Winter Diet Seeds: A Biochemical Approach to Health and Immunity

N. C. Chovatiya[1]*, A. R. Parmar[2], D. M. Solanki[3] and K. J. Chauhan[4]

[1]Assistant Professor, Department of Agricultural Chemistry & Soil Science,
[2]Associate Professor, Department of Horticulture,
[3]Assistant Research Scientist, Department of Agricultural Chemistry & Soil Science,
[4]Assistant Professor, Department of Agricultural Chemistry & Soil Science,
C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University (SDAU), Gujarat, India.

Corresponding Author
N. C. Chovatiya
Email: chovatiyanirbhay936@gmail.com

OPEN ACCESS

Keywords

Seed, Health, Immunity, Vitamins, Antioxidants

How to cite this article:

Chovatiya, N. C., Parmar, A. R., Solanki, D. M. and Chauhan, K. J. 2026. Winter Diet Seeds: A Biochemical Approach to Health and Immunity. *Vigyan Varta* 7 (06): 69-74.

ABSTRACT

Winter is associated with increased susceptibility to infections, metabolic stress, reduced sunlight exposure, and greater nutritional demands, making a balanced and functional diet essential for maintaining health and immunity. Seeds such as flaxseed, chia, sesame, sunflower, and pumpkin seeds are nutrient-dense foods rich in essential fatty acids, proteins, dietary fiber, vitamins, minerals, antioxidants, and bioactive phytochemicals that collectively support physiological resilience during the winter season. These seeds provide important micronutrients including vitamin E, zinc, magnesium, selenium, and iron, which act as cofactors in enzymatic reactions, enhance immune function, regulate metabolism, and protect cells against oxidative damage. Their antioxidants and phytonutrients, such as lignans, flavonoids, and phenolic compounds, help neutralize reactive oxygen species and reduce inflammation, while dietary fiber improves digestive health, supports beneficial gut microbiota, and promotes the production of short-chain fatty acids that strengthen immune responses. Additionally, essential fatty acids and antioxidants contribute to skin and mucosal integrity by maintaining membrane stability, hydration, and tissue repair during cold and dry weather. The combined biochemical synergy of these nutrients enhances nutrient

bioavailability, metabolic efficiency, and overall health, making seeds an economical, natural, and science-based functional food for strengthening immunity, maintaining metabolic balance, and improving resilience against seasonal stress during winter.

INTRODUCTION

Winter brings a change not only in weather but also in dietary needs. The cold months often coincide with increased susceptibility to infections, reduced sunlight exposure, and changes in metabolism. Choosing nutrient-dense seeds as a part of a winter diet can be a simple, natural, and effective way to boost immunity, enhance metabolism, and maintain health. Seeds are biochemical powerhouses providing essential fatty acids, micronutrients, antioxidants, and bioactive compounds that support physiological resilience during the winter months. De, L. C. (2020)

1.1 WHY SEEDS MATTER IN WINTER NUTRITION

Seeds matter in winter nutrition because they are compact, energy-dense foods that supply essential nutrients required to cope with cold stress and seasonal immune challenges. During winter, the body demands more **healthy fats, antioxidants, and micronutrients** to maintain body temperature, support metabolism, and strengthen immune defences. Seeds are rich in **omega-3 and omega-6 fatty acids, vitamin E, zinc, magnesium, dietary fiber, and bioactive phytochemicals**, which collectively help reduce inflammation, protect cells from oxidative damage, and enhance immune cell function (Raza *et al*., 2026). Their slow-digesting fats and fibers provide sustained energy and satiety, making seeds an ideal functional food for maintaining health, vitality, and immunity during the winter season.

1.2 VITAMINS AND MICRONUTRIENTS

Winter diet seeds are rich sources of essential vitamins and micronutrients that play a critical biochemical role in maintaining immunity, metabolism, and cellular protection during cold stress. Seeds such as sunflower, sesame, pumpkin, and flaxseed provide significant amounts of vitamin E, zinc, magnesium, iron, and selenium, which act as cofactors for numerous enzymatic reactions. Vitamin E, a lipid-soluble antioxidant, protects cell membranes from oxidative damage and supports immune cell integrity. Zinc is vital for DNA synthesis, enzyme activation, and proper functioning of innate and adaptive immune responses, while magnesium is essential for ATP production and energy metabolism (Stefanache *et al*., 2023). Selenium contributes to antioxidant defence through selenoenzymes like glutathione peroxidase. Together, these micronutrients enhance antioxidant capacity, regulate immune signalling, and help the body adapt to the metabolic and environmental stresses of winter.

