SOY: Nutritional Profile and Health Impact.

AdeS®: the health and flavour of soy.

A balanced diet promotes more than good body function, it is an important way to provide **vitality** and **well-being.** A good variety of foods should deliver all the nutrients necessary for a healthy body in a practical, delicious and creative way. vzv A healthy and fun diet is important for everybody, but particularly those who experience the stress of modern life and lack of time.

The increasing knowledge provided by nutrition science motivates the population to adopt balanced diets and healthier habits. There are many sources of inspiration for a healthy diet: nutrition guidelines, research into eating habits and new food products whose development is based on the latest scientific insights.

Aligned with this trend, Unilever has a team of professionals and specialists, including food engineers, dietitians and biologists, dedicated to the development of its products and the communication of their benefits.

AdeS® is a result of their commitment. As a synonym for the soymilk category in Latin America, **AdeS®** has been offering the benefits of soy for 20 years.

AdeS® is a line of soy-based beverage that, in addition to being naturally lactose and cholesterol free, offers delicious flavors and nutrients that can contribute to the family diet throughout the day.

This material contains important information about soy, including its nutritional characteristics and health benefits. Enjoy!

AdeS® team
Unilever

The Nutritional Profile of Soy

Although soy and soy products are beneficial for cardiovascular and overall health due to their high content of protein, polyunsaturated fats, fiber, vitamins and minerals and low saturated fat content, the consumption of soy remains low.

Potential reasons to explain this low consumption are a lack of knowledge of the nutritional benefits of soy, the soy-based products available in the market and the delicious and creative ways that soy can be included in the diet[1].

Amino acid profile of soy protein

Protein accounts for approximately 45% of the composition of soybeans[1]. Soy is a source of vegetable protein with a high biological value. The method established by the World Health Organization (WHO) to measure the protein quality - the Protein Digestibility Corrected Amino Acid Score (PDCAAS) - is based on human amino acid requirements and corrected for the protein's digestibility.[1,2,3].

When the PDCAAS is one (1), the highest score possible, it means that the protein contains sufficient quantities of all the essential amino acids and has an adequate digestibility, like many animal proteins[2,4]. Soy protein has an adequate amino acid profile and digestibility, i.e., the PDCAAS score is 1[2].

When compared to other vegetable proteins, the quality of soy protein is superior as it has an optimal balance of essential amino acids. It can be considered the only vegetable food with a complete protein, whose quality is equivalent to that of egg albumin, the gold standard protein[2,3,4].

In addition to Protein

Soybeans contain 18 - 20% of lipids of which 23% are monounsaturated fatty acids, 58% polyunsaturated and 15% saturated[1].

Carbohydrates contribute 35% of the nutritional value of the seed as insoluble carbohydrates from the hull (cellulose, hemi-cellulose and lignin) and soluble carbohydrates (fructose, sucrose, pectin and oligo-saccharides such as stachyose and raffinose - also known as galacto-oligosaccharides or GOS). GOS have been associated with symptoms such as bloating and flatulence due to the lack of the enzyme galactosidade in the human body[5].

Consequently GOS are not digested in the small intestine and arrive intact in the large intestine, where they are metabolized by microorganisms present in the intestinal flora. As a result of this process gases, such as carbon dioxide, hydrogen, nitrogen and methane are produced, which has a direct relationship with the food supply of the intestinal microflora[3,5].

Therefore, oligossacharides, which were previously criticized for inducing gas production, are today included among prebiotic substances, associated with functional improvement of the digestive system[5,6].

Soy also contains a significant quantity of minerals, such as calcium, iron, copper, phosphorus and zinc[1], and vitamins, particularly the vitamin-B complex[3]. The bioavailability of these micronutrients is affected by the presence of phytate, which acts as an anti-nutrient. However, it is not present in fermented soy foods and it's effects reduced in mineral fortified products[6].

