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Brussels Sprouts: A Tiny Vegetable with Huge Benefits

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Introduction

Brussels sprouts (*Brassica oleracea* var. *gemmifera*) are a member of the Brassicaceae (Cruciferae) family, commonly known as the cabbage family, which includes other highly nutritious vegetables such as broccoli, cauliflower and kale. Native to the Mediterranean region and cultivated widely in Europe since the 16th century, Brussels sprouts are small, leafy green buds resembling miniature cabbages, and have gained recognition not just for their distinctive taste but also for their impressive nutritional profile and associated health benefits. This article explores the nutritional components of Brussels sprouts, their physiological impacts, and the wide range of health benefits they offer. It also discusses how Brussels sprouts can be a valuable component of a balanced diet and help in the prevention of various diseases.

Fig. 1. Brussels sprouts growing in the axils of the expanding leaves

Fig. 2. Harvested Brussels sprouts resembling miniature cabbages

Nutritional Composition Of Brussels Sprouts

Brussels sprouts are a nutrient-dense and low-calorie vegetable, rich in vitamins, minerals, antioxidants and bioactive compounds that contribute to their health-promoting properties. Here is a breakdown of their key nutritional constituents:

1. **Macronutrients:** Brussels sprouts are low in calories, with a 100 g serving providing only 43 calories. This makes them a suitable option for people aiming to manage their

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weight. They are also low in fat (0.3 g), and provide moderate amounts of protein (3.4 g) and carbohydrates (8.9 g), which primarily come from dietary fibre (3.8 g). The high fibre content in Brussels sprouts supports digestive health and helps regulate blood sugar levels.

2. **Vitamins:** Brussels sprouts are an excellent source of several essential vitamins, including Vitamin C (85 mg per 100 g), Vitamin K (177 µg per 100 g, which is over 200% of the daily recommended intake), Vitamin A and small but significant amounts of B-complex vitamins, including folate (B_9), vitamin B_6 and thiamine (B_1).
3. **Minerals:** Brussels sprouts are also rich in essential minerals such as manganese (Mn), potassium (K), iron (Fe) and magnesium (Mg).
4. **Phytochemicals and antioxidants:** Beyond vitamins and minerals, Brussels sprouts are abundant in phytochemicals–natural compounds that have numerous health benefits. These include:

   (a) **Glucosinolates:** Brussels sprouts are particularly rich in glucosinolates, sulphur-containing compounds that are converted into biologically active isothiocyanates during digestion. Isothiocyanates, such as sulforaphane, have been shown to have anticancer properties.

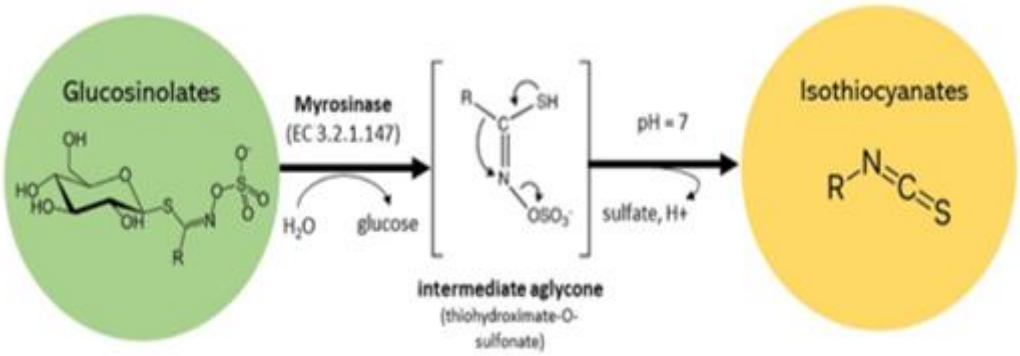

Fig. 3. General structure of glucosinolates and isothiocyanates and their

(b) Carotenoids: While not as abundant as in other vegetables like carrots, Brussels sprouts contain β-carotene and lutein, which are powerful antioxidants that help protect the eyes from age-related macular degeneration.

(c) Kaempferol: This antioxidant flavonoid found in Brussels sprouts has been associated with reduced inflammation and a decreased risk of chronic diseases.

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Health Benefits Of Brussels Sprouts

1. **Antioxidant and anti-inflammatory properties:** One of the primary health benefits of Brussels sprouts is their high antioxidant content. Free radicals–the unstable molecules that cause oxidative stress–are implicated in aging and the development of diseases such as cancer, cardiovascular diseases and neurodegenerative disorders. The antioxidants in Brussels sprouts, including vitamin C, kaempferol and carotenoids, help neutralise free radicals and reduce oxidative stress. Chronic inflammation is another contributing factor to a range of diseases, including arthritis, heart disease and cancer. Studies have shown that the consumption of Brussels sprouts can help reduce inflammatory markers in the body. Kaempferol, in particular, has been shown to inhibit the production of pro-inflammatory cytokines, potentially offering protective effects against inflammation-driven diseases.
2. **Cancer prevention:** Perhaps the most widely studied health benefit of Brussels sprouts is their potential role in cancer prevention. This benefit is largely attributed to their high content of glucosinolates, which are converted into isothiocyanates during digestion. Sulforaphane, one of the most potent isothiocyanates, has been extensively researched for its anticancer properties. Sulforaphane works by promoting the detoxification of carcinogens, reducing oxidative stress, and inhibiting the proliferation of cancer cells. It has shown promise in protecting against cancers of the breast, prostate, colon and lungs. Additionally, studies suggest that the consumption of cruciferous vegetables may reduce the risk of developing cancer due to their ability to modulate enzymes involved in detoxification and to inhibit the growth of cancer cells.
3. **Cardiovascular health:** Brussels sprouts may support heart health through several mechanisms. Their high fibre content helps lower cholesterol levels by binding to bile acids in the gut, and promoting their excretion. This, in turn, reduces the amount of cholesterol absorbed into the bloodstream. Additionally, the potassium in Brussels sprouts plays a crucial role in maintaining healthy blood pressure levels by balancing the effects of sodium (Na). High K intake is associated with a reduced risk of stroke and heart disease. Moreover, the anti-inflammatory properties of Brussels sprouts may further benefit cardiovascular health by reducing the risk of atherosclerosis, a condition characterised by the accumulation of plaque in the arteries. The presence of kaempferol

