Bioscience Evidence 2026, Vol.16, No.4, 329-344
http://bioscipublisher.com/index.php/be

Feature Review Open Access

Research Progress on Nutritional Quality, Bioactive Compounds, and Production Utilization of Colored Potatoes

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Bioscience Evidence, 2026, Vol.16, No.4 doi: 10.5376/be.2026.16.0025
Received: 18 Jul., 2026
Accepted: 20 Aug., 2026
Published: 27 Aug., 2026

Preferred citation for this article:
Wang X.W., and Ye J.T., 2026, Research progress on nutritional quality, bioactive compounds, and production utilization of colored potatoes, Bioscience Evidence, 16(4): 329-344 (doi: 10.5376/be.2026.16.0025)

Abstract Colored potatoes have attracted increasing attention in the fields of food nutrition, agricultural production, and functional product development due to their rich nutritional composition and high levels of bioactive compounds. This review focuses on the differences among purple-, red-, and yellow-fleshed potatoes in major nutritional traits, including starch, dry matter, and protein content, and analyzes the effects of genotype, ecological environment, cultivation practices, storage conditions, and processing methods on quality formation and bioactive compound accumulation. Purple- and red-fleshed potatoes generally contain higher levels of anthocyanins, total phenolics, and antioxidant capacity, whereas yellow-fleshed potatoes are characterized by higher carotenoid accumulation. However, high concentrations of functional compounds do not necessarily correspond to higher yield, dry matter content, or better processing suitability. Therefore, cultivar selection for colored potatoes should consider nutritional value, eating quality, production adaptability, and processing requirements simultaneously. This review summarizes the application potential of colored potatoes in fresh consumption, staple food products, snack foods, natural colorants, and functional ingredients. Future research should focus on the breeding of high-quality cultivars, region-specific production evaluation, sustainable cultivation practices, and nutrient-retention processing technologies, providing references for the efficient utilization and industrial development of colored potato resources.
Keywords Colored potatoes; Nutritional quality; Bioactive compounds; Production utilization; Difference analysis

1 Introduction

Potato (*Solanum tuberosum* L.) is one of the most widely consumed food crops worldwide and remains an important staple food for a large proportion of the global population. In addition to providing dietary energy, potato tubers are rich in carbohydrates, high-quality proteins, essential amino acids, vitamins, and minerals, making them an important component of global food and nutrition systems (Dessì et al., 2025). Potato germplasm resources are highly diverse, with approximately 5 000 cultivated varieties reported worldwide. Among these, an increasing number of red-, purple-, blue-fleshed, and other colored-flesh or colored-skin cultivars have attracted extensive attention from both scientific and industrial communities in recent years. Moreover, potato processing generates large amounts of by-products, while potato peels contain abundant valuable compounds, including polyphenols, vitamins, proteins, carbohydrates, and dietary fibers, indicating considerable potential for further utilization (Sampaio et al., 2021b).

Red- and purple-fleshed potatoes generally contain significantly higher levels of total phenolics, anthocyanins, and antioxidant activity than white- and yellow-fleshed potatoes. Some studies have reported that their antioxidant capacity or total phenolic content can be two to three times higher than that of conventional potato varieties (Polivanova and Gins, 2019). Anthocyanins are the most representative bioactive compounds in colored potatoes and are responsible for the red to purple coloration of tuber skin and flesh (Bandana et al., 2025). The composition of anthocyanins differs markedly among color types. Red-fleshed potatoes are mainly characterized by pelargonidin- and peonidin-based derivatives, whereas purple-fleshed potatoes are rich in petunidin-, malvidin-, delphinidin-, and cyanidin-derived anthocyanins, which commonly occur in acylated forms (Lachman and Hamouz, 2005).

In addition to anthocyanins, colored potatoes contain abundant phenolic acids, particularly chlorogenic acid and related hydroxycinnamic acid derivatives, as well as flavonoids, vitamin C, carotenoids, tocopherols, and other antioxidant compounds. Chlorogenic acid is consistently identified as the predominant phenolic acid in potato tubers and peels (Kalita et al., 2018). Flavonoids and phenolic acids are major contributors to antioxidant activity in colored-fleshed potatoes, whereas carotenoids such as lutein are more closely associated with yellow flesh coloration (Vaitkevičienė et al., 2020). Potato polyphenols have also been shown to inhibit key enzymes associated with diabetes development, including α-amylase, α-glucosidase, and aldose reductase, suggesting their potential value in functional food development (Bravo et al., 2023). However, the accumulation of nutritional components and bioactive compounds in colored potatoes is not constant but is influenced by multiple factors, including genotype, cultivation practices, maturity stage, storage conditions, and processing methods.

Against this background, investigating the differences in nutritional components and bioactive compounds among colored potatoes has both theoretical and practical significance. This review systematically summarizes the production and utilization value of colored potatoes, compares the major nutritional components and bioactive compounds among different color types and tissues, and analyzes the key factors influencing compositional variation. Furthermore, it summarizes current progress and future prospects in nutritional quality evaluation, cultivar improvement, product development, and comprehensive utilization of colored potatoes. The aim is to provide a better understanding of the relationship between pigmentation-related diversity and nutritional quality, and to support the enhancement of functional value and industrial utilization of colored potato resources.

2 Differences in Major Nutritional Components and Bioactive Compounds among Colored Potatoes

2.1 Differences in starch, dry matter, and eating quality

Although colored potatoes are often classified according to flesh color, starch and dry matter contents are determined primarily by genotype rather than by a simple ranking of purple-, red-, or yellow-fleshed cultivars. Solovyeva et al. (2024) evaluated 14 potato cultivars grown in northwestern Russia over three consecutive years and measured 12 quality traits, including dry matter, starch, protein, vitamin C, reducing sugars, carotenoids, anthocyanins, and phenolic compounds. The purple-fleshed cultivar Fioletovyi had an average dry matter content of only 19.67%, which was substantially lower than that of the high-dry-matter cultivar Sokur (>24%) and also lower than Grand (23.71%) and Krasavchik (23.31%). These findings indicate that darker flesh color or higher anthocyanin concentration does not necessarily correspond to greater dry matter or starch accumulation. Genotypic variation accounted for 38%~53% of the variation in dry matter, starch, protein, and sugar contents, whereas growing season and storage conditions had relatively limited effects on dry matter content.

In addition to differences in starch content, potatoes with different flesh colors also differ in amylose proportion, amylopectin structure, pasting behavior, and gel properties. Yang et al. (2018) extracted starches from yellow-, purple-, and red-fleshed potatoes and compared their physicochemical characteristics. Yellow-fleshed potatoes exhibited the highest amylose content (25.23%), followed by purple-fleshed (23.30%) and red-fleshed potatoes (20.26%) (Figure 1). Although all three starches displayed the typical B-type crystalline structure characteristic of potato starch, purple-fleshed potatoes contained a higher proportion of short amylopectin branches, and significant differences were observed among the three color groups in molecular weight distribution, branch-chain length, and pasting properties. The starch pastes of purple- and red-fleshed potatoes showed light transmittance values of 90.92% and 86.41%, respectively, which were markedly higher than that of yellow-fleshed potatoes (34.03%). These results suggest that starches from colored potatoes may possess unique functional properties for applications in transparent gels, thickened foods, and specialty starch-based products, distinguishing them from conventional yellow-fleshed potato starches.

2.2 Differences in protein, dietary fiber, vitamins, and minerals

In addition to starch, protein, dietary fiber, vitamins, and mineral elements are important nutritional characteristics that distinguish colored potatoes from conventional white-fleshed potatoes. Because colored potatoes originate from diverse local germplasm resources and improved cultivars with different genetic backgrounds, considerable variation exists in their nutritional composition. Some colored potato genotypes not only contain high levels of anthocyanins but also exhibit superior accumulation of protein, dietary fiber, and essential mineral elements, indicating their potential for developing nutrient-enriched staple foods and functional food products.