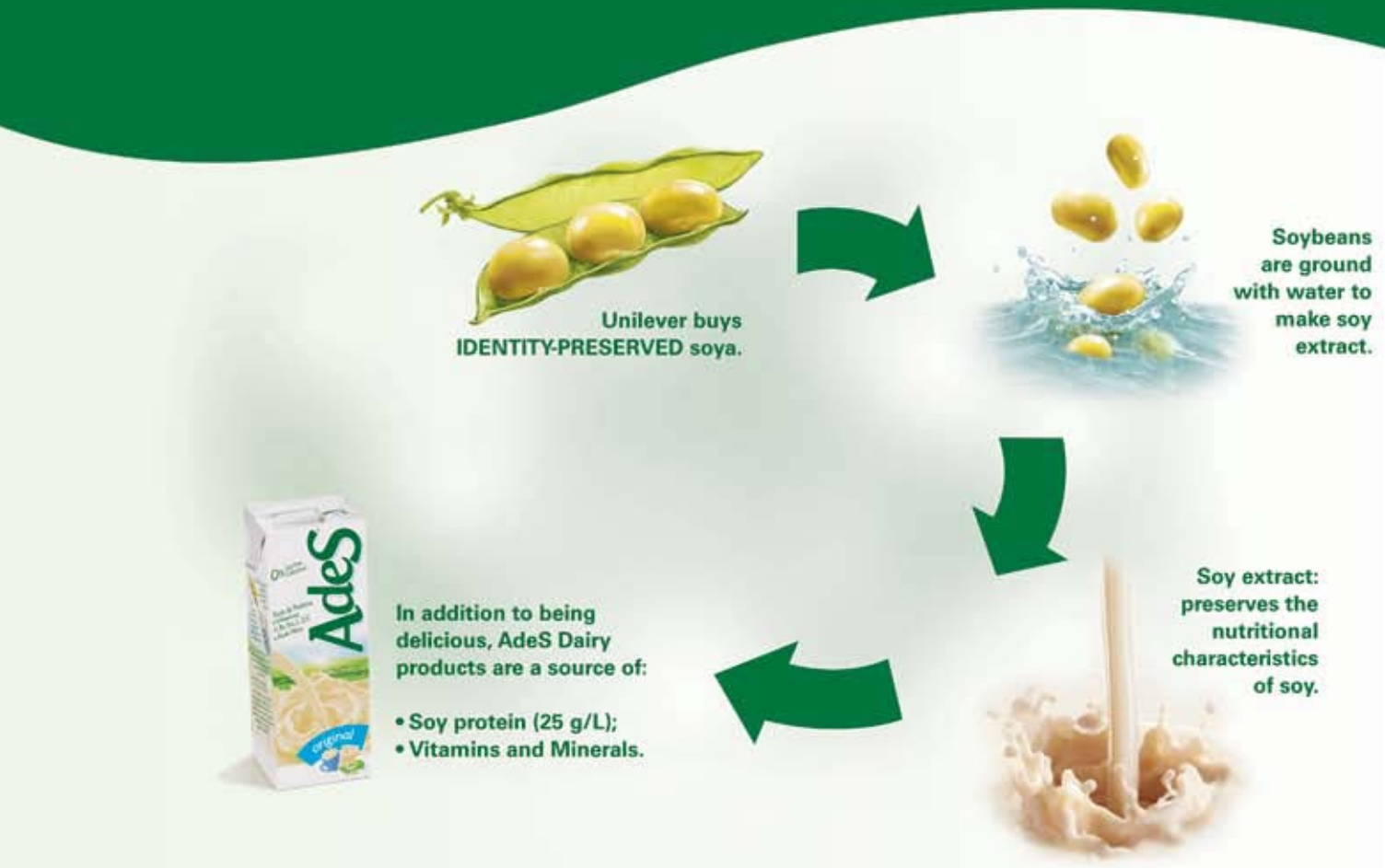
How to consume soy

Soy can be consumed in many ways, such as cooked beans, in salads or stews, in delicious dishes made with textured soy protein (TSP) such as soy burger, filled vegetables, strogonoff and lasagna. Other delicious and practical ways to include soy in daily diet are tofu, miso and soy beverages.

The production of soy beverages

The industrial process to obtain soy extract starts with the selection of soybeans, which are then ground in water before the soluble nutrients and part of the fat are separated from the other parts of the seed in a centrifuge. The liquid obtained is soy "extract", which is then thermally treated to preserve the protein content and give the product a good flavor.