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and other antioxidants helps prevent the oxidation of LDL cholesterol, a key factor in the development of heart disease.

4. **Digestive health:** The high fibre content in Brussels sprouts promotes digestive health by supporting regular bowel movements and preventing constipation. Dietary fibre adds bulk to the stool and facilitates its passage through the digestive tract, reducing the risk of gastrointestinal disorders such as diverticulitis and haemorrhoids. Moreover, Brussels sprouts contain both soluble and insoluble fibre. Soluble fibre helps feed beneficial gut bacteria, promoting a healthy microbiome, which is essential for overall digestive health and immune function. A healthy gut microbiota has been linked to a lower risk of obesity, type 2 diabetes mellitus (T2DM) and inflammatory bowel disease. The consumption of Brussels sprouts may also help protect the stomach lining from damage.
5. **Weight management:** Brussels sprouts are an excellent addition to a weight management plan due to their low-calorie content and high fibre levels. Foods high in fibre tend to promote satiety, which can help reduce overall calorie intake, and support weight loss efforts. The slow digestion of fibre-rich foods helps regulate blood sugar levels, reducing hunger pangs and preventing overeating. Additionally, Brussels sprouts are nutrient-dense, meaning they provide a high concentration of vitamins and minerals relative to their calorie content. This makes them an ideal food for those looking to lose weight while maintaining optimal nutrition.
6. **Bone health:** The high vitamin K content in Brussels sprouts plays a critical role in maintaining bone health. Vitamin K is essential for the activation of osteocalcin, a protein that helps bind calcium (Ca) to the bone matrix, thereby promoting bone mineralisation. Inadequate vitamin K intake has been linked to an increased risk of osteoporosis and fractures. Furthermore, Brussels sprouts provide small amounts of Ca, Mg and P, all of which contribute to bone strength and density. Adequate intake of these minerals is essential for reducing the risk of bone disorders, particularly in post-menopausal women who are at higher risk of osteoporosis.
7. **Blood sugar regulation:** The fibre content in Brussels sprouts can help stabilise blood sugar levels by slowing the absorption of glucose in the bloodstream. This can prevent spikes in blood sugar after meals, making Brussels sprouts a valuable food for individuals with T2DM or those at risk of developing the condition. Moreover, research has

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suggested that the antioxidants and anti-inflammatory compounds in Brussels sprouts may improve insulin sensitivity, further supporting healthy blood sugar regulation. Sulforaphane, in particular, has been shown to reduce the production of glucose in liver cells and improve glucose tolerance in animal studies.

8. **Immune system support:** Brussels sprouts are rich in vitamin C, which is essential for maintaining a healthy immune system. Vitamin C stimulates the production of white blood cells, which are responsible for fighting off infections. It also acts as an antioxidant, protecting immune cells from damage caused by free radicals. In addition to vitamin C, the other antioxidants in Brussels sprouts, such as β-carotene and flavonoids, further contribute to immune system function by reducing inflammation and oxidative stress. A strong immune system is critical for preventing infections, autoimmune diseases, and even certain types of cancer.

Culinary Uses and Preparation Of Brussels Sprouts

Brussels sprouts can be prepared in a variety of ways, making them a versatile addition to the diet. They can be steamed, roasted, sautéed, or even eaten raw in salads. However, the method of preparation can affect the retention of nutrients. For example, boiling Brussels sprouts for extended periods can lead to the loss of water-soluble vitamins such as vitamin C. To maximise their nutritional value, it is recommended to cook them lightly, such as by steaming. When roasting Brussels sprouts, adding heart-healthy fats like olive oil can enhance the absorption of fat-soluble nutrients like vitamin K and carotenoids. Pairing Brussels sprouts with other nutrient-rich foods, such as nuts, seeds, or lean proteins, can create a balanced meal.

Fig. 4. Different culinary preparations of Brussels sprouts–roasted (left), sautéed (centre) and salad (right)

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Conclusion

Brussels sprouts are a nutritional powerhouse that offers a wide range of health benefits. Their high content of vitamins, minerals, fibre and antioxidants makes them an essential component of a healthy diet. By incorporating Brussels sprouts into daily meals, individuals can take advantage of their impressive health-promoting properties and contribute to their overall well-being. Whether enjoyed roasted, steamed, or raw, Brussels sprouts are a delicious and nutrient-dense vegetable that deserves a place on every plate.