

Kales and Collards: Superfoods for health and wealth

Kale is a collective term used for various kales and collards that have originated basically from wild cabbage (*Brassica oleracea*) and are the result of evolutionary changes brought about by either natural selections or hybridisations. Kale, in general, demonstrates superior nutritional composition compared to conventional leafy vegetables positioning it as a comprehensive essential source of nutrients. Phytochemical analysis shows that it contains higher total antioxidant activity than other leafy green vegetables, primarily due to the presence of carotenoids, flavonols and glucosinolate-derived isothiocyanates conferring significant protection against various diseases. ICAR-Central Institute of Temperate Horticulture, Srinagar conserves more than 65 genotypes of kale including Kashmiri landraces (*Khanyari*, *Hanz Haak*, *GM Dari*, *Kawdari*) and exotic varieties (*Lacinato*, *Siberian* and *Russian kales*) that acts as an invaluable reservoir for targeted breeding. Furthermore, kale based value-added products developed by the institute offer functional food availability contributing to regional nutritional security and public health goals extendable to national level.

Keywords: Collards, Food Security, Kale, Kashmiri Landraces, Superfood

KALE (*Brassica oleracea* L. group Acephala), widely acclaimed as the 'King of leafy vegetables', is one of the earliest domesticated forms of wild cabbage (*Brassica oleracea* L.), with a long history of cultivation, dating back to more than 2000 years and the characteristic of being non-heading with leafy growth habit, is a member of the *Brassicaceae* family. Unlike cabbage, cauliflower and broccoli – its headed cultivars, the leaves of the kale remain loose, often flat or puckered and are harvested over an extended season. Previously, all types of kales and collards were together put into *Brassica oleracea* gp. Acephala. However, with increasing evolutionary reveals, many of them have been assigned specific botanical names. The exceptional genetic diversity of kale, resulting from its morphological plasticity and high cross-pollination, allows it to thrive in a wide range of agroclimatic environments. The scientific name of kale is, however, restrictive in nature, as with advancing phylogenetic understanding, the group is fast being segregated into different species and varieties. Different kinds of kale that differ as botanical varieties are Collard (*Brassica oleracea* var. *viridis*), Curly/scotch kale (*Brassica oleracea* var. *fimbriata*), Tuscan/Dinosaur kale (*B. oleracea* var. *palmifolia*), Chinese kale/Gai Lan (*Brassica oleracea* var. *alboglabra*) and a separate species *Brassica napus* that consists of siberian and russian kales thought to have originated from Rutabaga. Some lesser known kales like Walking stick kale and Redbor are characterised as *Brassica oleracea*.

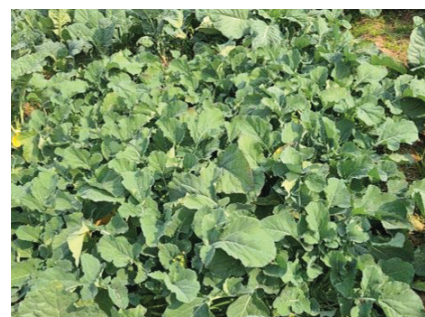
In the Indian subcontinent, kale has a unique cultural significance. Although it remains underexploited in the plains, the crop holds pride of place in the Union Territory of Jammu and Kashmir, particularly in the Kashmir Valley under the name '*Haak*'. The term '*Haak*' is derived from sanskrit word '*Shaak*', meaning edible greens. kashmiri cuisine is incomplete without '*Haak*'. Kale has been perfectly woven into the local food system for generations, unlike exotic vegetables that require careful adaptation. It is grown in kitchen gardens, home gardens and commercial farmlands in all districts of the valley.

Economically, kale has immense potential to diversify the vegetable basket of India. In an advancing urbanisation wherein, dietary habits change and demand for health-oriented foods increases, there exists a specific market potential for nutrient-rich traditional crops. The adaptability of kale to temperate and sub-temperate climates makes it suitable for hilly areas like Himachal Pradesh, Uttarakhand, Sikkim, and the North-eastern states, where vegetable cultivation often remains challenging during winters. Its high biomass production, multiple harvests, and resistance to pest and diseases further add to its advantages as a climate resilient crop.