During the manufacturing of AdeS®, other ingredients, such as water, fruit pulp or cacao, are mixed with the soy extract. The products are then enriched with vitamins and minerals. Before being packed, the product is homogenized and ultra-pasteurized where it is subjected to high temperatures for a few seconds followed by immediate cooling to destroy microorganisms.[7,8].



Isoflavones

Because of the increase in life expectancy, modern society today faces an increasing prevalence of chronic diseases such as cardiovascular disease, diabetes, obesity, osteoporosis and cancer, which can be influenced by both by diet and lifestyle[9].

Evidence from various epidemiological studies associates the consumption of vegetables with the low incidence of chronic diseases. Studies have detected the presence of bioactive compounds (phytochemicals) in vegetables associated with beneficial health effects[6,10].

Isoflavones are phytochemicals that are part of a larger group, the flavonoids, which are found in a large range of vegetable-based foods, particularly soy[6,10]. The content of isoflavones in soybeans is approximately 1 mg/g, but can range from 0.4 – 2.4 mg/g[10].

Since their discovery in 1982, various epidemiological studies have shown that populations that consume higher quantities of soy-based foods (50 – 200 mg of isoflavone/day)[10], such as Asian populations, present a lower risk for cardiovascular diseases, osteoporosis and some types of cancer compared to Western populations, who consume less soy (approximately 5 mg of isoflavone/day)[10].

In animals, isoflavones can have important biological effects such as vasidilatation, reduction of blood cholesterol and inhibition of atherosclerosis[11,12]. The three principal types of isoflavones found in soy are genistein, daidzein and glycitein. The amounts of these isoflavones can vary depending on the type of preparation and process used[13,14]. For example, the use of alcohol to extract isolated protein, or other soy-derived product, can remove a significant amount of isoflavones[15]. Isoflavones are found as glycosides bound to a sugar molecule (inactive form) or as aglycones (active form) [6,16].

Glucosides	**Aglycones**
Genistin, daidzin and glycitin.	Genistein, daidzein and glycitein.

Isoflavones are consumed as glucosides and are later hydrolyzed to the active aglycone form by bacteria present in the small intestine. These bacteria can also metabolize the other forms of isoflavones: **equol** (low estrogenic activity) and **0-desmethylangolensin** (no estrogenic activity).

Isoflavones are heterocyclic phenols structurally similar to the estrogenic steroids. In order to have estrogenic action, the diphenolic inactive structures of genistein (4', 5', 7' – trihydroxy-isoflavone -) and daidzein (4', 7' – dihydroxy-isoflavone -) are essential because the hydroxy groups and the aromatic rings of the molecules are recognized by the estradiol receptor and can produce agonist or antagonist estrogenic responses. The affinity of the estrogenic receptor for genistein is 100 - 10,000 times lower than its affinity for human estradiol[17].

Although the affinity is low, it has been the subject of much research, particularly in relation to the symptoms of menopause and cancer[17,18].

As they function as weak estrogens, isoflavones may act as antiestrogens by competing with the more potent and naturally-occurring endogenous estrogens such as 17b-estradiol for binding to the estrogen receptor.

This may be the reason for the reduced risk of estrogen-dependent cancer in Asian populations that regularly consume significant amounts of soy[17,18]. To cause effects in the body, isoflavone concentrations in the plasma need to be from 10,000 to 20,000 times higher than the level of circulating estradiol[17]. To date there is no evidence that the level of isoflavones absorbed by the human body during the normal consumption of soy affects estrogen-dependent processes. It is also unlikely that a normal consumption of soy affects the fertility of human beings or produces any adverse effect on pregnant women and the fetus[18].

Less known, but also important, is the enzymatic inhibition mechanism of isoflavones. There is evidence that genistein may inhibit some of the enzymes that participate in steroid metabolism, such as estrogen synthetase (aromatase), tyrosine-kinase, sulfatase, sulphotransferase, 5-a reductase, 17-beta hydroxysteroid dehydrogenase and 3-beta hydroxysteroid dehydrogenase[19]. Results from some scientific studies show genistein to be a potential anticarcinogen due to its antioxidant and tyrosine-kinase inhibition properties[20]. However, the majority of these studies show tumor reduction only with very high doses of this phytochemical (10-50 μM). Therefore, further studies are required to prove its effect[20].

