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Review Article

Comprehensive Review of Benincasa hispida (White Pumpkin): Nutritional Profile, Bioactive Compounds, and Functional Applications in Food and Health Industries

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ABSTRACT

White pumpkin (*Benincasa hispida*), also known as ash gourd or winter melon, is a nutrient-rich fruit with significant health benefits. It contains essential vitamins like A, B1, C, and niacin, along with minerals such as calcium, iron, potassium, and magnesium, supporting vital bodily functions. With its high water content and low-calorie profile, white pumpkin promotes hydration and satiety while being rich in dietary fiber, aiding in digestion and blood sugar regulation. Its bioactive components, including carotenoids, phenolics, flavonoids, and phytosterols, exhibit antioxidant, antiinflammatory, and antimicrobial properties, reducing the risk of chronic diseases. These components are being increasingly used in functional foods, nutraceuticals, and cosmetics. Various extraction methods, such as ethanol extraction, have been proven efficient in isolating bioactive compounds like rutin, with potential for industrial applications. Despite its health benefits, white pumpkin faces challenges in marketability and processing costs, but innovations like fortified products and sustainable farming practices could improve its acceptance. This review examines the nutritional composition, health benefits, extraction methods, and product development of white pumpkin, emphasizing its potential as a functional food ingredient.

INTRODUCTION

White pumpkin (*Benincasa hispida*), commonly referred to as ash gourd or winter melon, has long been an essential component of traditional diets

and medicinal practices in many cultures. Known for its culinary adaptability, this fruit is valued not only for its versatility in cooking but also for its impressive nutritional and therapeutic properties. With growing interest in functional foods, white

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pumpkin is gaining recognition as a valuable dietary ingredient with potential health benefits. One of the key attributes of white pumpkin is its low caloric content, making it an ideal food for weight-conscious individuals. With approximately 13 calories per 100 grams, it serves as a light yet nutrient-dense option. Additionally, its high-water content—nearly 90%—makes it an excellent natural hydrator, aiding in maintaining optimal fluid balance within the body. Alongside hydration, white pumpkin provides essential vitamins, including vitamin A, B1 (thiamine), C, and niacin. These vitamins contribute significantly to various physiological functions such as vision support, immune enhancement, and energy metabolism. Apart from vitamins, white pumpkin is a valuable source of key minerals such as calcium, iron, potassium, and magnesium. Calcium and magnesium are crucial for maintaining strong bones and preventing conditions like osteoporosis, while potassium aids in regulating blood pressure and supporting cardiovascular function. The presence of iron enhances oxygen transport and prevents anemia, making white pumpkin a beneficial dietary inclusion, particularly for individuals with iron-deficiency conditions. Another notable feature of white pumpkin is its high dietary fiber content, which plays a crucial role in promoting digestive health. Fiber aids in bowel regularity, reduces constipation, and supports gut microbiota, thereby enhancing overall digestive efficiency. Furthermore, dietary fiber is known to regulate blood sugar levels by slowing glucose absorption, making white pumpkin a suitable option for individuals with diabetes. It also contributes to lowering cholesterol levels, reducing the risk of cardiovascular diseases. Beyond its macronutrient and micronutrient composition, white pumpkin is rich in bioactive compounds such as carotenoids, flavonoids, phenolics, and phytosterols. These compounds exhibit potent antioxidant properties

that help neutralize free radicals, reducing oxidative stress, which is a primary contributor to chronic diseases like cancer, diabetes, and heart disease. Carotenoids, in particular, are known for their role in eye health and immune function, while flavonoids and phenolics possess anti-inflammatory properties that further enhance their protective benefits. In addition to their antioxidant properties, these bioactive compounds exhibit antimicrobial and anti-inflammatory effects, which can help combat infections and inflammatory disorders. For instance, phytosterols present in white pumpkin have been shown to contribute to cholesterol-lowering effects, thereby supporting heart health. Moreover, white pumpkin has been traditionally used in Ayurvedic and Chinese medicine for its cooling and detoxifying effects on the body. Various parts of the white pumpkin, including its seeds, flesh, and leaves, have been utilized in traditional and modern food applications. The seeds, in particular, are a rich source of linoleic acid, an essential fatty acid that supports cardiovascular health by improving lipid metabolism and reducing the risk of atherosclerosis. White pumpkin seeds also contain protein and beneficial phytochemicals, making them a valuable ingredient in functional food formulations. Despite its numerous health benefits, white pumpkin remains underutilized in global food markets due to limited consumer awareness and challenges in processing. The perishable nature of the fruit, along with its high water content, makes it difficult to store and transport efficiently. However, recent advancements in food processing technologies are helping to address these limitations. Techniques such as freeze-drying and spray-drying have enabled the development of white pumpkin powders, which retain most of the fruit's nutritional and bioactive properties while extending shelf life. These powders can be incorporated into soups, smoothies, and fortified