Germplasm, landraces, improved indian varieties and exotic varieties: The Kashmir Valley located in biodiverse Indian Himalayan region probably has the most diverse kale gene pool in the country. This diversity due to genomic plasticity in response to different micro-climates has largely been captured through seed saving and folk

taxonomy traditions of indigenous farmers and is now being generated through formal breeding and selection. For generations, Kashmiri farmers have identified, preserved and traded landraces based on traits such as leaf texture, frost resistance, plant height and palatability. Recognising the significance of this genetic wealth, ICAR-Central Institute of Temperate Horticulture (CITH), Srinagar has actively characterised and conserved more than 65 accessions of kale germplasm including indigenous

landraces, single plant collections and exotic introductions alongside developing breeding lines for agronomic and biochemical traits. The germplasm generated by the institute (breeding lines) have unique traits such as purple colour, leaf blade puckering or plant main stem branching. It also possesses remarkable variability for plant height, leaf shape, leaf length, leaf colour, petiole length, branching habit and plant stature. These traits have been well characterised and associated with *Brassica* based SSR markers for facilitating marker assisted breeding. Two microsatellites have highly been associated with seed yield and plant architecture. The germplasm has great potential for successful breeding programmes aimed at biofortification, adaptation to climatic changes and higher productivity as well as novel product development.



True siberian kale



Improved dwarf siberian



Red russian



Tuscan kale



Khanyari



GM dari



Hanz haak



Kawdari

Diverse varieties and species of kale at ICAR-CITH, Srinagar

The landraces reflect adaptation to local environmental conditions and centuries of farmer-driven selection. Several of them stand out for their agronomic and culinary value, for example, Khanyari is characterised by its succulent, puckered leaves, indeterminate, scantily branched, columnar growth habit and its adaptability to warmer temperatures, making it suitable for a wide range of environments. GM Dari bears large, flat leaves with high adaptability to cool-season cultivation resulting in enormous yields. Hanz Haak is a highly branched plant with rosette appearance of tightly arranged leaves on top of each branch that continue appearing indefinitely, ensuring multiple harvests over an extended period. In addition to these, other traditional varieties like Kawdari and Anchar Haak, each with unique characteristics suited to specific growing conditions and local preferences exist.

Likewise, ICAR-CITH has evaluated several exotic introductions for their performance under Kashmir conditions. True siberian kale, Improved dwarf siberian kale, and red and green russian kales have shown exceptional tolerance to frost. The dark green, blistered leaves of Lacinato/Dinosaur/Tuscan kale offers a distinctive earthy taste. These kales are all known for their high nutritional value and diverse culinary applications. In 2025, ICAR-CITH developed distinctiveness, uniformity and stability guidelines for testing new kale varieties for the purpose of registration. These guidelines were notified by PPV&FRA in 2026.

Climatic requirements and agronomic practices: Kale thrives in cool climate, tolerating temperatures as low as -10°C to -15°C , but optimum growth occurs between 15°C to 21°C .

Sowing, land preparation and transplanting: Seeds are sown in a well-prepared nursery bed. Kale prefers well-drained, organically rich loamy soil having pH between 5.5 and 6.5. The final field should be enriched with 15-20 tonne well-decomposed FYM or 7.5 to 10 tonne vermicompost per hectare well before transplanting. Seedlings with 4-5 true leaves are ready for transplanting 4-5 weeks after sowing. Seedlings are transplanted at a spacing of 60-45 cm between rows and 45-30 cm between plants depending on species/variety.

Fertilisation: As per the package of practices by State Agricultural University, apply fertilisers at 60 kg N, 40 kg P₂O₅ and 40 kg K₂O per hectare as basal dose at transplanting. Apply an additional 30-40 kg of nitrogen/hectare 3-4 weeks after transplanting to enhance leafy growth.

Irrigation: Kale requires consistent moisture for tender leaves. Regular watering is crucial, especially during dry spells. Drip irrigation is highly recommended to conserve water and prevent moisture borne diseases.

Weeding: Intercultural operations such as weeding should be done especially within the first month after transplanting to reduce competition for nutrients, water, and light.

Growing Seasons in Kashmir: It can be grown in two main seasons in the Valley:

Spring-Summer Crop:

- **Nursery Sowing:** Mid-February to Mid-March (under protected cover if frost is expected)
- **Transplanting:** Late March to April
- **Harvesting:** May to July

Autumn-Winter Crop (Main Season):

- **Nursery Sowing:** July
- **Transplanting:** August
- **Harvesting:** October onwards
- **Harvest:** Harvesting begins 45-60 days after transplanting. Multiple pickings ensure steady supply over an extended period.