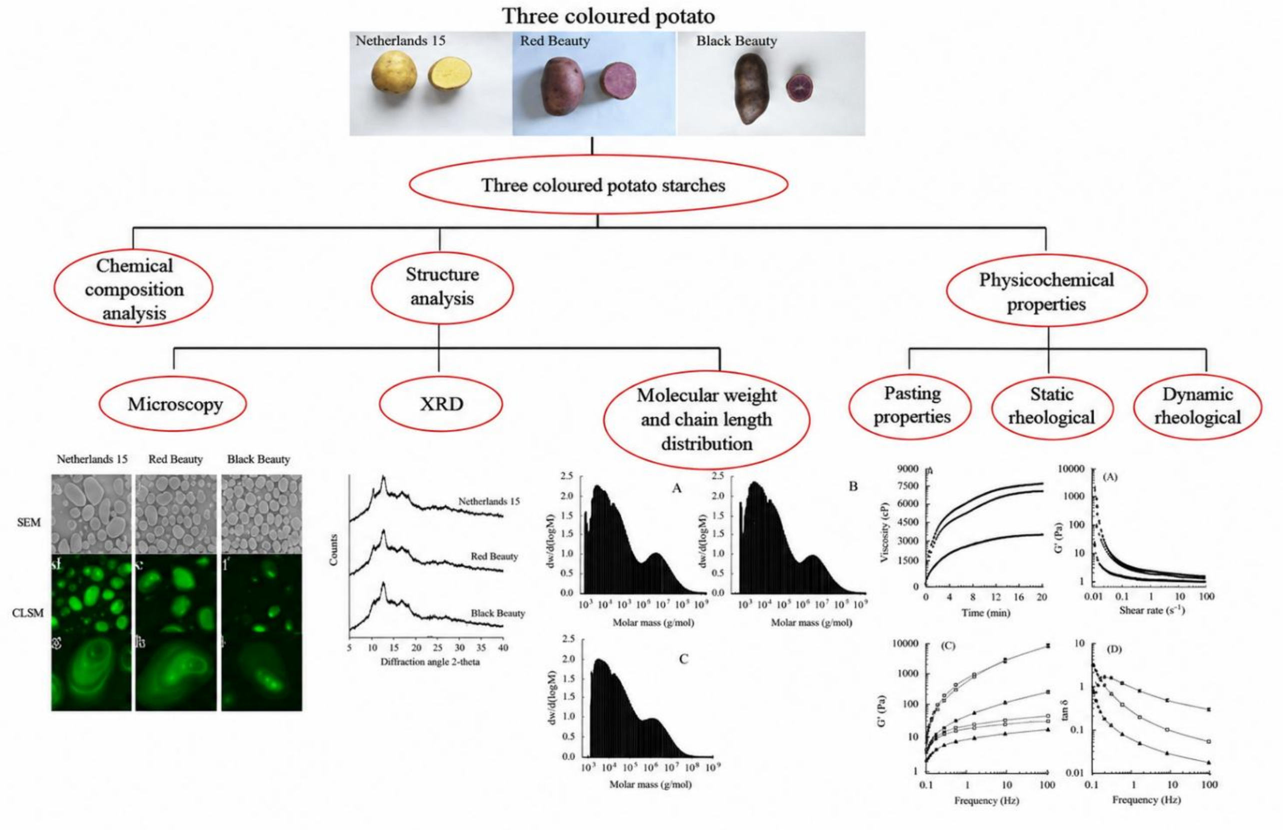

Figure 1 Analysis of the properties of three types of colored potato starch (Adapted from Yang et al., 2018)

Mineral composition also varies considerably among potatoes with different flesh colors. Zarzecka et al. (2024) compared seven potato cultivars with different flesh colors and reported significant varietal differences in the concentrations of iron (Fe), zinc (Zn), manganese (Mn), and other mineral elements. Several dark-fleshed cultivars showed relatively higher capacities for micronutrient accumulation, suggesting that flesh color may reflect not only differences in pigment composition but also variation in the ability to accumulate essential mineral nutrients.

Purple- and red-fleshed potatoes generally contain higher levels of total phenolics and exhibit stronger antioxidant activity than light-fleshed potatoes. In addition, some pigmented cultivars also possess relatively high dietary fiber contents. Saar-Reismaa et al. (2020) analyzed total phenolics, sugars, and mineral elements in potato tubers with different flesh colors and found that purple- and red-fleshed potatoes consistently contained higher concentrations of phenolic compounds, while mineral composition differed substantially among cultivars. These findings indicate that the nutritional advantages of colored potatoes extend beyond their natural pigments and are also associated with the combined accumulation of protein, dietary fiber, vitamins, and mineral nutrients, thereby enhancing their value for both human nutrition and functional food development.

2.3 Differences in anthocyanins, phenolic compounds, and carotenoids

The most prominent bioactive differences among colored potatoes are associated with anthocyanins, phenolic compounds, and carotenoids. Purple- and red-fleshed potatoes generally contain significantly higher levels of anthocyanins and phenolic compounds than white- and yellow-fleshed potatoes, whereas yellow-fleshed potatoes are mainly characterized by higher carotenoid accumulation, particularly xanthophyll compounds such as lutein and zeaxanthin. Anthocyanins are absent or present at very low levels in white-fleshed potatoes, while colored-flesh cultivars contain not only higher total anthocyanin concentrations but also more diverse anthocyanin profiles. Purple-fleshed potatoes are mainly characterized by cyanidin-, delphinidin-, malvidin-, and petunidin-derived pigments, whereas red-fleshed potatoes are dominated by pelargonidin derivatives (Kim et al., 2025).

Chlorogenic acid has repeatedly been identified as the predominant phenolic acid in potato tissues and generally accounts for a large proportion of total phenolic acids. Colored-fleshed cultivars usually contain higher levels of phenolic acids than light-fleshed cultivars (Kasnak and Palamutoğlu, 2022). Potato peels also contain abundant caffeic acid and caffeoylquinic acid derivatives, while acylated anthocyanins are commonly found in red and purple varieties (Sampaio et al., 2021b).

Carotenoids are present in all potato varieties, but their contents differ greatly among flesh colors. White-fleshed varieties generally contain approximately 50-100 μg/100 g fresh weight of carotenoids, whereas deep yellow or orange-fleshed varieties can reach approximately 2000 μg/100 g fresh weight. Lutein, zeaxanthin, and violaxanthin are the major carotenoid components (Brown, 2005). Yellow flesh is closely associated with lutein accumulation, whereas purple materials generally contain higher levels of total phenolics and anthocyanins.

Even within the same purple- or red-fleshed groups, anthocyanin contents can vary several-fold among cultivars. Anthocyanin concentrations in colored potatoes have been reported to range from 61.5 to 573.5 mg/kg fresh weight, with significant differences among cultivars such as Violette, Vitelotte, Blue Congo, Purple Majesty, and W8 (Hamouz et al., 2011; Soare et al., 2020).

2.4 Differences in antioxidant capacity and overall quality

Antioxidant capacity in colored potatoes is commonly evaluated using DPPH, ABTS, FRAP, and related assays. Purple- and red-fleshed potatoes generally exhibit higher antioxidant activity than yellow- and white-fleshed potatoes. The antioxidant activity of red-fleshed potatoes was reported to be 4.34 times higher than that of white- or yellow-fleshed types, while purple-fleshed potatoes showed a 5.03-fold increase (Hamouz et al., 2011). Blue Congo showed the highest DPPH and ABTS values, whereas Purple Majesty exhibited the highest total phenolic and anthocyanin contents, indicating that cultivar rankings may vary depending on the evaluation method and target compounds (Soare et al., 2020). FRAP analysis also demonstrated that colored-flesh cultivars generally possessed stronger antioxidant capacity than light-fleshed cultivars, with Vitelotte showing particularly high FRAP values (Cebulak et al., 2022).

Antioxidant activity is closely associated with anthocyanins and phenolic compounds, including chlorogenic acid and other phenolic acids. Flavonoids and phenolic acids are considered major contributors to antioxidant activity in red- and purple-fleshed potatoes, while vitamin C and carotenoids also contribute to total antioxidant capacity, particularly in non-purple materials (Xu et al., 2025).