1.3 ANTIOXIDANTS AND PHYTONUTRIENTS

Seeds are valuable sources of antioxidants and phytonutrients that protect the body against oxidative stress, which tends to increase during winter due to cold exposure, infections, and metabolic stress. Seeds such as **flaxseed, chia, sesame, and sunflower** contain bioactive compounds including **phenolic acids, flavonoids, lignans, and phytosterols**. These compounds neutralize reactive oxygen species (ROS), thereby preventing oxidative damage to lipids, proteins, and nucleic acids. **Lignans**, particularly abundant in flaxseed, exhibit strong antioxidant and anti-inflammatory properties and also contribute to

hormonal balance. **Phenolic compounds** act as redox modulators, enhancing endogenous antioxidant systems like glutathione, catalase, and superoxide dismutase. Through these biochemical mechanisms, antioxidants and phytonutrients from seeds support immune function, reduce inflammation, and promote cellular resilience during the winter season. (Carlsen *et al*., 2011)

1.4 DIETARY FIBER

Dietary fiber is a key nutritional component of seeds that contributes significantly to digestive health, metabolic regulation, and immune support during winter. Seeds such as **chia, flaxseed, sesame, and pumpkin seeds** are rich in both **soluble and insoluble fiber**, which helps regulate bowel movements and prevent digestive discomfort commonly experienced in colder months. Soluble fiber forms a gel-like matrix in the gut, slowing glucose absorption and promoting stable blood sugar levels, while insoluble fiber enhances intestinal motility. From a biochemical perspective, fermentable fiber serves as a substrate for beneficial gut microbiota, leading to the production of **short-chain fatty acids (SCFAs)** such as butyrate, propionate, and acetate. These SCFAs play a crucial role in maintaining gut barrier integrity, modulating immune responses, and reducing systemic inflammation, thereby strengthening overall health and immunity during winter (Dodevska *et al*., 2022).

2. FUNCTIONAL ROLES OF SEED NUTRIENTS IN WINTER HEALTH

2.1 IMMUNE SUPPORT

Seed nutrients play a vital functional role in strengthening the immune system during winter, a season marked by increased vulnerability to infections and environmental stress. Seeds provide essential **micronutrients such as zinc, selenium, and magnesium**, along with **vitamin E and omega-3 fatty acids**, all of which are crucial for optimal immune function. **Zinc** supports the development and activation of immune cells, including T-lymphocytes and natural killer cells, while **selenium** enhances antioxidant defenses through selenoproteins that protect immune cells from oxidative damage. **Vitamin E** improves both innate and adaptive immune responses by maintaining membrane integrity and reducing lipid peroxidation. Additionally, **omega-3 fatty acids** modulate cytokine production, helping to balance inflammatory responses. Through these biochemical mechanisms, seed nutrients enhance immune resilience, reduce inflammation, and support the body's defense system during the winter season.

2.2 SKIN AND MUCOSAL INTEGRITY

During winter, cold temperatures and low humidity often impair skin hydration and weaken mucosal barriers, increasing susceptibility to infections. Seed nutrients play a crucial role in maintaining **skin and mucosal integrity** by supplying essential lipids, antioxidants, and micronutrients. Seeds are rich in **essential fatty acids**, particularly omega-3 and omega-6 fatty acids, which are integral components of cell membranes and help preserve skin elasticity and barrier function. **Vitamin E** acts as a protective antioxidant, preventing oxidative damage to skin lipids and maintaining membrane stability. Additionally, **zinc** supports tissue repair, collagen synthesis, and epithelial cell renewal in both skin and mucosal linings of the respiratory and digestive tracts. From a biochemical perspective, these nutrients strengthen lipid bilayers, reduce inflammation, and support rapid cellular regeneration, thereby protecting the skin and mucosal surfaces against dryness, irritation, and pathogen entry during winter.