foods, enhancing their functional value. Additionally, white pumpkin extracts are being explored for their potential applications in nutraceuticals and pharmaceuticals. Ethanol extraction and other solvent-based techniques have proven effective in isolating key bioactive compounds like rutin, a flavonoid with antioxidant and anti-inflammatory properties. Such extracts can be used in the formulation of dietary supplements, functional beverages, and even cosmetic products. With growing consumer interest in plant-based and health-enhancing foods, white pumpkin holds significant potential for expansion in the global market. Efforts to promote its benefits through research, product innovation, and sustainable farming practices could further enhance its acceptance. The development of value-added products, including ready-to-eat snacks, fortified beverages, and herbal formulations, can provide new opportunities for integrating white pumpkin into modern diets.

2. Nutritional Profile:

White pumpkin (*Benincasa hispida*), commonly referred to as ash gourd or winter melon, is widely recognized for its impressive nutritional composition and health benefits. This fruit has been traditionally incorporated into various culinary and medicinal applications due to its rich array of essential vitamins, minerals, and bioactive compounds. Similarly, Kundur (*B. hispida*), another variety of ash gourd, shares similar nutritional attributes, making both fruits valuable additions to functional diets. Their increasing use in nutraceuticals and fortified food products highlights their significance in modern health-conscious lifestyles. White pumpkin is an excellent source of essential vitamins such as vitamin A, B1 (thiamine), C, and niacin. These micronutrients play crucial roles in various physiological functions, including immune

support, vision enhancement, and energy metabolism. Their presence also contributes to the nutritional value of functional food products like orange-white pumpkin crush. In addition to vitamins, white pumpkin provides important minerals, including calcium and iron, which are vital for bone health, oxygen transport, and metabolic activities. With a low caloric content of approximately 13 calories per 100 grams and a high water composition of around 90%, it serves as an excellent hydrating and weight-management food (Ravi et al., 2010; Cao Yuhong et al., 2014). Dietary fiber is another significant component of white pumpkin, supporting digestive health by promoting bowel regularity and reducing constipation. Fiber aids in regulating blood sugar levels, making it beneficial for individuals with diabetes. Additionally, it helps lower cholesterol levels, reducing the risk of cardiovascular diseases. Apart from its fiber content, white pumpkin is packed with antioxidants and phytochemicals, including carotenoids, flavonoids, phenolics, and phytosterols. These bioactive compounds exhibit potent anti-inflammatory and anti-cancer properties, protecting cells from oxidative damage and reducing the risk of chronic diseases such as diabetes, heart disease, and cancer (Ravi et al., 2010; Cao Yuhong et al., 2014). Similarly, Kundur (*B. hispida*) is a nutrient-dense fruit rich in essential minerals such as potassium, calcium, and magnesium, which play key roles in heart health, muscle function, and nerve signaling. Potassium, in particular, is essential for regulating blood pressure and reducing the risk of hypertension. While its protein content ranges from 0.3% to 0.5%, Kundur provides essential amino acids, particularly through its seeds, which contain linoleic acid—a beneficial polyunsaturated fatty acid that supports cardiovascular health by improving lipid metabolism and reducing the risk of atherosclerosis (Aggarwal et al.; Liu et al.,