3 Varietal Differences and Selection for Production

3.1 Differences among purple-, red-, and yellow-fleshed varieties

Purple-fleshed potato varieties generally exhibit the highest anthocyanin content and antioxidant activity, and they often contain relatively high levels of total phenolics, particularly chlorogenic acid derivatives. Red-fleshed or red-skinned varieties also contain higher levels of anthocyanins and phenolic compounds than white- or yellow-fleshed potatoes; however, their anthocyanin contents are usually lower than those of deep purple varieties. Due to genotypic differences, the antioxidant capacity of some red-fleshed varieties may overlap with that of non-pigmented cultivars (Ceci et al., 2022) (Figure 2). Yellow-fleshed potatoes generally contain lower levels of anthocyanins but have higher nutritional value associated with carotenoids, particularly lutein and zeaxanthin. In some comparisons, yellow-fleshed materials also showed higher soluble solids and vitamin C contents than other colored-flesh materials (Rachappanavar et al., 2024).

Agronomic performance does not always correspond to pigment intensity. Colored varieties produced lower yields than the non-pigmented cultivar Musica in one comparison, although colored materials exhibited higher dry matter content. Some colored germplasms are late-maturing types and are therefore unsuitable for early production under Arctic conditions, although several materials can still achieve relatively high final yields and acceptable starch contents. In addition, white-, cream-, or yellow-fleshed genotypes may perform better in terms of dry matter, starch content, specific gravity, and overall processing suitability. Therefore, darker flesh color does not necessarily indicate superior industrial performance or broader nutritional advantages.

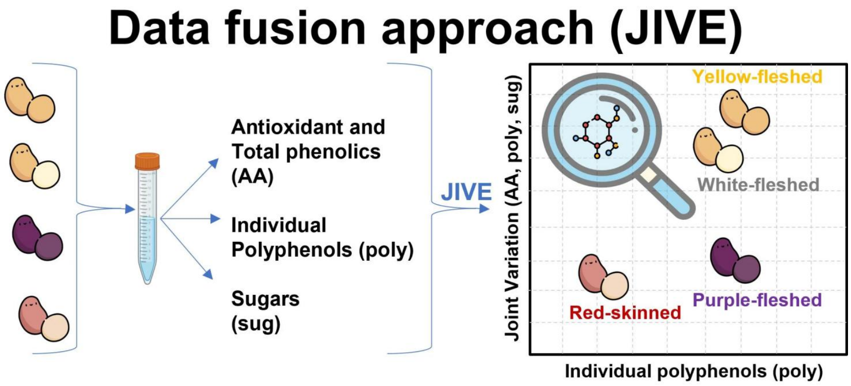

Figure 2 Integration of antioxidant activity, polyphenols, and sugars for the discrimination of coloured potato cultivars using the JIVE data fusion approach (Adapted from Ceci et al., 2022)

3.2 Differences among varieties within the same color group

Substantial differences exist among varieties within the same color group. In purple- and red-fleshed potatoes, anthocyanin composition and concentration vary considerably among cultivars, and metabolic profiles differ between tuber flesh and peels. Even within purple-fleshed materials, anthocyanin content can vary several-fold. Violette and Vitelotte showed relatively high anthocyanin levels, whereas Blue Congo with light marbling patterns contained considerably lower amounts (Hamouz et al., 2011). When multiple colored cultivars were evaluated under the same cultivation conditions, Blue Congo exhibited the highest DPPH and ABTS antioxidant capacities, Purple Majesty showed the highest total phenolic and anthocyanin contents, while the highest flavonoid content was observed in another cultivar. These results indicate that no single purple- or red-fleshed variety consistently dominates all quality traits (Soare et al., 2020).

Production characteristics also vary substantially within the same color category. In the Murmansk region, different colored potato varieties showed differences in early yield formation, final yield, starch content, and environmental adaptability. Fioletik and Severnoye Siyaniye showed relatively faster early yield accumulation, whereas Fioletik, Gurman, and Perlamutrovyy achieved higher final yields (Travina, 2021). Significant differences were also observed among cultivars in dry matter content, reducing sugar accumulation, browning susceptibility, cold-induced sweetening tolerance, and frying suitability. Fontane showed the best suitability for frying processing; Jelly had broader utilization potential but was less suitable for industrial frying due to higher reducing sugar content; and Gaudi showed poor overall processing performance (Bedini et al., 2024).

3.3 Selection of varieties for fresh consumption

External quality traits, including tuber size, shape, eye depth, and skin color, directly influence consumer purchasing decisions, whereas internal quality traits such as flavor, texture, and nutritional characteristics determine repeat purchase behavior (Ballco et al., 2023). Product appearance strongly affects consumer preference, while sensory quality after cooking or frying is also an important factor determining acceptance.

In regions where early-market supply provides economic advantages, early maturity and marketable yield are critical traits. However, some colored potato varieties mature late and are therefore unsuitable for early production systems. Disease resistance, storage ability, resistance to browning, and tolerance to cold-induced sweetening also influence the fresh-market value of colored potatoes during transportation and storage (Seid and Tessema, 2024).

3.4 Selection of varieties for processing

Current processing studies generally consider dry matter content and specific gravity as core evaluation indicators, while low reducing sugar content is required to prevent excessive browning and undesirable flavors during frying. Processing varieties for French fries generally require dry matter contents above approximately 19.5%, whereas chip-processing varieties should reach about 20% dry matter while maintaining low reducing sugar levels (Hussen, 2019). Lady Rosetta and Courage are considered suitable cultivars for chip production (Islam et al., 2022), whereas Fontane is particularly suitable for frying because of its high dry matter content, low reducing sugar level, firm texture, and low browning susceptibility (Bedini et al., 2024).

For processing into potato flour, noodles, steamed bread, baked products, natural pigments, or functional ingredients, selection criteria should be adjusted according to the final application. High-dry-matter genotypes are more suitable for flour-based products, whereas some anthocyanin-rich materials are better suited for pigment extraction or functional product development rather than conventional starch-oriented processing. For colored potatoes intended for processing, anthocyanin content should be considered in addition to conventional indicators such as dry matter and starch content.

4 Differences among Production Regions and Ecological Conditions

4.1 High-altitude and cool-climate production areas

High-altitude and cool-climate regions in western China, including Yunnan, Guizhou, Gansu, Qinghai, and related plateau or mountainous areas, are generally favorable for tuber coloration and phytochemical accumulation in colored potatoes. However, these responses are strongly influenced by genotype and altitude range. In Yunnan, tuber color intensity of purple and red potatoes increased as altitude increased from approximately 1 800 to 3 300 m. Total phenolics, total flavonoids, total anthocyanins, and anthocyanin biological yield continued to increase until approximately 2 800 m altitude (Wu and Xiao, 2024). A controlled temperature experiment using local colored potato varieties from Yunnan further supported this field observation. Moderate low-temperature conditions improved yield and secondary metabolite accumulation, particularly anthocyanins, whereas excessive low temperature (10 ℃) caused leaf damage and potentially inhibited tuber formation and pigmentation (Chen et al., 2024).

Studies conducted in southwestern and northwestern China indicate that high altitude improves not only tuber coloration but also some basic quality traits. In Sichuan, purple potato cultivar ‘Ziyun 1’ showed continuous increases in yield, crude protein, starch, and anthocyanin contents when grown from 800 to 2 500 m altitude, while soluble sugar content decreased. The high-altitude region was considered suitable for producing high-yield and high-quality purple potatoes (Zheng and Zhang, 2013). Among colored potato clones grown at different altitudes, anthocyanin content was highest at high altitude and lowest at intermediate altitude, with significant differences among purple and red clones in pigment content and composition (Qi et al., 2023).

A multi-environment trial conducted in Gansu included humid plateau, semi-arid, and arid regions, and demonstrated that genotype × environment interactions significantly affected all yield and quality traits. Vitamin C, reducing sugars, and carotenoids were particularly sensitive to environmental variation. G25 performed best for yield, dry matter, and carotenoid accumulation in humid Weiyuan, G18 showed better adaptation to semi-arid Anding, and G7 was more suitable for arid Yongchang. These results indicate that cool-climate regions are not homogeneous and require site-specific cultivar matching (Zhou et al., 2025).

High-altitude and cool-climate regions also face practical production constraints. Experimental sites in Gansu differed greatly in altitude, rainfall, sunshine duration, and frost-free period, with annual precipitation ranging from 185 to 550 mm and frost-free periods from 134 to 166 days, indicating simultaneous risks of drought and short growing seasons (Zhou et al., 2025). Under Arctic-like cool conditions, many colored potato varieties behaved as late-maturing types and were unsuitable for early production, even when final yields were acceptable (Liu et al., 2023).

