

# Soybean bioactive peptides: A new horizon in preventing chronic diseases

*Soybeans, an excellent source of dietary peptides, have antihypertensive, anticholesterol, and antioxidant activities, and appear to prevent cancer. The processing of soy protein into peptides in the GI tract greatly increases their healthful effects by exposing active groups within the amino acid chain. Lunasin, one of the most promising of these peptides, has been shown in recent studies to be an effective anti-cancer agent. Found in a variety of readily available foods, lunasin is an accessible component to healthy living.*



The bioactive peptides produced by soybeans possess diverse and unique health benefits. These can be effective in the prevention of age-related chronic disorders, such as cardiovascular disease, cancer, obesity, and decreased immune function. Bioactive peptides are released from dietary proteins by either gastrointestinal digestion or by the processing of foods. Evidence also suggests that these peptides can be absorbed by the gastrointestinal system, thus exerting their action on specific target organs. The purpose of this review is to summarize the most recent evidence concerning the possible benefits of soybean peptides, particularly the peptide lunasin, in cancer prevention. Research and clinical trials have demonstrated the biological activities of peptides, but their mechanism of action requires further investigation. It is also important to discover new peptides with health benefits in soy-hydrolyzates and fermented foods. The identification of novel bioactive compounds will contribute towards the development of functional foods that can be used to enhance health and quality of life.

## Nutritional importance of soybean

Soybeans, a common source of bioactive peptides, contain about 40% protein and are used in foods, livestock feed, and oil production,

## KEY POINTS

- Dietary bioactive peptides are short amino acid chains produced by digestion or processing of proteins.
- Bioactive soy peptides possess antioxidant, antihypertensive and anticancer properties.
- Soy is an important source of bioactive peptides.
- Fermented and hydrolyzed soy products, such as yogurt and cheese, are a good source of peptides.
- Dietary peptides can be absorbed by the body.
- The unique soy peptide lunasin may be beneficial in cancer prevention.

and are the source of other healthcare products, such as sterols and vitamin E. The major soy proteins are known as  $\beta$ -conglycinin and glycinin, which account for 65%–80% of total soy proteins. Because soy protein contains all the amino acids that are essential to human nutrition, it is a great substitute for animal protein. The use of soy in human nutrition has increased significantly. There are numerous products on the market which are based on soy or contain soy ingredients. Protein products for food uses include defatted flakes, grits and flour, protein concentrate, protein isolate, and textured protein products. Soybeans can also be used to produce whole bean products

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TABLE 1

Examples of biologically functional peptides derived from soy proteins

Source	Activity	Reference
Native and heated soy protein isolate	Antioxidant activities	27
Defatted soy meal	Hypotensive	11
Soybean	Antihypertensive IC <sub>50</sub> = 26.5 μM	6
Korean fermented soybean paste	Antihypertensive peptide: IC <sub>50</sub> = 2.2 μM	13
Soybean glycinin	Hypocholesterolemic peptide	21
Genetically modified soybean protein	Antioxidative; Antihypertensive	7
Defatted soy protein	Anticancer	10

(sprout, milk, sauce, tofu, miso, and others).

Epidemiological studies suggest that populations consuming high levels of soybean products have both lower incidences of cancer and lower mortality rates for the major cancer types commonly found in the Western hemisphere.<sup>1</sup> Thus, as the main components of soybean, soy proteins are receiving increased attention with respect to their health effects. Bowman Birk inhibitor (BBI), a soy protein component, has been shown to suppress carcinogenesis in human prostate cancer cells and has also been the subject of promising clinical trials in cancer patients.<sup>2,3</sup>

The low incidence of hypercholesterolemia, heart disease, and cancer in certain Asian populations has also been associated with a high consumption of soy protein.<sup>4</sup> By hydrolyzing soy protein isolates, bioactive peptides may be formed that are related to a lower incidence of cancer.<sup>5</sup>

**Dietary bioactive peptides**

Dietary peptides are protein fragments or short amino acid chains produced by enzymatic digestion in the gut or by the processing of food via fermentation and hydrolysis. Food-derived bioactive peptides from dietary proteins commonly contain 2–9 amino acids.<sup>6</sup> However, this range may be extended to 20 or more amino acid units.<sup>6</sup> It is known that during gastrointestinal digestion or food processing, these peptides are released from the parent protein and act as regulatory compounds with hormone-like activities.<sup>7</sup> Numerous peptides with various bioactive functions have been identified in soy. These include primarily antihypertensive, anticholesterol, antioxidant and cancer prevention peptides, among other newer functions being discovered. In a

database named Biopep, more than 1500 different bioactive peptides have been presented.<sup>8</sup> Among them, angiotensin converting enzyme (ACE) inhibitors and dipeptidyl peptidase IV inhibitors, which show antihypertensive activity, are the most common. Peptides with other biological activities, such as opioid agonistic and antagonistic, antioxidative, anticancer and immunomodulatory actions have also been identified.

Fermentation is considered to be an efficient way to produce bioactive peptides. Bioactive peptides can be released by the microbial activity of fermented food or through enzymes derived from microorganisms.<sup>7</sup> Fermented soy milk and cheese have been extensively studied to investigate their potential to form bioactive peptides. Interest in fermented soybean products—such as natto, tempeh, soy sauce, soy paste—has grown in recent years.

Table 1 presents soy protein hydrolysates that yield either antioxidant peptides,<sup>9</sup> peptides with anticancer properties<sup>10</sup> or with hypotensive activity.<sup>11</sup> Immunomodulatory peptides derived from tryptic hydrolysates of soybean proteins act to stimulate superoxide anions, which trigger nonspecific immune defense systems.<sup>12</sup>

**Biological activities of soybean peptides**  
**Antihypertensive**

Antihypertensive peptides are the most commonly occurring bioactive peptides in foods. They show their activity by inhibiting angiotensin-converting enzyme. ACE is a non-specific dipeptidyl carboxypeptidase associated with the regulation of blood pressure by modulating the rennin-angiotensin system. This enzyme converts the decapeptide angiotensin I into the potent vasoconstricting octapeptide angiotensin II, which leads to an increase in blood pressure. Therefore, inhibition of the ACE will result in an antihypertensive effect.<sup>13</sup>

Several ACE inhibitory bioactive peptides have been found in enzyme hydrolysates of soy proteins. The peptide fractions given orally to spontaneously hypertensive rats (SHR) at a level of 2.0 g/kg body weight markedly lowered their blood pressure. Antihypertensive peptides were also found in soybean alcalase digest.<sup>11</sup> Oral doses of these peptides significantly (*P* < 0.05) decreased systolic blood pressure of SHR in a dose-de-

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