2013). A unique characteristic of Kundur is its changing sugar composition during ripening. While the fruit initially contains natural sugars, these gradually decrease as it ripens, whereas organic acids such as malic and citric acid increase, altering the fruit's flavor profile. This transformation enhances its versatility in culinary applications, making it suitable for soups, herbal drinks, and nutraceutical formulations. Additionally, Kundur provides vitamins A, C, and several B vitamins, along with trace minerals like copper, zinc, and selenium, all of which contribute to immune function, cellular repair, and metabolic balance. Its high phytochemical content further strengthens its antioxidant capacity, helping to mitigate oxidative stress and lower the risk of chronic illnesses (Doharey et al., 2021). The increasing focus on plant-based nutrition and functional foods has led to greater recognition of white pumpkin and Kundur for their potential applications in food technology, fortified beverages, and dietary supplements. Advancements in food processing, such as freeze-drying and spray-drying, have enabled the development of white pumpkin powders and extracts that retain their nutritional and bioactive properties while enhancing shelf life. These innovations have made it possible to incorporate white pumpkin into various food formulations, addressing challenges related to perishability and accessibility.

Below is a detailed breakdown of the nutritional value of white pumpkin per 100 grams:

Table 1: Nutritional Value (in 100 G)

SI. No	Compounds	Nutritional Value
1.	Energy	13-20 kcal
2.	Carbohydrate	3.0-4.0 g
3.	Protein	0.6-1.0 g
4.	Fat	0.1-0.2 g
5.	Dietary fiber	0.5-11 g
6.	Vitamin C	8-10 mg
7.	Vitamin A	200 -300 IU

8.	Vitamin E	0.3-0.5 mg
9.	Vitamin K	1.1-1.5µg
10.	Folate (B9)	10-15 µg
11.	Calcium	15-25 mg
12.	Magnesium	10-15 mg
13.	Potassium	200-300 mg
14.	Iron	0.3-0.8 mg
15.	Zinc	0.2-0.4 mg

The (Table:1) detailed nutritional analysis highlights the remarkable composition of white pumpkin, reinforcing its role as a functional food ingredient. Despite its nutritional advantages, both white pumpkin and Kundur face challenges in marketability due to limited consumer awareness and processing complexities. However, with increasing research and technological advancements, innovative approaches such as value-added products and sustainable farming practices are enhancing their acceptance.

3. Health Benefits of Bioactive Components:

White pumpkin (*Benincasa hispida*), a nutrient-dense food, is recognized for its abundant bioactive compounds, including carotenoids, phenolics, flavonoids, tocopherols, terpenoids, and phytosterols. These compounds exhibit strong antioxidant properties that help mitigate oxidative stress, thereby reducing the risk of chronic diseases such as cancer and cardiovascular disorders. Additionally, their anti-inflammatory and antimicrobial activities play a crucial role in managing inflammatory conditions like arthritis, further highlighting the importance of including white pumpkin in a balanced diet (Hussain et al., 2022). Beyond its bioactive potential, white pumpkin is a rich source of essential vitamins and minerals, notably vitamin C and selenium, which are vital for boosting immune function and enhancing skin health. The various edible parts of the fruit, including its seeds, leaves, and flesh, contribute significantly to both traditional and modern culinary applications, making it a versatile

ingredient in health-conscious diets (A.I. Aziz et al., 2023). Furthermore, white pumpkin serves as a functional ingredient in the food industry, particularly in ready-to-serve (RTS) and ready-to-eat (RTE) products. The presence of polyphenols and antioxidants aids in combating oxidative damage, supporting overall well-being, and contributing to the development of health-oriented food formulations. The additional presence of amino acids, phytosterols, and polysaccharides further enhances immune function and reduces inflammation, making white pumpkin a valuable component of nutraceuticals and functional foods (Alan, E et al., 2023). Similarly, ash gourd (*B. hispida*), a close relative of white pumpkin, offers an impressive range of health benefits due to its rich nutritional composition. It is particularly valued for its antimicrobial properties, which help strengthen the immune system and protect against infections. With its low-calorie content, ash gourd also supports weight management, making it an excellent choice for individuals looking to maintain a healthy metabolism while staying hydrated (Aggarwal, A et al., 2023). One of its notable applications is in the preparation of Winter Melon Gulkand, a product derived from ash gourd that exhibits higher antioxidant activity compared to commercial variants. Known for its cooling properties, it is particularly beneficial in hot climates, offering numerous bioactive compounds that contribute to improved digestion, detoxification, and metabolic health (Sugriv et al., 2019). The growing recognition of white pumpkin and ash gourd in health-focused diets underscores their immense potential as functional food ingredients. Their ability to combat oxidative stress, support immune function, and provide essential nutrients makes them valuable in both traditional and modern food applications. With ongoing advancements in food technology and consumer awareness, these nutrient-rich fruits

continue to gain significance in the development of innovative health-promoting products.

