. 2001. Exposure to soy-based formula in infancy and endocrinological and reproductive outcomes in young adulthood. *Journal of the Medical Association*. 286 (7) 807-814.
55. Trock, B.J., Hilakivi-Clarke, L. and Clarke, R. 2006. Meta-analysis of soy intake and breast cancer risk. *Journal of the National Cancer Institute*. 98 (7) 459-471.
56. USDA, 2006. *Study Examines Long-Term Health Effects of Soy Infant Formula* [online]. Available from: www.ars.usda.gov/is/AR/archive/jan04/soy0104.htm?pf=1 [Accessed September 18 2006].
57. WHO, 2004. *Vitamin and mineral requirements in human nutrition*, Second edition. World Health Organization and Food and Agriculture Organization. Available from: http://whqlibdoc.who.int/publications/2004/9241546123.pdf [Accessed January 23 2006].
58. Wu, A.H., Wan, P., Hankin, J., Tseng, C.C., Yu, M.C. and Pike, M.C. 2002. Adolescent and adult soy intake and risk of breast cancer in Asian-Americans. *Carcinogenesis*. 23 (9) 1491-1496.
59. Ye, Y.B., Tang, X.Y., Verbruggen, M.A. and Su, Y.X. 2006. Soy isoflavones attenuate bone loss in early postmenopausal Chinese women : A single-blind randomized, placebo-controlled trial. *European Journal of Nutrition*. 45 (6) 327-334.
60. Zhan, S. and Ho, S.C. 2005. Meta-analysis of the effects of soy protein containing isoflavones on the lipid profile. *American Journal of Clinical Nutrition*. 81 (2) 397-408.