With respect to antioxidant action, some studies have shown that isoflavones neutralize free radicals therefore reducing oxidation, principally of LDL - cholesterol[21]. Despite this, the evidence for the benefits of isoflavones on cardiovascular health is still not conclusive. Around 19 studies with isoflavones showed no effect on LCL - cholesterol and other risk factors for cardiovascular diseases[15]. The benefits of soy on cardiovascular health may be due to soy protein rather than isoflavones.

Although there is some evidence associating isoflavones with health benefits, the American Heart Association does not recommend the consumption of isoflavone supplements because the efficacy and safety of isoflavones in the prevention or treatment of different types of cancer, such as breast, endometrium and prostate cancer, have not been established yet. The reduction in risk factors for cardiovascular desease and menopause symptoms are still not confirmed[15].

Soy and Health

The health effects of soy have gained considerable attention from the scientific community, especially for its potential role in improving the blood lipid profile, one of the important risk factors for cardiovascular disease. There are also other interesting results linking soy to potential benefits for diabetes, obesity, osteoporosis, cancer, menopause and lactose intolerance.

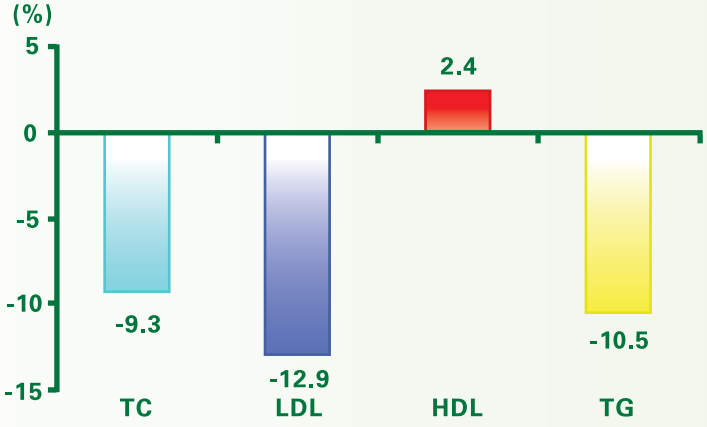
Cardiovascular health

Cardiovascular disease is the number one cause of death globally and is projected to remain the leading cause of death. An estimated 17.5 million people died from cardiovascular disease in 2005, representing 30% of all global deaths. The overall number of deaths caused by CVD has been increasing and if appropriate action is not taken, by 2015, an estimated 20 million people will die from cardiovascular disease every year, mainly from heart attacks and strokes[23,24].

According to the World Health Organization, lifestyle changes associated with urbanization, industrialization and globalization are the key causes of this situation. Amongst the main risk factors identified by epidemiological studies is dyslipidemia. Nutritional therapy can play an important role in the prevention and/or treatment of dyslipidemia[23].

Anderson et al. conducted a meta-analysis of 38 studies that showed a significant reduction in total cholesterol (9.3%) , LDL - cholesterol (12.9%) and triglycerides (10.5%) in patients whose diets contained soy protein in place of animal protein[25].

Meta-analysis of 38 studies with soy[25]



Source: Adapted from Anderson et. al., 1995.

Based on this data, the Food and Drug Administration (FDA)[26] in the United States approved a labeling claim that foods containing soy protein can protect against coronary heart disease.