4.2 Northern dryland production areas

In northern dryland regions, including Inner Mongolia, Ningxia, Shaanxi, Hebei, and adjacent sandy or oasis areas, abundant solar radiation favors tuber dry matter and starch formation, whereas limited rainfall makes water management a major factor determining yield and quality. Field experiments in sandy areas of northern China showed that irrigation frequency, irrigation amount, and fertilizer level significantly influenced potato growth, yield, starch content, vitamin C content, and marketable tuber formation. Under the same irrigation frequency and fertilizer level, full irrigation resulted in the highest tuber yield, starch content, and vitamin C content; however, irrigation water use efficiency decreased as water supply increased (Wang et al., 2019).

Water deficit generally reduces yield, but moderate regulation at appropriate growth stages can improve water-use efficiency and maintain or even enhance certain quality traits. A meta-analysis of field experiments in northern China showed that deficit irrigation increased water-use efficiency by 10.0% and irrigation water-use efficiency by 31.6%, but reduced yield by 16.4% overall (Niu et al., 2024). In a desert oasis region of northwestern China, mild water deficit during tuber initiation increased water-use efficiency and irrigation water-use efficiency by 25.55% and 32.33%, respectively, without significantly reducing yield, while also increasing starch content. However, water deficit during tuber bulking reduced starch, protein, and reducing sugar contents (Zhang et al., 2024a).

4.3 Southern winter and mountain production areas

In southern winter potato production regions, including Guangdong, Guangxi, Fujian, Zhejiang, and related mountainous or early-spring production systems, the major ecological advantage is the ability to utilize cool seasons for potato production and supply products to the market earlier. Potato growth is optimal under cool, frost-free conditions rather than high temperatures; therefore, local production commonly relies on early planting, plastic mulching, and early-maturing cultivars to complete tuber development before high temperatures become limiting.

Compared with plateau regions, southern winter and mountain production areas usually experience higher humidity, greater rainfall pressure, and stronger disease risks. In Guangdong, one of the major winter potato production regions, phytoplasma disease incidence reached 20%–35% in surveyed fields, and tubers produced in this region may transmit the disease to spring and summer potato production areas (Cheng et al., 2019).

High rainfall, heavy soils, and disease pressure also affect quality maintenance. In southern Shanxi, rotation with maize or soybean increased tuber yield by 18.39%-20.69%, while also improving marketable tuber rate and increasing tuber nitrogen, phosphorus, potassium, crude protein, vitamin C, starch, and dry matter contents, while reducing reducing sugar content (Liu et al., 2026). Rotation also reduced pathogenic fungi such as Fusarium and Alternaria, indicating that rational crop rotation can partially alleviate the negative impacts of humid environments.

5 Cultivation Practices Affecting Nutritional Quality and Bioactive Compound Accumulation

5.1 Effects of fertilization management

Combined application of nitrogen (N), phosphorus (P), and potassium (K) generally improves tuber yield, starch content, and overall quality more effectively than the application of individual nutrients, indicating that balanced nutrient supply is essential for colored potato production rather than simply increasing nitrogen inputs (Wang et al., 2024). Under ridge–furrow film mulching systems in semi-arid regions, N, P, and K have different effects on dry matter accumulation and yield formation. Excessive nitrogen application slows dry matter accumulation and reduces tuber yield per plant, whereas higher phosphorus and potassium inputs promote assimilate translocation to tubers, thereby increasing tuber dry matter accumulation and yield (Li et al., 2023).

Among nutrient factors, the effects of nitrogen fertilization on colored potatoes have been most extensively studied. In purple potato cultivar ‘Huasong 66’, a low nitrogen rate of 90 kg·hm^{-2} resulted in better agronomic performance and significantly increased total anthocyanin content. Meanwhile, starch and vitamin C contents were also higher than those under high nitrogen treatment (Zhang et al., 2024b).

In purple-blue potato ‘Blue Congo’, nitrogen was more effective than potassium in increasing anthocyanin content; however, potassium application at 120–150 kg ha^{-1} still enhanced polyphenol accumulation and antioxidant capacity. This indicates that although potassium has a weaker direct effect on pigment accumulation than nitrogen, appropriate potassium management can still improve functional quality (Michalska et al., 2016). In purple potato production, potassium mainly affects starch accumulation, whereas phosphorus promotes the formation of flavonoids, anthocyanins, and carotenoids. Fertilization and weed-management studies have shown that complete fertilization can increase tuber phosphorus and potassium concentrations and total yield, but certain management combinations may also increase reducing sugar content, highlighting the importance of nutrient balance for both yield and processing quality (Amjadi et al., 2025).

In southern Shanxi, potato rotation with summer maize or soybean combined with straw incorporation significantly increased tuber nitrogen, phosphorus, potassium, starch, vitamin C, and dry matter contents, while improving marketable tuber rate and reducing reducing sugar accumulation (Liu et al., 2026). Soil improvement systems involving compost application increased soil organic matter and nutrient availability, enhanced aggregate stability and microbial activity, and increased marketable tuber yield by 22%~28% compared with conventional systems (Larkin, 2024). Under water stress conditions, combined application of iron nanoparticles and growth-promoting yeast increased tuber weight and promoted the accumulation of chlorogenic acid and related phenolic compounds, suggesting that micronutrient and biostimulant strategies may help maintain functional quality of colored potatoes under adverse environments (Berríos et al., 2026).

5.2 Effects of irrigation and soil moisture

Short-term water deficit generally reduces plant growth, yield, and tuber quality, with the vegetative growth stage and tuber initiation stage being particularly sensitive to water shortage. Under limited water availability, irrigation should therefore be prioritized before and during early tuber formation (Wagg et al., 2021). In northwestern China, irrigation amount significantly affected tuber yield, marketable tuber production, maximum tuber weight, starch content, vitamin C content, and dry matter accumulation. When irrigation levels increased from 60% ETc to 100% ETc, these parameters increased accordingly (Zhang et al., 2023).

Field experiments conducted under light soil conditions showed that drip irrigation improved productivity and tuber nutritional composition, while drip irrigation combined with nitrogen fertigation resulted in higher vitamin C content and antioxidant activity in tubers (Jakubowski et al., 2024). A three-year field study further demonstrated that drip irrigation increased dry matter, starch, vitamin C, total phenolics, chlorogenic acid, and antioxidant capacity, while fertigation further enhanced vitamin C and phenolic compound accumulation (Wichrowska et al., 2021).

5.3 Effects of planting density and field management

Increasing planting density generally increases tuber number per unit area and total yield; however, intensified competition among plants for light, water, and nutrients often reduces individual tuber weight (Gadana, 2021). In purple potato cultivar ‘Jinyun No. 5’, the optimized combination of basal fertilizer application and a planting density of 5.25 plants $\cdot m^{-2}$ simultaneously increased yield, anthocyanin content, and starch content, indicating that planting density affects not only yield components but also nutritional quality in colored potatoes (Zhong et al., 2025).

For mini potato and seed tuber production, relatively higher planting density is more suitable because it increases the proportion of small and medium-sized tubers and improves seed tuber grading efficiency. A planting arrangement of 40 cm × 20 cm combined with 50% recommended fertilizer dosage achieved better economic benefits for seed tuber production (Dhangrah et al., 2024). For large fresh-market tuber production, lower or moderate planting density is preferable because it promotes larger tuber size, higher individual tuber weight, and improved yield components. For processing raw materials, moderate planting density is generally more appropriate because optimized density combined with balanced fertilization improves tuber size, market quality, and starch accumulation, whereas excessive density may reduce compositional stability.

Ridging and earthing-up are considered important field management practices for maintaining potato yield and quality. In semi-arid northwestern China, plastic film mulching combined with ridge planting increased tuber yield by 3.7%-20.77% and 7.89%-26.35% across two growing seasons, respectively. This practice also increased the proportion of large tubers and reduced the number of small tubers, with ridge planting combined with full plastic film mulching showing the best performance (Shi et al., 2022). These yield improvements were associated with increased soil alkali-hydrolyzable nitrogen, available phosphorus, enzyme activity, and beneficial microbial populations.

