

The safety of soya

We give you the facts on the wealth of health benefits and the supposed risks of the humble soya bean

Viva!
HEALTH

Over the years, we have heard how soya (*Glycine max*) is a great source of nutrients, can protect against heart disease, certain cancers and may reduce the risk of breast cancer, osteoporosis and menopausal symptoms; it might even help boost brain power. However, not all the reports on soya are favourable; 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. Viva! Health has looked at the research in its entirety and sets the record straight.

Soya history

There is a long history of people safely consuming soya. According to archaeological research, soya was already cultivated in northern China between 7,000 and 6,600 BC, around 5,000 BC in Japan and 1,000 BC in Korea (Lee *et al.*, 2011).

Soya was gradually introduced to other countries and continents. It reached Europe in the early 1700s but was grown mainly in botanical gardens as a curiosity (Shurtleff and Aoyagi, 2007). It took about a century for soya to be grown by numerous botanists and farmers across Europe and another one for soya foods to become widely available (Shurtleff and Aoyagi, 2007).

In 1765 the soya bean was introduced to the USA (Boerma, 2014) but it followed a similar journey as soya in Europe and wasn't widely cultivated until the 20th century (Shurtleff and Aoyagi, 2004).

During the 20th century, soya became an important part of the diets of many populations across the world. In particular, it became a staple food for vegetarians and vegans because of its versatility, wealth of 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 is a particularly good source of protein – it contains more protein than other pulses and offers all nine essential amino acids (protein building blocks) that the human body needs.

It is also a good source of polyunsaturated fats (including the essential omega-3s) and is free of cholesterol. Compared to cow's milk, soya milk contains less saturated fat and more unsaturated essential fats, which can lower your cholesterol levels.

Soya products provide an excellent source of disease-busting antioxidants, B vitamins (including folate), iron and zinc. Calcium-fortified soya foods 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.

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.



Phytoestrogens

Phytoestrogens are natural substances found in many fruits, vegetables, beans, peas, seeds and wholegrains. Isoflavones are a type of phytoestrogen found in soya beans. Soya isoflavones include compounds called genistein, daidzein and glycitein.

The chemical structure of phytoestrogens is similar, but not identical to, human oestrogen and 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, but they are far less potent (Moutsatsou, 2007). Compared to oestrogen, isoflavones are 100 to 1,000 times weaker (Farhat *et al.*, 2023).

Each gram of soya protein in traditional soya foods, such as tofu or soya milk, provides about 3.5 milligrams of isoflavones (Messina *et al.*, 2006). Foods based on soya protein isolate have less – around one milligram of isoflavones per gram of soya protein (Messina *et al.*, 2022).

However, we don't absorb all the isoflavones we eat but only a

fraction of them, with considerable individual differences (Messina *et al.*, 2022). Depending on your gut bacteria and genes, one of the isoflavones – daidzein – can be transformed into equol during digestion. Equol is another health-beneficial compound but not everyone can make it – only 25 to 50 per cent of people do (Mayo *et al.*, 2019). Interestingly, it's been reported that around 59 per cent of vegetarians produce equol while only 25 per cent of meat-eaters do, which suggests that diet plays a role and different diets may determine your ability to produce it (Mayo *et al.*, 2019).

The concerns that were once raised about phytoestrogens were based on animal experiments and centred around possible adverse effects on sexual development and reproduction. These types of experiments are fundamentally flawed on many levels and aren't relevant to humans, our physiology or our intake of soya foods.

There have been thousands of human studies on the safety of phytoestrogens in the human diet and the conclusion of one of the largest reviews on this topic is that soya intake at levels similar to a typical Asian intake (100 milligrams daily which comes from about 25 grams of soya protein) is safe and healthy (Messina *et al.*, 2022). This figure was suggested not because higher soya consumption could be harmful but simply because there are no studies on people regularly consuming more than that. Bear in mind that soya milk contains four grams of protein per 100 millilitres and tofu around 12 grams of protein per 100 grams so to achieve the intake of 25 grams of soya protein, you'd have to eat three to four servings of soya daily.