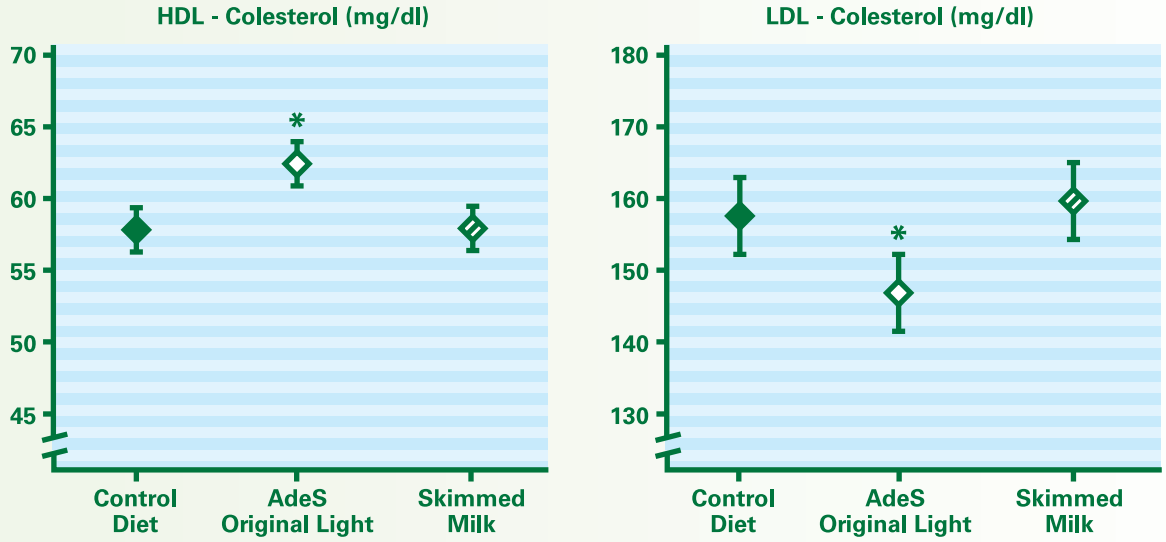
The FDA based this decision on clinical studies showing that at least 25 g per day of soy protein lowered total and LDL cholesterol as part of a diet reduced in saturated fat and cholesterol[26]. In a more recent meta-analysis, Anderson et. al. showed that 2 or 3 servings of soy products throughout the day seem to be more effective than a single dose[27].

The results of recent studies on which component of soy is responsible for its health effects are conflicting, demonstrating the importance of continued investigations into soy and its role in cardiovascular health[29]. Weggemans & Trautwein published a meta-analysis in 2003 that concluded that the beneficial changes in the LDL and HDL - cholesterol profiles associated with soy consumption do not depend on isoflavone content[29].

However, a 2005 meta-analysis of 23 studies evaluated by Zahn[30], showed that the consumption of soy protein with isoflavones improves lipid profile with significant reductions in total cholesterol, LDL - cholesterol and triglycerides and an increase in HDL - cholesterol.

Nevertheless, the positive effects of soy on lipid profile and consequently, its protective effect on the cardiovascular system are attributed mainly to soy protein rather than isoflavones[15,31]. In 2006, after assessing 22 randomized trials, the American Heart Association (AHA), in a position statement, did not rule out benefits of soy on cardiovascular and general health based on the nutritional profile of soy as a whole: vegetable protein, polyunsaturated fatty acids, fibers, vitamins, minerals and low of saturated fat content[15].

In Brazil, a clinical trial conducted by the Federal University of São Paulo and the Dante Pazzanese Institute of Cardiology and published in 2004, examined the influence of AdeS® Original Light, a beverage made with soy extract, compared with skimmed cow's milk[32]. Sixty hypercholesterolaemic patients following a diet based on the AHA recommendations, i.e., up to 30% total fat and 10% saturated fat, were evaluated. The diet with the soy beverage resulted in the best lipid profile, with a decrease in LDL - cholesterol and an increase in HDL - cholesterol, in addition to reduced lipid peroxidation[32].



P<0.05 Source: Adapted from Bricarello et al., Nutrition, 2004[32].

Furthermore, interesting, although inconclusive, data suggests that soy can promote coronary benefits independent of its effect on lipid concentrations.

There is some evidence that soy reduces the size of LDL - cholesterol particles, improves the endothelium function, reinforces arterial elasticity and inhibits the oxidation of LDL - cholesterol[27]. The Rotterdam study[33] indicated that the consumption of soy protein could be associated with the enhancement of arterial elasticity, as opposed to the stiffness characteristic of atherosclerosis. Three-hundred hypertensive Chinese who consumed 40 g of soy protein daily for 12 weeks showed a reduction in blood pressure[33].

The latest review published by Anderson[27] indicates that the effects of soy on the cardiovascular system, including the lower oxidation of LDL - cholesterol and triglycerides, lower platelet aggregation and less inflammation, could be mediated by peptides produced during protein hydrolysis in the intestine[27].

As cardiovascular disease can be asymptomatic and many individuals ignore their blood cholesterol and triglycerides levels, it is worth emphasizing that including foods with soy protein in the diet can improve the lipid profile of the population[23, 27, 29, 30, 32, 33].