2.3 METABOLIC AND HORMONAL BALANCE

Winter conditions often lead to reduced physical activity and altered metabolic rates, making metabolic and hormonal balance essential for maintaining overall health. Seeds contribute significantly to this balance by providing **healthy fats, high-quality proteins, dietary fiber, and essential micronutrients**. **Magnesium** present in seeds acts as a cofactor for numerous enzymes involved in carbohydrate, lipid, and protein metabolism, supporting efficient ATP production. **Omega-3 fatty acids** influence hormonal signaling by improving insulin sensitivity and regulating lipid metabolism, thereby preventing metabolic disturbances. The dietary fiber in seeds helps stabilize blood glucose levels and supports gut-derived hormonal signals that regulate appetite and energy homeostasis. Biochemically, these nutrients interact to modulate endocrine responses, enhance metabolic efficiency, and support hormonal stability, helping the body adapt to seasonal metabolic shifts during winter.

3. PRACTICAL WAYS TO INCLUDE SEEDS IN A WINTER DIET

Incorporating seeds into the winter diet is simple, economical, and nutritionally effective. Seeds can be consumed in whole, roasted, soaked, or ground forms, depending on digestibility and culinary preference. Flaxseed and chia seeds are best consumed in ground or soaked form and can be added to warm porridges, soups, smoothies, or curd to enhance omega-3 and fiber intake. Pumpkin and sunflower seeds can be lightly roasted and consumed as a healthy winter snack or mixed into trail mixes for sustained energy. Sesame seeds are traditionally used in winter preparations such as laddoos, chikkis, and chutneys, providing warmth, calcium, and antioxidants. Seeds may also be sprinkled over salads, vegetable curries, or incorporated into whole-grain breads and rotis. Regular, moderate consumption of a variety of seeds ensures a balanced intake of essential fatty acids, micronutrients, and bioactive compounds, supporting immunity and overall health during the winter season.

4. BIOCHEMICAL SYNERGY IN SEED-BASED WINTER DIETS

The health benefits of seeds in winter nutrition arise not from individual nutrients alone, but from their **biochemical synergy**, where multiple components interact to enhance physiological functions. **Essential fatty acids**, when combined with **antioxidants such as vitamin E and phenolic compounds**, protect lipid membranes from oxidation while simultaneously modulating inflammatory pathways. **Dietary fiber** works in synergy with micronutrients by improving gut health, enhancing mineral absorption, and stimulating the production of **short-chain fatty acids**, which regulate immune and metabolic signaling. **Proteins, amino acids, and trace elements** present in seeds collectively support enzyme activity, hormone synthesis, and cellular repair mechanisms. This integrated biochemical interaction amplifies nutrient bioavailability and functional efficiency, making seed-based winter diets highly effective in strengthening immunity, maintaining metabolic balance, and improving overall resilience against seasonal stress. **This biochemical synergy makes seeds an ideal functional food during winter. (**Alasalvar *et al*., 2021)

Table 1. Health Benefits and Uses of Functional Seeds

Seed	Key Benefits	How to Consume	References
Flaxseed (Linum usitatissimum)	Omega-3 fatty acids (ALA), lignans, dietary fiber	Ground in porridge, smoothies, yogurt, warm milk	(Noreen *et al*., 2023)
Chia Seeds (Salvia hispanica)	PUFAs, antioxidants, soluble fiber	Chia pudding, soaked in	(Khalid *et al*., 2023)

		water, added to soups	
Pumpkin Seeds (Cucurbita pepo)	Zinc, magnesium, tryptophan, protein	Lightly roasted snacks, trail mix, added to curries	(Idouraine *et al*., 1996)
Sunflower Seeds (Helianthus annuus)	Vitamin E, selenium, healthy fats	Sprinkled on salads, seed mixes, roasted snacks	Puraikalan, Y., and Scott, M., (2023)
Sesame Seeds (Sesamum indicum)	Calcium, sesamin antioxidants, healthy fats	Tahini, laddoos, sprinkled on meals	(Sharma *et al*., 2020)
Watermelon Seeds	Protein, iron, magnesium	Roasted and powdered, added to snacks	(Tabiri *et al*., 2016)
Hemp Seeds	Complete protein, omega-3 & omega-6 balance	Added to smoothies, cereals, salads	(Matran *et al*., 2009)
Poppy Seeds (Khus-khus)	Calcium, minerals, mild sedative effect	Ground in gravies, winter sweets	Seeds, P. (2025)

CONCLUSION

Winter demands more than just a warm blanket; it requires a diet that actively supports immunity, metabolism, and overall well-being. Seeds — with their rich biochemical profiles provide targeted nutrients that enhance immune responses, support cellular health, and help the body adapt to seasonal stresses. Integrating a variety of seeds into the winter diet is a simple, natural, and science-backed approach to maintaining health and resilience when it matters most.