Phytoestrogens and female hormones

The effect of soya and isoflavone consumption on female hormones has been extensively studied. Some studies found minor effects on oestrogen levels, but they were not considered significant while other studies found no effect whatsoever – either in pre- or post-menopausal women (Domínguez-López *et al.*, 2020; Messina *et al.*, 2022).

It is thought that phytoestrogens can only ever have a mild 'normalising' effect on oestrogen levels and that depends on your current hormone status. If your oestrogen levels are low, for example in the menopause, phytoestrogens slightly increase them but if your oestrogen levels are high, phytoestrogens bind to oestrogen receptors in your cells and so block some of your own



oestrogens from accessing them (Mueller *et al.*, 2004). However, this effect is only very small and doesn't produce any side effects – on the contrary, it's one of the reasons why soya is thought to have a protective effect against breast cancer (more info below).

Nutritional values of selected soya foods

	Protein (g)	Carbohydrates (g) – including fibre	Fat (g)	Calcium (mg) Recommended daily intake is 700 mg	Iron (mg) Recommended daily intake is 8.7-14.8 mg	Zinc (mg) Recommended daily intake is 7-9.5 mg
Tofu made with calcium salts (100 g)	12	3.8	5.5	267	2.1	1.1
Edamame – shelled green soya beans (75 g – ½ cup)	10	9	3	60	1.8	0.7
Soya milk, calcium fortified (100 ml)	4	1	2	120	0.5	0.3
Soya yoghurt (100 g)	4	3	2	120	0.7	0.2
Tempeh (100 g)	20	8	11	96	2	1.6
Soya flour (42 g – ½ cup)	16	13.5	8.5	86	2.7	1.6

Menopausal symptoms

Many studies show that supplementing the diet with soya foods or soya isoflavones can reduce the frequency or severity of hot flushes and other menopausal symptoms in women (Chen and Chen, 2021). In some women, soya isoflavones don't have a noticeable effect and it is thought it may be due to gut bacteria – women who produce equal in their intestines experience greater relief than women who don't (Chen and Chen, 2021).

Another issue that comes with declining oestrogen levels during and after the menopause is gradual loss of bone density. Sex hormones stimulate bone maintenance but when their levels drop, many women experience a slow decline of bone health which greatly increases the risk of osteoporosis and fragility fractures in some women.

A large study analysed all previous studies on postmenopausal bone health and isoflavones and found them to be beneficial in alleviating bone loss (Lambert *et al.*, 2017). A later review analysing more data came to the same conclusion and highlighted that when isoflavone supplements containing at least 50 milligrams of genistein were used daily, the effect was the most beneficial (Inpan *et al.*, 2024).

As the overall diet has an effect on our health, obtaining isoflavones from soya foods as a primary source is advisable (with the addition of a supplement if needs be). The best sources of isoflavones are the least processed foods such as edamame, tofu, tempeh, miso and soya milk.



Phytoestrogens and male hormones

Much research has also focused on phytoestrogens and testosterone, the main male sex hormone. A review of 41 clinical studies on the topic concluded that isoflavones intake, even when exceeding 75 milligrams daily, does not affect testosterone levels (Reed *et al.* 2020).

The study also found that isoflavones have no effect on oestrogen levels in men, which is in agreement with a previous review that concluded soya isoflavones have no feminising effect on men (Messina, 2010). A later study tested the effect of daily soya isoflavone intake over 18 months and compared it with a daily dose of casein (dairy protein) and found no effect on the participants' testosterone or oestrogen levels (Bosland *et al.*, 2021).

When it comes to sperm or semen quality, clinical studies show no effect of isoflavones (Messina *et al.*, 2022).

Soya and cancer

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.