6 Changes during Storage and Processing

6.1 Changes in nutritional components during storage

Low-temperature storage generally causes limited changes in starch itself but significantly increases reducing sugar content through cold-induced sweetening (CIS), particularly under storage conditions at 4 °C. Meanwhile, sucrose content usually decreases, accompanied by increased invertase activity (Galani Yamdeu et al., 2016). This response shows strong genotype dependence. CIS-resistant cultivars such as Verdi, Lady Claire, and Kiebitz can be stored at 4 °C for four months with only slight increases in glucose content, whereas susceptible cultivars such as Pirol, Agria, and Markies rapidly accumulate sugars during cold storage, resulting in brown to black chips after only two months of storage at 4 °C (Visse-Mansiaux et al., 2024). In colored potatoes, prolonged low-temperature storage may simultaneously increase reducing sugars, anthocyanins, and phenolic compounds; therefore, improved antioxidant capacity does not necessarily indicate improved processing suitability.

Vitamin C and phenolic compounds show different patterns of change during storage. Multi-variety potato studies have shown that total phenolics and several phenolic acids may increase during storage under different temperatures, while antioxidant capacity generally increases during the early storage period and declines at later stages (Galani et al., 2017).

Storage at 7 °C and 75% relative humidity is effective in reducing weight loss, sprouting, greening, and decay; however, this condition also promotes the greatest accumulation of simple sugars, with reducing sugar levels increasing by 26.0-68.5-fold, which is undesirable for frying processing (Gikundi et al., 2023). Therefore, storage of fresh-market potatoes mainly focuses on minimizing weight loss, sprouting, and visual quality deterioration, whereas processing potatoes require storage conditions that suppress sprouting while avoiding excessive sugar accumulation.

6.2 Effects of cooking methods

Steaming, boiling, baking, and microwave heating all influence the color and nutritional composition of colored potatoes. Compared with more intensive or prolonged heat treatments, steaming and microwave heating generally preserve phytochemicals more effectively. In purple-fleshed potatoes, cooking treatments overall reduced vitamin C, phenolics, anthocyanins, carotenoids, and antioxidant activity; however, steaming and microwave treatments retained more health-promoting compounds, whereas stir-frying caused the greatest losses. In red- and purple-fleshed potatoes, microwave treatment increased the measured anthocyanin contents in all tested cultivars, while baking and boiling also resulted in slight increases. These increases were likely caused by heat-induced tissue disruption and enhanced pigment extractability rather than the formation of new anthocyanins (D'Amelia et al., 2022) (Figure 3).

Boiling requires particular attention because hydrophilic compounds can easily leach into cooking water. Studies on colored root crops have shown that anthocyanin-rich purple tissues are more prone to color loss during boiling because water-soluble pigments dissolve into the cooking medium. In multi-variety potato studies after storage, boiling caused relatively limited losses; however, steaming and microwave treatment were more effective in retaining a broader range of phytochemicals.

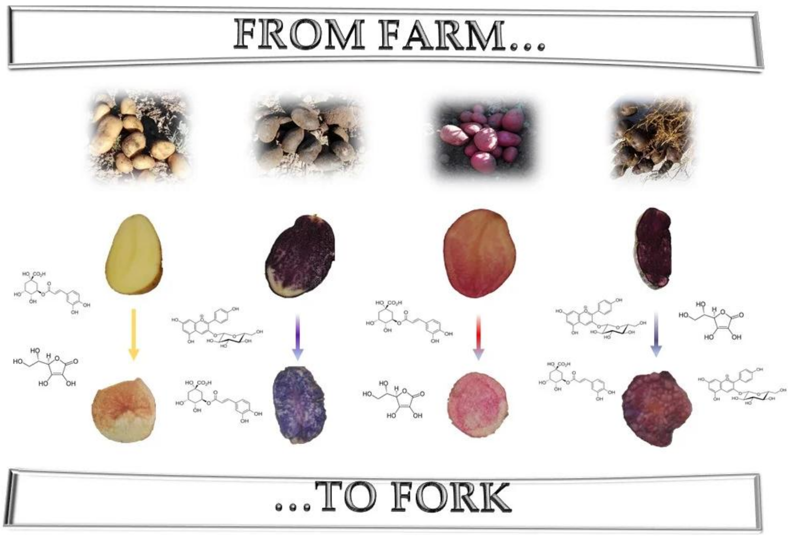

Figure 3 Farm-to-fork overview of coloured potatoes, highlighting tuber diversity, processing, and bioactive compounds (Adapted from D’Amelia et al., 2022)

6.3 Effects of frying, baking, and drying

In chips produced from colored-flesh potatoes, frying resulted in anthocyanin losses of 57.14%–83.94%, and higher frying temperatures further increased anthocyanin degradation across all tested cultivars. Significant varietal differences were observed. Blaue Anneliese retained more anthocyanins than Valfi and Rosemarie, which may be associated with differences in anthocyanin composition. Malvidin and pelargonidin derivatives appeared to be more stable than petunidin derivatives. Slice thickness also influenced final texture and sensory quality. Among tested conditions, 1 mm slices of Blaue Anneliese fried at 160 ℃ showed the highest retention of phenolics and anthocyanins, whereas chip hardness increased with increasing slice thickness (Vaitkevičienė et al., 2022).

Baking generally causes less damage than frying, but its effects on bioactive compounds are not always consistent. In colored potatoes, frying caused a 46% loss of anthocyanins in Blue Star, whereas baking slightly increased the measured pigment content (D’Amelia et al., 2022). Baking increased total phenolics, anthocyanins, and antioxidant activity, whereas chip processing resulted in greater losses and a larger reduction in vitamin C content.

The stability of pigments during drying and storage is mainly affected by temperature, light exposure, and food matrix characteristics. Anthocyanin stability in colored potatoes decreased as temperature increased from 4 ℃ to 37 ℃. After 10 days of storage, pigment retention reached 82.73% under dark conditions but decreased to 57.73% under natural light exposure. Therefore, low-temperature storage and light-protective packaging should be prioritized during the processing and storage of functional ingredients (Han et al., 2024).

6.4 Processing safety and quality stability

Acrylamide formation after frying or baking is positively correlated with fructose, glucose, and sucrose contents. Under the same temperature conditions, frying produced an average of 16.5 times more acrylamide than baking. Yellow-fleshed varieties produced significantly lower acrylamide levels than red- and purple-fleshed varieties, indicating that higher anthocyanin content does not necessarily guarantee safer frying performance (Orsák et al., 2022).

Problems associated with cold storage are more pronounced in cultivars susceptible to cold-induced sweetening because sugar accumulation not only darkens fried products but also increases acrylamide formation risk. In ‘Michuñe negra’, fructose content increased during cold storage, and acrylamide levels after frying exceeded the EFSA benchmark in all treatments (García-Ríos et al., 2023).

Glycoalkaloids represent another important safety concern, particularly in greened, sprouted, or unpeeled potato materials. These toxic metabolites are mainly concentrated in the potato peel. Processing can substantially reduce their levels. Peeling and blanching can remove approximately 90% of tuber glycoalkaloids, while organic acid pretreatment can further reduce α-chaconine levels in colored potato snacks and French fries (Pęksa et al., 2024).

7 Utilization and Product Development of Colored Potatoes

7.1 Development of fresh and specialty products

Fresh colored potatoes, mini potatoes, small-packaged potatoes, and gift potato products are mainly developed based on their unique appearance and compositional characteristics rather than yield alone. In fresh markets, tuber size, shape, appearance, flavor, color, and cooked texture all contribute to product quality, while starch and sugar contents remain key indicators because they influence mealiness after cooking and color development during frying (Stark et al., 2020). Consumers and processors often evaluate potato quality directly based on tuber shape and skin color, and these traits exhibit moderate to high heritability, making them important breeding targets for fresh-market colored potatoes (Yusuf et al., 2024).

Fresh product development is also influenced by cooking quality, texture, and storage performance. Colored potato varieties differ substantially in yield, specific gravity, and suitability for chip processing. Many colored genotypes contain higher dry matter than light-fleshed control varieties, which may contribute to firmer or mealier textures after cooking depending on genotype characteristics. For fresh-cut products, both cultivar selection and storage duration are critical factors. After nine months of storage, tuber age significantly affected most physicochemical properties, and cultivar Birgit showed better suitability for fresh-cut processing than Lady Claire (Dite Hunjek et al., 2020). Vacuum packaging combined with sodium ascorbate treatment provided better preservation of fresh-cut quality than sodium chloride treatment and modified-atmosphere packaging, whereas modified-atmosphere packaging was more effective in suppressing off-flavor development during storage. These results indicate that packaging strategies should be optimized according to cultivar characteristics and product types rather than applying a universal approach to all fresh products (Gikundi et al., 2024).