Lactose intolerance and cow's milk allergy

Intolerance to lactose (the sugar present in of cow's milk) is characterized by the deficiency of the intestinal enzyme lactase[34,35]. Individuals with lactose intolerance present symptoms such as abdominal cramps, vomiting and diarrhea, which are relieved with the withdrawal of dairy products[34].

The mechanisms involved in cow's milk allergy are different from those found in lactose intolerance. Various proteins can cause allergy, but those from milk and eggs are the most common. They cause greater problems for young children due to the increased production of immunoglobulins against the different allergenic sites in these proteins. There is a wide range of symptoms, including gastrointestinal, respiratory, ocular, neurological and skin problems.[36, 37.] Soy-based beverages can be a dietary alternative for both lactose intolerance and cow's milk allergy for children, as long as they follow clinical and nutritional recommendations for adequate energy and nutrient intake[38].

Obesity

Surveys conducted in Latin American and Caribbean countries in 2002 found that 50 - 60% of adults and 7 - 12% of children under 5 years of age were overweight or obese. In Argentina, Colombia, Mexico, Paraguay, Peru and Uruguay, more than half of the population is overweight and over 15% obese. Between now and 2015, the prevalence of overweight in the Americas is expected to increase in both men and women[39].

Some clinical trials that studied the impact of soy-based foods in place of conventional foods indicated weight loss in both animals and humans[40].

Diabetes

In 2006, an estimated 35 million people in the Americas were diabetic—a number that is projected to increase to 64 million by 2025[39]. Diet can play an important role in the prevention and management of the disease. For individuals with diabetes, the inclusion of soy protein compared to a diet based exclusively on the recommendations of the American Diabetes Association promoted increased weight loss[42].

Beneficial changes were also observed in the glycaemic profile, showing that a diet based on soy protein could be an interesting strategy for weight loss and blood glucose management[42]. One study showed that, when compared to the milk protein casein, soy protein enhanced insulin sensitivity and glucose effectiveness[43].

A randomized study that examined the lipid profile and the renal function of patients with diabetes type 2 and nephropathy showed that the consumption of soy milk resulted in a decrease in total cholesterol, LDL - cholesterol and triglycerides, in addition to improving the levels of urea and proteinuria[44].

The inclusion of soy in the diet modified the risk factors for Coronary Artery Disease (CAD) and improved renal function in these patients[44].

Osteoporosis

Populational and experimental studies suggest that soy can have a positive impact on the reduction of bone mass after menopause[45]. Various studies have shown a strong association between the high consumption of soy and bone density in women due to the decreased urinary excretion of calcium caused by either the reduced presence of sulphur-containing amino acids in soy protein or unknown mechanisms related to isoflavones[46, 47, 48].

A study with more than 24,000 Chinese women in the perimenopause showed a decreased fracture risk[49]. Another study which evaluated 500 Japanese children for five consecutive years (from 10 to 15 years of age) also showed a positive effect of soy consumption on bone density[50]. However, the duration and sample size of these two studies were not sufficient to give conclusive results[45,51].

Cancer

The hypothesis that the consumption of soy has an impact on the prevalence of breast and endometrium cancer is based on their low incidence in Asian women and because soy isoflavones demonstrated benefits in animal models[52,53].

To date, epidemiological evidence is not conclusive - some studies suggest a lower incidence of breast cancer in populations that consume diets rich in soy protein whereas other studies did not find an association[52, 54, 55, 56]. The exact mechanism of this potential protective effect still needs to be clarified, but isoflavones are probably involved[49, 57, 58, 59].

Contrary to this, some scientists have suggested that the estrogenic effect of isoflavones increases the risk for breast and endometrial cancer[57, 58]. However, only one out of 15 recently published clinical trials that studied the effect of isoflavones on endometrial tissue showed a relationship with an increased risk of endometrial cancer[57].

This study investigated the effects of isoflavone supplements on endometrial tissue and not soy-based foods, so the observed effects may not necessarily apply to foods. Therefore, there is no contra-indication for the consumption of soy products by women who present risk for breast cancer or by women who already have this disease, according to the results from studies in humans and animals[58, 59, 60].