Research revealed that soya isoflavones bind mainly to oestrogen beta receptors which has antiproliferative (anti-cancer) effects (Messina *et al.*, 2022) – on the other hand, stimulating oestrogen alpha receptor has proliferative (pro-cancer) effects. Furthermore, isoflavones also have anti-cancer properties that are oestrogen receptor-independent and act as antioxidants too (Boutas *et al.*, 2022). Scientific studies show that regular consumption of soya is associated with a lower risk of cancer in general (Fan *et al.*, 2022).

Soya and breast cancer

There were concerns that soya foods may increase the risk of breast cancer or make the condition worse in some women. Extensive research over the last 25 years suggests that there are no such negative effects of soya on breast cancer. In fact, eating soya during childhood and adolescence may lower the risk of breast cancer later in life and eating soya after being diagnosed with it lowers the risk of recurrence and may improve treatment outcomes.

Many studies, looking at the links between soya and breast cancer, show this clear inverse relationship between the amount of isoflavones (present in soya) consumed and breast cancer in both pre- and post-menopausal women (Boutas *et al.*, 2022). In other words, women who eat hardly any soya isoflavones in their diet, have a higher risk of breast cancer compared to those who eat a moderate to higher intake.

For women who have had a breast cancer diagnosis, studies suggest that post-diagnosis soya intake may lower the risk of cancer recurrence (Messina *et al.*, 2022). Experts at the American Institute for Cancer Research in 2021 stated that soya is safe for breast cancer survivors: "Consistent findings from population studies indicate no increased risk for breast cancer survivors who consume soya foods. In fact, limited evidence shows potential for greater overall survival, and perhaps decreased recurrence, among women a year or more after diagnosis who include moderate amounts of soya" (American Institute for Cancer Research, 2021).

This is the view shared by other health bodies, such as the American Cancer Society (Rock *et al.*, 2012) and the Canadian Cancer Society (Canadian Cancer Society, 2024). The European Food Safety Authority (EFSA) has concluded that there is no indication for adverse effects of isoflavones on the breast tissue of postmenopausal women (EFSA ANS Panel, 2015).

Higher breast tissue density is considered a risk factor for breast cancer. Several human studies on breast health have found no significant effects of soya isoflavones on breast tissue density in women who had breast cancer nor in women considered at higher risk of the disease (Hooper *et al.*, 2010; Wu *et al.* 2015). A recent study found that long-term soya isoflavone consumption may even

decrease breast tissue density in premenopausal women, which lowers the risk of breast cancer (Lu *et al.*, 2022).

For this protective effect, it is reasonable to recommend that girls and young women include one or two servings of soya foods in their daily diet. This could include, for example, one medium serving of tofu, a glass of soya milk, a serving of soya yoghurt, a portion of tempeh or edamame beans. For women who have been diagnosed with breast cancer, the same moderate intake is considered safe and may even offer some protection (American Institute for Cancer Research, 2021).

In conclusion, soya foods don't increase the risk of breast cancer or breast cancer recurrence.

Endometrial cancer

The lining of the uterus – endometrium – is also very sensitive to hormones, so it follows that scientists assumed soya isoflavones may affect it. A number of studies revealed that soya consumption has a protective or neutral effect on the uterus (Zhang *et al.* 2015; Zhong *et al.*, 2018). A review of clinical studies showed no adverse effects of soya isoflavones on endometrial thickness or health (EFSA ANS Panel, 2015).

Prostate cancer

Prostate cancer is another hormone-sensitive cancer and its rates are lowest in Asian countries, where soya foods are regularly consumed as part of a normal diet.

A meta-analysis of 30 studies showed that regular consumption of soya foods is clearly linked to a lower risk of prostate cancer (Applegate *et al.*, 2018). It is thought that this may be because soya isoflavones bind mainly to oestrogen beta receptors which are more abundant in the prostate tissue and their stimulation can prevent cancer cells from dividing and – at the same time – isoflavones can also bring about a natural cancer cell death (Hsu *et al.*, 2010; Applegate *et al.*, 2018).