7.2 Development of staple food products

With the increasing consumer demand for natural functional foods, the utilization of colored potatoes has gradually expanded from traditional fresh consumption to staple food applications. Current research has mainly focused on incorporating whole flour or cooked mashed potatoes from purple- and red-fleshed cultivars into bread, pasta, composite flours, and other baked products. The primary objective is to replace artificial colorants with natural anthocyanins while simultaneously enhancing the antioxidant activity and nutritional value of staple foods (Figure 4).

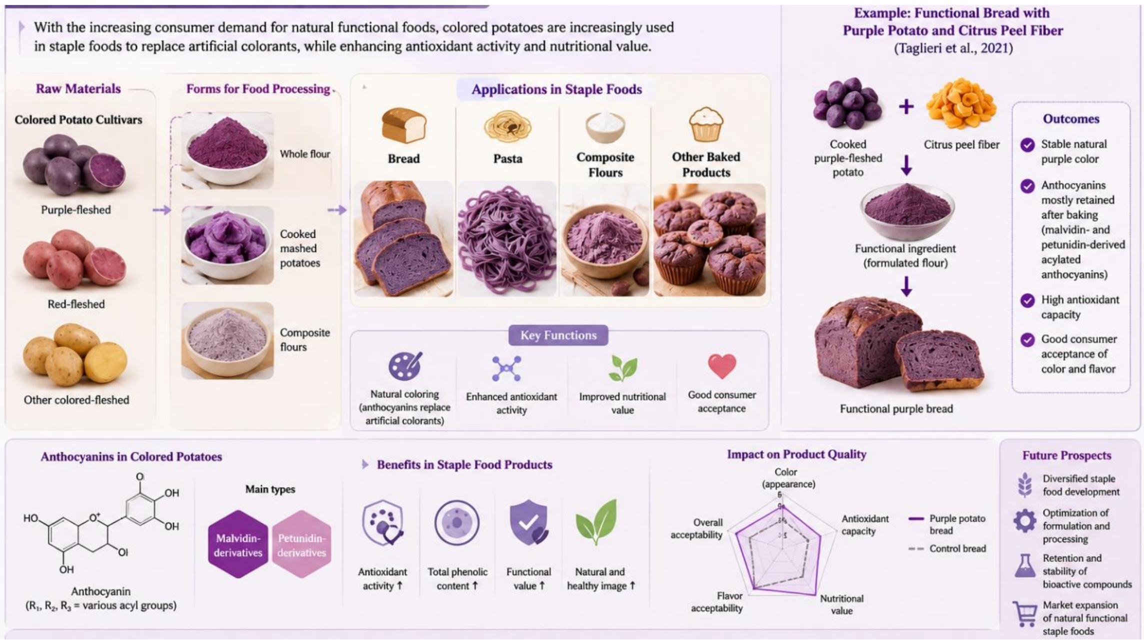

Figure 4 Development of staple food products from colored potatoes and their functional benefits

Bread is one of the most extensively studied applications. Taglieri et al. (2021) developed a functional bread using cooked purple-fleshed potato flour combined with citrus peel fiber. The purple potato imparted a stable natural purple color to the bread while retaining various acylated anthocyanins, predominantly malvidin- and petunidin-derived pigments. After baking, most anthocyanins remained detectable in the final product, resulting in bread with high antioxidant capacity. Moreover, consumers showed good acceptance of both the color and flavor of the product. These findings indicate that purple-fleshed potatoes can serve not only as natural colorants but also as functional ingredients for the development of specialty bread products.

7.3 Development of snack and convenience foods

Colored potatoes are suitable for developing chips, French fries, crisps, puffed snacks, dried potato cubes, frozen products, mashed potatoes, and instant foods because their natural pigments can create visually distinctive products without synthetic colorants. Compared with conventional potato snacks, products made from red- and purple-fleshed potatoes generally exhibit higher antioxidant activity and more attractive colors. Natural antioxidants in purple potato snacks can also delay lipid oxidation during storage. However, raw materials for chip processing still require appropriate dry matter and starch contents, low reducing sugar levels, and acceptable frying color characteristics.

Processing methods strongly influence anthocyanin retention. Frying, blanching, pre-drying, and drying treatments all reduce anthocyanin contents, with the greatest pigment losses occurring during the final frying or drying stages. Compared with French fries and dried potato cubes, chip processing generally retains more anthocyanins, and omitting blanching can further improve pigment retention (Rytel et al., 2021). Conventional frying and drying processes may damage nutritional compounds and sensory quality; therefore, future development of colored potato products should increasingly adopt baking, microwave treatment, and other mild processing technologies (Saini et al., 2023).

7.4 Development of natural colorants and functional ingredients

Purple and red potatoes are promising raw materials for anthocyanin-based natural colorants, whereas yellow-fleshed potatoes are more suitable for carotenoid-oriented nutritional enrichment. Anthocyanins in purple potatoes are mainly composed of cyanidin, delphinidin, and malvidin derivatives, while red potatoes are dominated by pelargonidin derivatives. Anthocyanin concentration is highest in potato peels, followed by whole tubers, while flesh generally contains lower levels. Therefore, potato peels, small-sized tubers, and processing by-products can serve as valuable sources for pigment extraction and nutrient-rich powder production.

Processed products prepared from unpeeled colored potatoes generally contain higher levels of polyphenols, proteins, dietary fiber, and anthocyanins. However, potato peels also contain higher concentrations of glycoalkaloids, requiring appropriate safety control during utilization.

Aqueous extracts from colored potatoes have demonstrated antioxidant, antibacterial, and antifungal activities. They also showed acceptable sensory properties and maintained good color stability for 30 days when applied in soft drink formulations, indicating practical potential as natural food colorants (Sampaio et al., 2021a). Extraction efficiency is influenced by both extraction methods and genotype. In one study, 70% ethanol extraction showed better performance than 70% methanol extraction, while significant differences in total phenolic and flavonoid contents were observed among cultivars. After optimized extraction and resin purification, anthocyanin yield reached 84.47 mg C3GE/100 g DW (Han et al., 2024).

Despite their potential, the development of colored potato-based natural colorants and functional ingredients still faces several challenges, including high extraction costs, reduced pigment stability outside the original food matrix, large variation in pigment content among genotypes, and the lack of standardized raw material criteria and quality evaluation systems. Future efforts should focus on improving extraction efficiency, enhancing pigment stability, and establishing standardized quality control systems to support commercial-scale applications.

Author Contributions

The authors designed the study, performed data collection and analysis, interpreted the results, prepared the manuscript, and approved the final version.

Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Amjadi H., Heidari G., Babaei S., and Sharifi Z., 2025, Evaluation of yield, yield components and some quality traits of tuber of potato (*Solanum tuberosum* L.) under different weed and nutritional management practices, Frontiers in Plant Science, 15: 1495541.
https://doi.org/10.3389/fpls.2024.1495541

Ballco P., Gomez M.I., and Gracia A., 2023, Consumers' acceptability and sensory evaluation of a traditional local fresh potato variety, Spanish Journal of Agricultural Research, 21(2): e0105-e0105.
https://doi.org/10.5424/sjar/2023212-20076

Bandana, Sharma V., Singh R.K., Kumar D., and Singh B., 2025, Heat-induced changes in bioactive compounds of colourful potato varieties, Current Science, 127(11): 1120.
https://doi.org/10.18520/cs/v128/i11/1120-1125

Bedini G., Haff R.P., Benelli A., Bandiera A., Taormina E., Massantini R., and Moscetti R., 2024, Potatoes (*Solanum tuberosum* L.) grown at "Patata dell'alto Viterbese" PGI have different quality characteristics and storage responses, Postharvest Biology and Technology, 214: 112991.
https://doi.org/10.1016/j.postharvbio.2024.112991

Berríos D., Peña F., González F., Santander C., Bustamante L., Contreras B., Cornejo P., and Ruíz A., 2026, Metabolic and productive effects in *Solanum tuberosum* subjected to water stress under the application of a bioencapsulated soil yeast and iron nanoparticles, Journal of the Science of Food and Agriculture, 106(9): 5658-5670.
https://doi.org/10.1002/jsfa.70629