Nutritional and Medicinal Value: Kale has achieved international recognition as a superfood because of its nutritional profile and high concentration of health-promoting compounds. Comparative nutrient profiling of most popular leafy greens clearly indicates kale's superiority in nutritional content (Table 1). Kale contains 4.3 g protein/100 g fresh weight, far higher than in other leafy greens, thereby, ensuring a high satiety index and plant predominant eating habits. The dietary fiber content in kale is 3.6 g/100 g, ensuring glucose metabolism and colonic health. The micronutrient content in kale is particularly noteworthy. Its calcium content is 150 mg/100 g, nearly four times higher than in cabbage and three times higher than in broccoli. Although kale contains less iron

Table 1. Comprehensive nutrient comparison per 100 g of fresh weight

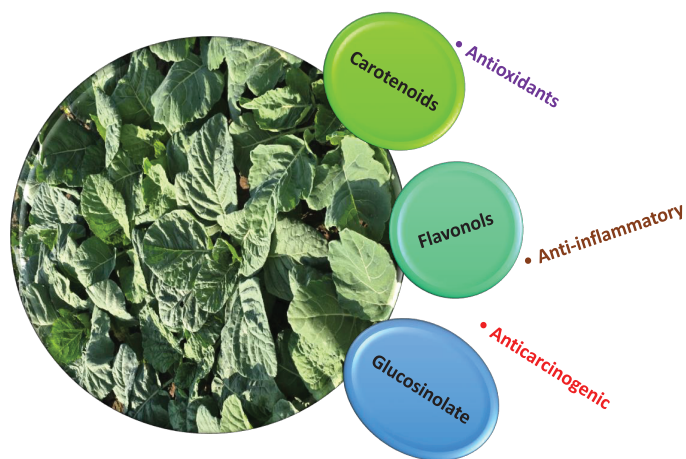
Nutrient/100g	Kale	Spinach	Amaranth	Cabbage	Broccoli	Lettuce	Rocket
Energy (kcal)	49	23	230	25	34	14	25
Protein (g)	4.30	2.90	2.50	1.30	2.80	1.40	2.60
Fat (g)	0.90	0.40	0.30	0.10	0.40	0.20	0.70
Carbohydrate (g)	8.80	3.60	4.00	5.80	7.00	2.90	3.70
Sugar (g)	2.30	0.40	0.50	3.30	1.70	1.20	2.10
Fibre(g)	3.60	2.20	2.50	2.50	2.60	1.20	1.60
Calcium (mg)	150	99	215	40	47	36	160
Iron (mg)	1.50	2.70	2.30	0.50	0.70	0.90	1.50
Magnesium (mg)	47	79	55	12	21	13	47
Phosphorous (mg)	92	49	50	26	66	20	52
Potassium (mg)	491	558	611	170	316	194	369
Sodium (mg)	38	79	20	18	33	28	27
Zinc (mg)	0.60	0.50	0.70	0.20	0.40	0.15	0.50
Vitamin C (mg)	120.00	28.00	43.00	36.00	89.00	9.20	15.00
Thiamine (mg)	0.11	0.08	0.03	0.06	0.07	0.04	0.04
Riboflavin (mg)	0.13	0.19	0.16	0.04	0.12	0.08	0.09
Niacin (mg)	1.00	0.72	0.9	0.23	0.64	0.38	1.00
Vitamin B ₆ (mg)	0.27	0.20	0.18	0.12	0.19	0.09	0.07
Folate (µg)	141	194	85	43	63	38	97
Vitamin B12 (µg)	0	0	0	0	0	0	0
Vitamin A (IU)	9990	9377	2910	98	623	745	2373
Vitamin E (mg)	1.50	2.00	1.50	0.15	0.78	0.20	0.40
Vitamin K (µg)	705	482	1140	76	126	24	108

than spinach and amaranth, it contains more iron than meat products. Kale contains 491 mg/100 g potassium, ensuring cardiovascular health, while magnesium content is 47 mg/100 g, ensuring neuromuscular functions and glucose metabolism. Vitamin K content in kale is 705µg/100g, which plays vital role in coagulation/hemostasis, while high folate content which is 141 µg facilitates DNA replication and fetal growth.

Phytochemically, kale is notable for its exceptionally high total antioxidant capacity, frequently placing it among the top-ranking vegetables in terms of ORAC (Oxygen Radical Absorbance Capacity) value. Its key bioactive compounds include:

Carotenoids (*lutein and zeaxanthin* 12–20 mg/100 g): These xanthophylls are deposited in the macula lutea of the human retina, acting to absorb phototoxic blue light and to quench singlet oxygen. They have also been epidemiologically linked to a decreased risk of age-related muscular degeneration.

Flavonols (*quercetin and kaempferol glycosides* 50–80 mg/100 g): These polyphenols have potent anti-



Biactive compounds in kale

inflammatory, antiplatelet and vasodilatory properties and have been shown to inhibit histamine release and to stabilise mast cells.