4. Extraction Methods:

Among the different extraction techniques, the 95% ethanol extract (B95) stood out as the most efficient in extracting bioactive components, particularly rutin. This extract also exhibited the highest flavonoid and phenolic content, demonstrating the strongest antioxidant activity. The study further confirms that all extracts, including B95, were non-toxic and safe for consumption, indicating their potential applications in food and cosmetic industries (Pimpak et al., 2023; Shao et al., 2019). The extraction process for *Benincasa Hispida* involves several crucial steps to ensure the maximization of bioactive compound yields. Initially, the plant material is crushed and filtered to increase the surface area for better extraction. This is followed by the leaching process, where solvents are used to extract the bioactive compounds, and centrifugation is employed to separate the liquid from the solid material. The liquid extract is then re-extracted to further increase the yield of bioactive substances. The supernatant from this process is combined and purified by adding ethyl alcohol, which precipitates the bioactive substances. This step is followed by filtration and washing to remove impurities (Fang et al., 2017; Bhadange et al., 2023). To remove smaller molecules and salts from the extract, protein precipitation is carried out. This is followed by dialysis with a pH 7 phosphate buffer, which helps purify the extract further. Subsequently, gel filtration chromatography is used to fractionate proteins based on size, which aids in isolating fractions that may possess bioactive properties (Darusman et al., 2009). In order to identify and quantify the bioactive compounds present in the extracts, advanced techniques such as High-



Performance Liquid Chromatography (HPLC) and High-Performance Thin-Layer Chromatography (HPTLC) are employed. These chromatographic methods allow for the precise analysis of the composition of the extracts, helping to identify specific bioactive compounds and their concentrations. The efficiency of the extraction process is influenced by various factors, including temperature, time, and the solvent-to-plant material ratio, all of which can impact the yield and composition of the extracted bioactive compounds. Phytochemical screening was conducted on the extracts to evaluate their bioactive properties. The results revealed that the extracts possess a wide range of beneficial activities, including antioxidant, antimicrobial, and anti-inflammatory effects. However, it was found that different extraction methods yield different profiles of bioactive compounds. This variation highlights the importance of selecting the right extraction method to target specific bioactive substances based on their intended applications (Une et al., 2014). In summary, the extraction of bioactive compounds from Benincasa Hispida using various methods, particularly the 95% ethanol extract, has proven to be effective in isolating compounds like rutin, flavonoids, and phenolics. These extracts exhibit strong antioxidant activity and are safe for potential use in food and cosmetic industries. Advanced techniques such as HPLC, HPTLC, and gel filtration chromatography allow for precise identification and quantification of these compounds, and the process is influenced by several factors that affect yield and bioactivity. Phytochemical screenings further support the diverse bioactivity of the extracts, demonstrating their promise in various industrial applications.

5. Products Developed from White Pumpkin:

In Ayurvedic medicine, the seeds of Benincasa hispida are traditionally mashed with milk to create a tonic believed to have rejuvenating properties. This tonic is often considered to enhance vitality and well-being. In addition to the seeds, the pulp of the ash gourd is also utilized to produce medicinal extracts, which have been shown to exhibit both antioxidant and antibacterial activities. Studies highlight that acetone and chloroform extracts of the plant possess significant hydrogen peroxide scavenging potential, suggesting that the plant can help reduce oxidative stress and protect against cellular damage (Sharma et al., 2014). The nutritional profile of Benincasa hispida contributes to its popularity in health supplements. The plant is rich in bioactive compounds, including alkaloids, phenolic compounds, and flavonoids, all of which contribute to its health-enhancing properties. These compounds have antioxidant effects, which help combat free radicals in the body, thereby protecting cells and tissues from damage. Due to its nutritional and therapeutic properties, Benincasa hispida is increasingly being incorporated into health supplements aimed at boosting immunity and promoting overall health (Sharma et al., 2014). The plant also contains various phytochemicals that contribute to its medicinal benefits. These include triterpenes such as alnusenol and multiflorenol, flavones like isovitexin, and sterols including lupeol and beta-sitosterol. These compounds contribute to the plant's anti-inflammatory, antioxidant, and antimicrobial effects, making it an essential component in natural medicine (Pagare et al., 2011). The medicinal use of Benincasa hispida extends to its entire plant, as all parts—seeds, pulp, and rind—are traditionally utilized for various therapeutic effects. These effects include laxative, diuretic, and tonic properties, alongside aphrodisiac and cardiogenic benefits. The plant has been used to treat a wide range of health