Bravo C., Peña F., Nahuelcura J., Vidal C., González F., Jiménez-Aspee F., Bustamante L., Contreras B., and Ruíz A., 2023, Stability of phenolic compounds, antioxidant activity and color parameters in colored-flesh potato chips, Molecules, 28(16): 6047.
https://doi.org/10.3390/molecules28166047

Cebulak T., Krochmal-Marczak B., Stryjecka M., Krzysztofik B., Sawicka B., Danilčenko H., and Jarienè E., 2022, Phenolic acid content and antioxidant properties of edible potato (*Solanum tuberosum* L.) with various tuber flesh colours, Foods, 12(1): 100.
https://doi.org/10.3390/foods12010100

Ceci A.T., Franceschi P., Serni E., Perenzoni D., Oberhuber M., Robatscher P., and Mattivi F., 2022, Metabolomic characterization of pigmented and non-pigmented potato cultivars using a joint and individual variation explained (JIVE), Foods, 11(12): 1708.
https://doi.org/10.3390/foods11121708

Chen B.C., Wu X.J., Guo H.C., and Xiao J.P., 2024, Effects of appropriate low-temperature treatment on the yield and quality of pigmented potato (*Solanum tuberosum* L.) tubers, BMC Plant Biology, 24(1): 274.
https://doi.org/10.1186/s12870-024-04951-7

Cheng M., Dong J., Han C., Zhang Z., and McBeath J.H., 2019, First report of Phytoplasma 'Candidatus Phytoplasma aurantifolia' associated with purple top diseased potatoes (*Solanum tuberosum*) in Guangdong province, China, Plant Disease, 103(5): 1015.
https://doi.org/10.1094/PDIS-04-18-0701-PDN

D'Amelia V., Sarais G., Fais G., Dessì D., Giannini V., Garramone R., Carputo D., and Melito S., 2022, Biochemical characterization and effects of cooking methods on main phytochemicals of red and purple potato tubers, a natural functional food, Foods, 11(3): 384.
https://doi.org/10.3390/foods11030384

Dessì D., Fais G., and Sarais G., 2025, Nutritional and chemical characterization of red and purple potatoes peels: A polyphenol-rich by-product, Foods, 14(10): 1740.
https://doi.org/10.3390/foods14101740

Dhangrah V.K., Kumar V., Singh S., Singh Y.P., and Singh K., 2024, Impact of planting density and RDF levels on growth, yield, and seed tuber production of potato (*Solanum tuberosum* L.), Journal of Experimental Agriculture International, 46(10): 1-8.
https://doi.org/10.9734/jeai/2024/v46i102919

Dite Hunjek D., Pranjić T., Repajić M., and Levaj B., 2020, Fresh-cut potato quality and sensory: Effect of cultivar, age, processing, and cooking during storage, Journal of Food Science, 85(8): 2296-2309.
https://doi.org/10.1111/1750-3841.15353

Gadana D.B., 2021, Review on the effect of planting density and seed tuber size on yield and yield components of potato (*Solanum tuberosum* L.), Galaxy International Interdisciplinary Research Journal, 9(05): 353-362.

Galani J.H.Y., Mankad P.M., Shah A.K., Patel N.J., Acharya R.R., and Talati J.G., 2017, Effect of storage temperature on vitamin C, total phenolics, UPLC phenolic acid profile and antioxidant capacity of eleven potato (*Solanum tuberosum*) varieties, Horticultural Plant Journal, 3(2): 73-89.
https://doi.org/10.1016/j.hpj.2017.07.004

Galani Yamdeu J.H., Gupta P.H., Patel N.J., Shah A.K., and Talati J.G., 2016, Effect of storage temperature on carbohydrate metabolism and development of cold-induced sweetening in Indian potato (*Solanum tuberosum* L.) varieties, Journal of Food Biochemistry, 40(1): 71-83.
https://doi.org/10.1111/jfbc.12190

García-Ríos D., Alvaro J., Zúñiga M., Campos D., Aguilar-Galvez A., Mariotti-Celis M., Pedreschi F., and Pedreschi R., 2023, Targeted primary and secondary metabolite analysis of colored potato "Michuñe Negra" grown in soilless culture and during prolonged cold storage: Implications in acrylamide formation during frying, Agronomy, 13(5): 1209.
https://doi.org/10.3390/agronomy13051209

Gikundi E.N., Buzera A., Orina I., and Sila D., 2024, Impact of the temperature reconditioning of cold-stored potatoes on the color of potato chips and French fries, Foods, 13(5): 652.
https://doi.org/10.3390/foods13050652

Gikundi E.N., Buzera A.K., Orina I.N., and Sila D.N., 2023, Storability of Irish potato (*Solanum tuberosum* L.) varieties grown in Kenya, under different storage conditions, Potato Research, 66(1): 137-158.
https://doi.org/10.1007/s11540-022-09575-8

Hamouz K., Lachman J., Pazderů K., Tomášek J., Hejtmánková K., and Pivec V., 2011, Differences in anthocyanin content and antioxidant activity of potato tubers with different flesh colour, Plant, Soil and Environment, 57(10): 478-485.
https://doi.org/10.17221/265/2011-PSE

Han L., Li R., Jin X., Li Y., Chen Q., He C., and Wang M., 2024, Metabolomic analysis, extraction, purification and stability of the anthocyanins from colored potatoes, Food Chemistry: X, 22: 101423.
https://doi.org/10.1016/j.fochx.2024.101423

Hussen E.S., 2019, Review on genetic variation in potato (*Solanum tuberosum* L.) for processing quality traits, Journal of Natural Sciences Research, 9: 12.

Islam M., Naznin S., Naznin A., Uddin M., Amin M., Rahman M., Tipu M., Alsuhaibani A.M., Gaber A., and Ahmed S., 2022, Dry matter, starch content, reducing sugar, color and crispiness are key parameters of potatoes required for chip processing, Horticulturae, 8(5): 362.
https://doi.org/10.3390/horticulturae8050362

Jakubowski T., Rolbiecki S., Rolbiecki R., Wichrowska D., Figas A., Jagosz B., Atılgan A., Pál-Fám F., Keszthelyi S., and Krakowiak-Bal A., 2024, Response of *Solanum tuberosum* L. to drip irrigation and nitrogen application: Productivity, nutrition composition, bioactive compounds, antioxidant activity, Journal of Plant Protection Research, 64(3): 307-315.
https://doi.org/10.24425/jppr.2024.151250

Kalita D., Holm D.G., LaBarbera D.V., Petrash J.M., and Jayanty S.S., 2018, Inhibition of α-glucosidase, α-amylase, and aldose reductase by potato polyphenolic compounds, PLoS One, 13(1): e0191025.
https://doi.org/10.1371/journal.pone.0191025

Kasnak C. and Palamutoglu R., 2022, Antioxidant capacity and phenolic content of new Turkish cultivars of potato, Potato Research, 65(3): 571-580.
https://doi.org/10.1007/s11540-022-09542-3

Kim I.V., Nawaz M.A., Volkov D.I., Klykov A.G., Razgonova M.P., and Golokhvast K.S., 2025, Identification and quantification of anthocyanins in various organs of potato varieties (*Solanum tuberosum* L.) as potential visual selection markers during breeding, Plants, 14(13): 2042.
https://doi.org/10.3390/plants14132042

Lachman J. and Hamouz K., 2005, Red and purple coloured potatoes as a significant antioxidant source in human nutrition-a review, Plant, Soil and Environment, 51(11): 477.
https://doi.org/10.17221/3620-PSE

Larkin R.P., 2024, Potato cropping system and variety impacts on soil properties, soilborne diseases, and tuber yield in a long-term field trial, Agronomy, 14(12): 2852.
https://doi.org/10.3390/agronomy14122852

Li H., Yang X., Kang Y., Li W., Li H., and Qin S., 2023, Effects of nitrogen, phosphorus and potassium combined fertilisation on the dry matter accumulation, distribution and yield of potato under ridge and furrow film mulch cropping, Potato Research, 66(3): 851-871.
https://doi.org/10.1007/s11540-022-09596-3