Table 2. Major kale value-added products developed at ICAR-CITH, Srinagar

Product	Key ingredients	Processing	Nutritional enhancement	Images
Kale chapatti	5% kale powder + wheat flour	Dough rest 20 min, hot plate	Protein and fiber	
Soup premix	7% kale powder + flours/spices	Dry blending	Minerals, glucosinolates	
Seasoning mix	Kale powder + chili/turmeric	Fine grinding	Antioxidants	
Kale pickle	Blanched kale + spice oil	Brining 24-48h, anaerobic	Probiotics, phenolics	
Savory crackers	Shredded kale + starch/fat	Sheet 0.3mm, bake 150°C/20 min	Crunchy protein snack	
Sugar-free muffins	Kale powder + polyols/maida	Bake 160°C/25 min	Zero sugar, green hue	

Product	Key ingredients	Processing	Nutritional enhancement	Images
Savory muffins	Kale powder + polyols/ maida	Bake 160°C/ 25 min	Savory, green hue	
Instant noodles	Kale powder + wheat flour	Oven dry 40°C/36h	Increased phytochemicals	
Papads	Shredded kale + rice flour	Sun dry, hot oil fry	Traditional papad into functional food	
Kale powder	Kale leaf (veins removed)	NaHCO ₃ dip (20 g/L), blanch 85-90°C/30-40 sec, tray dry 50°C/2-3% moisture	ORAC >10 mmol TE/g	
Kale shreds	Kale leaf lamina	Cut 3-5 mm shred, blanch 90 °C/30-40 sec, centrifuge, air dry, airtight PE pouches	Value ingredient in bakery products	
Brined kale	Kale shreds + 20% brine	Blanch 90 °C/2 min, 85:15 leaf: brine ratio	Probiotics + phenolics preserved	
Kale pakoras	Kale stems + rice flour batter	Clean stems, steam for 15 min, dip in batter, deep fry	Zero-waste, green hue	

Glucosinolates and isothiocyanates (20–40 µmol/100 g FW): Glucosinolates are hydrolysed to form isothiocyanates, including sulphoraphane and iberin, in the presence of myrosinase enzyme. These electrophiles facilitate carcinogen elimination by inducing phase II detoxification enzymes e.g., quinone reductase, glutathione S-transferase.

Medicinal uses: Kale has been utilised globally in traditional medicine practices for preventing and treating chronic and degenerative disorders. Its therapeutic roles encompass gastric ulcers, hypercholesterolemia, hyperglycemia, rheumatism and hepatic diseases. These health- protective effects stem from bioactive constituents, including glucosinolates, carotenoids and polyphenols. Consequently, pharmaceutical and nutraceutical industries worldwide are formulating kale based-dietary supplements and functional foods.

Value added products from kale: Despite its exceptional nutritional profile, fresh kale faces significant marketability barriers: Bulky volume, high moisture content (84–87 %), rapid post-harvest deterioration and limited refrigerated shelf life (5–7 days.) These constraints restrict market reach beyond production areas and cause substantial losses during peak harvest. To address these challenges, ICAR-CITH has pioneered innovative nutrient-preserving processing technologies, transforming traditional kashmiri *haak* into stable value-added products (Table 2).

Recently celebrated ‘Kale Carnival’ at CITH showcased the diverse germplasm and the products arising out of it, confirming consumer acceptance ratings >8/10 across diverse demographics. These breakthrough innovations strategically position kale as India’s response to global superfood demand, seamlessly bridging himalayan culinary heritage with modern nutraceutical science.



Glimpses of Kale Carnival at ICAR-CITH, Srinagar

SUMMARY

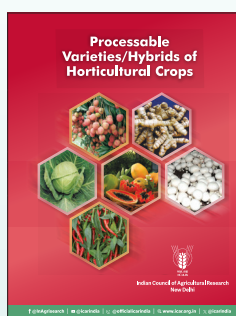
Kale represents an outstanding model of nutritional density, phytochemical diversity and genetic variability, reiterating its position as a key component in the development of dietary and food security. This article confirms kale's nutritional superiority over traditional leafy vegetables, particularly in protein content, dietary fibre, vitamins A, C and K and essential minerals. The Kashmir valley preserves rich genetic diversity where landraces like *Khanyari*, *Kawdari*, *Hanz haak*, and *GM dari* showcase

emerges not just as a superfood, but as a strategic asset for nutritional security, genetic conservation and agri-entrepreneurship.

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