conditions, such as jaundice, dyspepsia, urinary calculi, blood diseases, insanity, epilepsy, fever, and menstrual disorders. Its broad medicinal uses underscore its importance in herbal medicine, where it is regarded as a valuable and versatile plant for addressing various health issues (Pagare et al., 2011). As health-conscious eating becomes a growing trend, *Benincasa hispida* is increasingly being incorporated into functional foods and fortified products, which offer additional health benefits beyond basic nutrition. The plant's rich nutritional composition, coupled with its numerous health-promoting properties, makes it a desirable ingredient in modern health foods. Research continues to explore the potential of *Benincasa hispida* in improving immune function, supporting digestive health, and providing antioxidant protection. These benefits contribute to the plant's growing presence in the health and wellness market (Muzahid et al., 2023).

6. Challenges And Future Direction of White Pumpkin

The study identifies challenges in standardizing BPS, an inhomogeneous acidic polysaccharide, for consistent quality in skincare products, highlighting the need for further research to understand its physicochemical properties and how the NRF2/HO-1 pathway influences antioxidant and moisturizing functions (Xiaoyan et al., 2022). Similarly, *Benincasa hispida* faces limited marketability due to low consumer awareness of its health benefits and the complexity of processing methods, which can drive up production costs. To overcome these barriers, innovative product formulations, such as fortified Gulkand, health drinks, snacks, or supplements, should be explored, with a focus on its rich protein and dietary fiber content (Jiang et al., 2015). Emphasizing sustainable farming practices could further appeal to environmentally conscious

consumers, positioning *Benincasa hispida* as a superfood. Collaborative efforts with food technologists can help optimize extraction techniques, preserving bioactive compounds while improving product quality (Sugriv et al., 2019). Additionally, standardizing fermentation processes to enhance bioactive compounds in *Benincasa hispida* is crucial, though scaling up these processes poses challenges. Regulatory compliance and validation of health claims through clinical trials are needed to ensure safety and consumer trust (Sun et al., 2024). Effective marketing strategies, including tastings and informative campaigns, will be essential in raising awareness of the health benefits and promoting *Benincasa hispida* as a functional food ingredient.

7. CONCLUSION:

White pumpkin (*Benincasa hispida*) holds great promise as a functional food ingredient due to its impressive nutritional composition and rich array of bioactive compounds. Its low-calorie and high-water content, along with essential vitamins and minerals, make it a beneficial addition to health-conscious diets. The presence of bioactive compounds such as carotenoids, phenolics, flavonoids, and phytosterols contributes to its antioxidant, anti-inflammatory, and antimicrobial properties, supporting its role in managing chronic diseases. However, despite its numerous health benefits, white pumpkin remains underutilized in the global market due to low consumer awareness and challenges in processing. Innovative extraction techniques and product development strategies, such as the use of ethanol for bioactive component isolation, have shown promise in enhancing the usability of white pumpkin in various industries, including food, nutraceuticals, and cosmetics. Additionally, the development of new products such as fortified Gulkand, health drinks, and freeze-dried stock cubes could help



boost its marketability. Further research is needed to standardize extraction and processing methods to maximize the health benefits of white pumpkin while making it more accessible to consumers. Raising awareness through marketing efforts and validating health claims through clinical trials will be crucial for expanding the use of white pumpkin as a valuable food ingredient and nutraceutical component.

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