REFERENCES

Alasalvar, C., Chang, S. K., Bolling, B., Oh, W. Y., & Shahidi, F. (2021). Specialty seeds: Nutrients, bioactives, bioavailability, and health benefits: A comprehensive review. *Comprehensive Reviews in Food Science and Food Safety*, *20*(3), 2382-2427.

Carlsen, M. H., Halvorsen, B. L., & Blomhoff, R. (2011). Antioxidants in nuts and seeds. In *Nuts and seeds in health and disease prevention* (pp. 55-64). Academic Press.

De, L. C. (2020). Edible seeds and nuts in human diet for immunity development. *Int. J. Recent Sci. Res*, *6*(11), 38877-38881.

Dodevska, M., Kukic Markovic, J., Sofrenic, I., Tesevic, V., Jankovic, M., Djordjevic, B., & Ivanovic, N. D. (2022). Similarities and differences in the nutritional composition of nuts and seeds in Serbia. *Frontiers in Nutrition*, *9*, 1003125.

Idouraine, A., Kohlhepp, E. A., Weber, C. W., Warid, & Martinez-Tellez, J. J. (1996). Nutrient constituents from eight lines of naked seed squash (Cucurbita pepo L.). *Journal of agricultural and food chemistry*, *44*(3), 721-724.

Khalid, W., Arshad, M. S., Aziz, A., Rahim, M. A., Qaisrani, T. B., Afzal, F., ... & Anjum, F. M. (2023). Chia seeds (Salvia hispanica L.): A therapeutic weapon in metabolic disorders. *Food science & nutrition*, *11*(1), 3-16.

Matran, I. M., Stefan, L., & Cioca, A. (2009). The role of hemp seed derivatives bakery, related to the ratio of essential polyaunsaturated fatty acids omega 3 and omega 6, cold pressed hemp oil, complete protein and fibres. *Rompan news*, *15*, 263-270.

Noreen, S., Tufail, T., Ul Ain, H. B., & Awuchi, C. G. (2023). Pharmacological, nutraceutical, and nutritional properties of flaxseed (Linum usitatissimum): An insight into its functionality and disease mitigation. *Food Science & Nutrition*, *11*(11), 6820-6829.

Puraikalan, Y., & Scott, M. (2023). Sunflower seeds (Helianthus Annuus) and health benefits: A review. *Recent Progress in Nutrition*, *3*(3), 1-5.

Raza, N., Sadaf, A., Mushtaq, R., Mehmood, M. A., Amrao, L., Islam, F., ... & Shah, M. A. (2026). Nutritional and Health Potential of Edible Seeds: Micronutrient Bioavailability and Mechanistic Insights. *Food Science & Nutrition*, *14*(2), e71480.

Seeds, P. (2025). POPPY SEEDS AND THE SUPERNATURAL. *Encyclopedia of Spices and the Spice Trade: History, Cuisine, and Culture*, 254.

Sharma, L., Saini, C. S., Punia, S., Nain, V., & Sandhu, K. S. (2020). Sesame (Sesamum indicum) seed. In *Oilseeds: health attributes and food applications* (pp. 305-330). Singapore: Springer Singapore.

Stefanache, A., Lungu, I. I., Butnariu, I. A., Calin, G., Gutu, C., Marcu, C., ... & Damir, D. (2023). Understanding how minerals contribute to optimal immune function. *Journal of immunology research*, *2023*(1), 3355733.

Tabiri, B., Agbenorhevi, J. K., Wireko-Manu, F. D., & Ompouma, E. I. (2016). Watermelon seeds as food: Nutrient composition, phytochemicals and antioxidant activity.