In conclusion, the benefits of soy in relation to cancer are not proven and further studies are required[15].

Soy and Balanced Diet

Soy has been grown in China and Korea for more than 2,000 years. Although Western countries are the major producers and are responsible for meeting the demand of Eastern countries, the consumption of soy is still low in the West compared to Asian countries[61].

However, soy has really been appreciated since the beginning of this century as science has started to show that it has a good nutritional profile, especially due to the benefits associated with its optimal protein profile.[62] - as has been shown in the previous chapters.

With the introduction of new growing techniques, the reduction of the characteristic soy taste after processing and, consequently, the introduction of new soy products in the market, soy has started to be consumed in other countries, contributing to the promotion of a more balanced diet[61].

Most part of the protein consumed in western diets comes from animal sources, such as meat, milk and eggs, and has a high biological value because it contains all the amino acids essential for our health - unlike vegetable proteins. However, the content of saturated fat in foods of animal origin is high and this is associated with increased LDL - cholesterol[62,63,64].

Soy has some advantages compared to foods of animal origin and compared to legumes,

like beans and lentils, because, unlike other vegetable foods, it contains protein with a high biological value comparable to animal protein[65], but with a lipid profile characteristic of grains: a high level of polyunsaturated and monounsaturated fat and low level of saturated fat, with no cholesterol.

For this reason, the American Heart Association considers soy as a food with good nutritional profile for cardiovascular health[15].

Furthermore, studies that show a relation between the consumption of soy protein and a decrease in LDL - cholesterol and increase in HDL - cholesterol[32] also encourage the inclusion of soy in the diet.

On the other hand, although soy isoflavones have been extensively studied[15], research on their role is still inconclusive. This is why the inclusion of soy in the diet is recommended for the benefits associated with its protein and its content of mono and polyunsaturated fat.

Because it combines these unique features in its nutritional profile, soy and soy products have been considered an ally of physicians and dietitians in their recommendations for a balanced diet. The combination of soy with other foods with an appropriate nutritional profile may produce effects that enhance the overall health benefits, particularly with respect to cardiovascular health. Clinical trials have shown that soy combined with viscous fiber, plant sterol and almonds as part of a balanced diet decreased LDL - cholesterol and optimized the already proven effects of margarine with phytosterols[66].

In order to meet the current needs of society, nutrition science has progressed. Today it is known that a balanced diet with a variety of different coloured vegetable foods that are sources of vitamins, minerals, fibers and phytochemicals[64] can improve several body functions, such as decrease LDL - cholesterol levels[64,68] and consequently help to reduce the risk of some chronic diseases[64].

These foods provide much more than just energy and macronutrients such as protein or fat because they provide unique bioactive compounds that make them functional foods[28]. This is the case for soy protein, phytosterols, and possibly isoflavones.

Anyhow, the habit of including foods with a better nutritional profile such as soy beans and soy products should not be an isolated action, but rather be part of a balanced diet that takes the culture and social life of individuals into consideration, i.e., nutrition combined with eating pleasure.

Knowing how to introduce soy in the diet is the first step in increasing its consumption:

- At breakfast and as snacks: soy beverage is a nutritious drink option. A 200-mL glass provides 6.25g of soy protein, 25% of the daily quantity recommended to help to reduce LDL - cholesterol levels.
- At main meals with all the family, soy can be consumed in many different ways: soy beverage can be used as a culinary ingredient in different recipes such as dressings, fillings, doughs and desserts. When cooked, soybeans can be used to prepare a more nutritious salad or soup. As textured soy protein, soy can replace ground beef in traditional recipes such as kibbe, stuffed eggplant or sauces for pasta and lasagna. Soy meat cubes are often used in vegetarian dishes such as strogonoff and feijoada (a typical Brazilian dish with meat, pork and black beans).

Soy beverages can be an option to treat both cow's milk allergy and lactose intolerance in adults and children over than two years of age, with appropriate clinical and nutritional guidance regarding the adequate intake of energy and the other nutrients[70].

For healthy individuals, the inclusion of soy-based foods in the diet should not exclude milk or meat-based foods. On the contrary, it is a way to balance the amount of good fat, vitamins, minerals and fibers in the diet[15].

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