Bowel cancer

What we eat has a huge impact on our digestive tract and the risk of bowel (colorectal) cancer in particular. There are multiple studies demonstrating the protective effect of soya on intestinal health and their data speak clearly – soya food consumption lowers the risk of bowel cancer (Jiang *et al.*, 2016; Yu *et al.*, 2016; Belobrajdic *et al.*, 2023).

Researchers believe this may be due to several phytonutrients that soya contains, including isoflavones, but also because soya foods may have a positive effect on gut bacteria, supporting gut health (Belobrajdic *et al.*, 2023).

Heart health

Scientists agree that soya can promote heart health – a fact supported by dozens of scientific studies (Messina, 2016).

A meta-analysis of studies on soya and the health of the heart and blood vessels revealed that soya food consumption lowers the risk of heart disease, stroke and cardiovascular disease (narrowing and hardening of the arteries – atherosclerosis) (Yan *et al.*, 2017).

Scientists believe this effect is down to several health-supporting properties of soya, such as its antioxidants, healthy fats and fibre content but also compounds that directly improve the blood vessel lining resilience and reduce the stickiness of cholesterol (Yan *et al.*, 2017).

High levels of cholesterol in the blood increase your risk of heart disease because they contribute to atherosclerosis – the build-up of fatty plaques on your artery walls. Soya protein has cholesterol-lowering properties and according to scientists, 25 grams of soya protein daily can reduce your cholesterol levels – this claim was approved by official health bodies in more than 10 countries (Messina, 2016). A meta-analysis of clinical trials showed that soya consumption not only lowers cholesterol levels but also has a positive effect on other blood lipids (Tokede *et al.*, 2015). The authors pointed out that these effects were stronger with whole soya foods (soya milk, edamame) than with soya protein extracts.

It is thought that soya lowers LDL-cholesterol (the bad one) because during its digestion, several peptides are formed and these stimulate specific cells in the liver that break down cholesterol that's already in the blood and also reduce the synthesis of new cholesterol in the liver (Caponio *et al.*, 2020; Macchi *et al.*, 2021).

What's more, isoflavones and some soya peptides may prevent artery plaques from forming (Sekikawa *et al.*, 2019; Kim *et al.*, 2021). And because isoflavones are strong antioxidants, they prevent LDL-cholesterol from oxidizing and therefore lower the risk of atherosclerosis or slow down its progress (Sekikawa *et al.*, 2019).

Another cholesterol-lowering mechanism of soya is that it replaces other, less healthy foods (Messina, 2016). If you eat bacon for breakfast and replace it with soya, simply replacing the unhealthy food with something more nutritious will improve your health.

Research has also revealed that isoflavones help to maintain blood vessel health because they have a protective effect on blood vessel lining and help to relax blood vessel walls which may slightly lower your blood pressure (Yamagata, 2018; Kim *et al.*, 2021).

In summary, eating soya is great for your heart!



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.

There have been concerns that soya can affect thyroid function and hormones but long-term trials have shown that isoflavones don't affect the thyroid in healthy people (Messina *et al.*, 2022). Research confirms that as long as you have sufficient iodine intake soya is safe and won't affect thyroid hormones (Hüser *et al.* 2018).

Toddlers aged one to three should get 70 micrograms of iodine per day, older children between 100 and 130 micrograms and adults 140 micrograms. The best sources are seaweed (arame, wakame and nori) and iodised salt. Kelp is very high in iodine so use only sparingly or use kelp tablets with specified iodine content so you know you're not getting too much. Many other foods also contain iodine but in low and varying amounts depending on iodine levels in the soil in which they're grown. They include wholegrains, green beans, courgettes, kale, spring greens, watercress, strawberries and organic potatoes with skin. Some plants milks also contain a source of iodine as potassium iodide – always check the ingredients!

Even with sufficient iodine intake, soya foods may increase the amount of thyroid medication needed by hypothyroid patients because soya protein may interfere with the absorption of levothyroxine – the synthetic thyroid hormone (Messina, 2016). Experts don't discourage hypothyroid patients from eating soya, they simply suggest either altering the medication dose or taking levothyroxine 30 to 60 minutes before breakfast or four hours after the last meal (Garber *et al.* 2012).

Soya infant formula

There's no doubt that breastmilk is best for babies and all mothers should be encouraged to breastfeed. Breastmilk is the most perfect food for a baby and gives them the very best start in life. However, for various reasons beyond our control, feeding with infant formula may be necessary to ensure your baby is well-fed.

All infant formulas are nutritionally complete. They must comply with strict standards specifying the nutritional composition each formula must have in order to be approved and introduced into the market. Soya-based infant formulas can provide all the nutrients required by a growing infant and millions of babies worldwide have been safely fed soya-based infant formulas over the last 60 years (Vandenplas *et al.*, 2021).

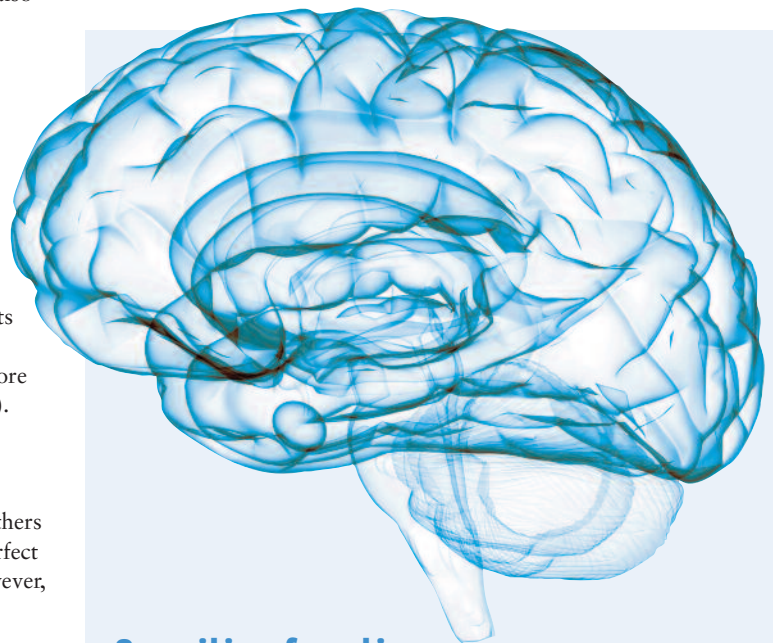
A wealth of scientific studies on soya-based infant formulas found that they are a perfectly safe feeding option, ensure normal growth and development of babies, healthy bones, immune system and have no adverse effects on their reproductive and endocrine (hormone) functions (Andres *et al.*, 2012; Agnoli *et al.*, 2017; Sinai *et al.* 2019; Vandenplas *et al.*, 2014 and 2021; Verduci *et al.*, 2019; Chin *et al.*, 2021; Chen *et al.*, 2023).

The only situation when soya formulas should be used with caution is in babies with hypothyroidism – a reduced

function of the thyroid gland. If the baby has to receive thyroid hormones to treat this condition and is also fed soya formula, the amount of the hormones may need to be adjusted to make sure enough is absorbed (Testa *et al.*, 2018). Another safe option for a vegan baby with hypothyroidism would be a rice-based infant formula.

Of course, soya is not a natural food for babies but nor is cow's milk. Cow's milk is meant for fast-growing calves, not humans, and is loaded with oestrogens – and not the mild ones derived from plants but potent oestrogens from another mammal. Cow's milk is also implicated in a whole range of health problems in children such as digestive upsets, ear infections and skin conditions, and it can interfere with iron absorption from the diet.

Soya formula is a safe and suitable feeding option but the official advice is that you should only give it to your baby if your GP or health visitor advises it. All these uncertainties are based on animal studies where rats and mice were either fed or injected very high doses of isoflavones – studies that have been highly criticised and deemed unreliable. Human data show that soya formula does not produce any adverse effects.



Cognitive function

Studies from Japan and Taiwan reported that a diet high in soya isoflavones can significantly lower the risk of age-related cognitive decline and dementia – by around 50 per cent (Ozawa *et al.*, 2013; Lin *et al.*, 2018; Nakamoto *et al.*, 2018).

Earlier studies from King's College, London, found that soya isoflavones achieved significant improvements in memory, mental flexibility and sustained attention tasks in students and postmenopausal women (File *et al.*, 2001; Duffy *et al.*, 2003).

A large review and meta-analysis of controlled trials examining the effect of soya isoflavones on cognition found that their regular intake helps to improve overall cognitive function and memory (Cui *et al.*, 2020).

However, some other studies have not found this clear positive effect of soya on cognition but rather a neutral one. Research suggests that the difference in people's ability to produce equal from the isoflavone daidzein may play a role in this – equal producers experience greater cognitive benefits from eating soya than non-producers (Igase *et al.*, 2017; Cui *et al.*, 2020; Sekikawa *et al.*, 2022).

Equal can be produced from daidzein only by specific gut bacteria and it seems we can create a gut environment that will support these bacteria by eating a diet rich in complex carbohydrates and with low or moderate amounts of fat (Gong *et al.*, 2023). However, not everyone has these bacteria and more studies need to be done to pinpoint how we can source them and make them available for everyone.





Oestrogen in cow's milk

The hormone content of cow's milk has been widely discussed amongst scientists for many years. Cow's milk has been shown to contain over 35 different hormones and to stimulate our own production of insulin-like growth factor 1 (IGF-1) (Grosvenor *et al.*, 1992; Melnik *et al.*, 2023).

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 modern dairy cow is milked, she is also pregnant and therefore secreting high levels of hormones into the milk (Melnik *et al.*, 2023). These hormones have been linked to a wide range of illnesses and diseases, including certain hormone-dependent cancers such as ovarian and breast cancer. And research has shown that pasteurisation and homogenisation has only a small effect on the hormone levels and there's no difference between the hormone content of conventional versus organic dairy products (Pape-Zambito *et al.*, 2010; Melnik *et al.*, 2023).

The hormones and growth factors in milk 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. 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?

Traditional versus modern soya foods

Most of the traditional soya products such as tofu, tempeh, soya milk, soya sauce and miso, use the whole bean and so contain more nutrients than foods based on soya protein isolate alone. The latter is a protein extract from soya beans which can be labelled as textured vegetable protein (TVP) and is used in various mock meats and other processed foods. It follows that tofu is healthier than a TVP sausage.

Highly processed foods tend to contain too much fat, salt/sugar and artificial additives, which have all been linked to health problems. However, many mock meat products contain much less fat than their meaty equivalents (check the packaging for details) and provide a cholesterol-free source of good protein. This makes them a better option than their meaty counterparts, which contain saturated fat, animal protein, cholesterol and hormones. There's a simple rule – eat wholefoods daily but have processed mock meats no more than three times a week.

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. If you want to eat tofu daily and use soya milk for breakfast or drinks during the day, you absolutely can – it's safe and healthy.

Soya and the environment

Some people believe soya is bad for the environment because it's grown on deforested land in the Amazon and elsewhere in the region. They're right to be concerned but vegans are not the problem – between 75 and 80 per cent of the world's soya production is fed to livestock so that people can eat meat, eggs and dairy (Climate Focus, 2019; Bambridge-Sutton, 2023). In the US, 90 per cent of soya is used for animal feed (American Soybean Association, 2024).

Nature and our health would benefit greatly if more people ate soya instead of animal products as less soya would have to be grown overall. What's more, most of the soya for human consumption in Europe is also grown in Europe, sustainably and without genetic modification. If you want to be 100 per cent sure of no genetic modification in your soya product, look for certified organic products.



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