Liu J., Shi J., and Li Y., 2026, Potato yield and quality, soil chemical properties and microbial community as affected by different potato rotations in Southern Shanxi Province, China, Plants, 15(1): 117.
https://doi.org/10.3390/plants15010117

Liu Y., Li Y., Liu Z., Wang L., Bi Z., Sun C., Yao P., Zhang J., Bai J., and Zeng Y., 2023, Integrated transcriptomic and metabolomic analysis revealed altitude-related regulatory mechanisms on flavonoid accumulation in potato tubers, Food Research International, 170: 112997.
https://doi.org/10.1016/j.foodres.2023.112997

Michalska A., Wojdyło A., and Bogucka B., 2016, The influence of nitrogen and potassium fertilisation on the content of polyphenolic compounds and antioxidant capacity of coloured potato, Journal of Food Composition and Analysis, 47: 69-75.
https://doi.org/10.1016/j.jfca.2016.01.004

Niu Y., Zhang K., Khan K.S., Fudjoe S.K., Li L., Wang L., and Luo Z., 2024, Deficit irrigation as an effective way to increase potato water use efficiency in Northern China: A meta-analysis, Agronomy, 14(7): 1533.
https://doi.org/10.3390/agronomy14071533

Orsák M., Kotíková Z., Podhorecká K., Lachman J., and Kasal P., 2022, Acrylamide formation in red-, purple- and yellow-fleshed potatoes by frying and baking, Journal of Food Composition and Analysis, 110: 104529.
https://doi.org/10.1016/j.jfca.2022.104529

Pęksa A., Tajner-Czopek A., Gryszkin A., Miedzianka J., Rytel E., and Wolny S., 2024, Assessment of the content of glycoalkaloids in potato snacks made from colored potatoes, resulting from the action of organic acids and thermal processing, Foods, 13(11): 1712.
https://doi.org/10.3390/foods13111712

Polivanova O.B. and Gins E.M., 2019, Antioxidant activity of potatoes (*Solanum tuberosum* L.) and anthocyanin content, its biosynthesis and physiological role, Овощи России, (6): 84-90.
https://doi.org/10.18619/2072-9146-2019-6-84-90

Qi Z., Wang W., Liu Z., Niu N., Li Z., Chen L., Zhu J., Li D., and Liu Y., 2023, Anthocyanin profiles in colored potato tubers at different altitudes by HPLC-MS analysis with optimized ultrasound-assisted extraction, Foods, 12(22): 4175.
https://doi.org/10.3390/foods12224175

Rachappanavar V., Kumar M., Kumar V., Patil V.U., and Sharma V., 2024, Evaluation of processing quality attributes of potato (Solanum spp.) genotypes grown in Mid-Hills of Himachal Pradesh, Potato Research, 67(3): 901-929.
https://doi.org/10.1007/s11540-023-09646-4

Rytel E., Tajner-Czopek A., Kita A., Tkaczyńska A., Kucharska A.Z., and Sokół-Łętowska A., 2021, The influence of the production process on the anthocyanin content and composition in dried potato cubes, chips, and French fries made from red-fleshed potatoes, Applied Sciences, 11(3): 1104.
https://doi.org/10.3390/app11031104

Saar-Reismaa P., Kotkas K., Rosenberg V., Kulp M., Kuhtinskaja M., and Vaher M., 2020, Analysis of total phenols, sugars, and mineral elements in colored tubers of *Solanum tuberosum* L., Foods, 9(12): 1862.
https://doi.org/10.3390/foods9121862

Saini R., Kaur S., Aggarwal P., Dhiman A., and Suthar P., 2023, Conventional and emerging innovative processing technologies for quality processing of potato and potato-based products: A review, Food Control, 153: 109933.
https://doi.org/10.1016/j.foodcont.2023.109933

Sampaio S.L., Lonchamp J., Días M.I., Liddle C., Petropoulos S., Glamočlija J., Alexopoulos A., Santos-Buelga C., Ferreira I., and Barros L., 2021a, Anthocyanin-rich extracts from purple and red potatoes as natural colourants: Bioactive properties, application in a soft drink formulation and sensory analysis, Food Chemistry, 342: 128526.
https://doi.org/10.1016/j.foodchem.2020.128526

Sampaio S.L., Petropoulos S., Días M.I., Pereira C., Calhelha R., Fernandes Â., Leme C.M.M., Alexopoulos A., Santos-Buelga C., Ferreira I., and Barros L., 2021b, Phenolic composition and cell-based biological activities of ten coloured potato peels (*Solanum tuberosum* L.), Food Chemistry, 363: 130360.
https://doi.org/10.1016/j.foodchem.2021.130360

Seid E. and Tessema L., 2024, Evaluation of tuber quality, yield and yield related traits of potato (*Solanum tuberosum* L.) genotypes at Holetta, Central Ethiopia, CABI Agriculture and Bioscience, 5(1): 99.
https://doi.org/10.1186/s43170-024-00285-4

Shi M., Kang Y., Zhang W., Yang X., Fan Y., Yu H., Zhang R., Guo A.X., and Qin S., 2022, Plastic film mulching with ridge planting alters soil chemical and biological properties to increase potato yields in semiarid Northwest China, Chemical and Biological Technologies in Agriculture, 9(1): 16.
https://doi.org/10.1186/s40538-022-00284-5

Soare R., Dinu M., Băbeanu C., and Soare M., 2020, Evaluation and comparison of antioxidant activity and biochemical compounds in some coloured potato cultivars, Plant, Soil and Environment, 66(6): 281-286.
https://doi.org/10.17221/202/2020-PSE

Solovyeva A., Rogozina E., Chalaya N., and Sitnikov M., 2024, Biochemical composition of tubers of new Russian potato cultivars, Agronomy, 14(4): 834.
https://doi.org/10.3390/agronomy14040834

Stark J.C., Love S.L., and Knowles N.R., 2020, Tuber quality, In: Potato Production Systems, Cham: Springer International Publishing, pp.479-497.
https://doi.org/10.1007/978-3-030-39157-7_15

Taglieri I., Sanmartin C., Venturi F., Macaluso M., Bianchi A., Sgherri C., Quartacci M.F., De Leo M., Pistelli L., Palla F., Flamini G., and Zinnai A., 2021, Bread fortified with cooked purple potato flour and citrus albedo: An evaluation of its compositional and sensorial properties, Foods, 10(5): 942.
https://doi.org/10.3390/foods10050942

Travina S.N., 2021, Revealing the potential of potato varieties with colored pulp in the conditions of the Murmansk region, Vavilovia, 4(1): 36-47.
https://doi.org/10.30901/2658-3860-2021-1-36-47

Vaitkevičienė N., Jarienė E., Kulaitienė J., and Levickienė D., 2022, The physico-chemical and sensory characteristics of coloured-flesh potato chips: Influence of cultivar, slice thickness and frying temperature, Applied Sciences, 12(3): 1211.
https://doi.org/10.3390/app12031211

Vaitkevičienė N., Kulaitienė J., Jarienė E., Levickienė D., Danillčenko H., Średnicka-Tober D., Rembiałkowska E., and Hallmann E., 2020, Characterization of bioactive compounds in colored potato (*Solanum tuberosum* L.) cultivars grown with conventional, organic, and biodynamic methods, Sustainability, 12(7): 2701.
https://doi.org/10.3390/su12072701

Visse-Mansiaux M., Shumbe L., Brostaux Y., Ballmer T., Smit I., Dupuis B., and Vanderschuren H., 2024, Identification of potato varieties suitable for cold storage and reconditioning: A safer alternative to anti-sprouting chemicals for potato sprouting control, Food Research International, 184: 114249.
https://doi.org/10.1016/j.foodres.2024.114249

Wagg C., Hann S., Kupriyanovich Y., and Li S., 2021, Timing of short period water stress determines potato plant growth, yield and tuber quality, Agricultural Water Management, 247: 106731.
https://doi.org/10.1016/j.agwat.2020.106731

Wang H., Yang Y., Yao C., Feng Y., Wang H., Kong Y., Riaz U., Zaman Q., Sultan K., Fahad S., and Deng G., 2024, The correct combination and balance of macronutrients nitrogen, phosphorus and potassium promote plant yield and quality through enzymatic and antioxidant activities in potato, Journal of Plant Growth Regulation, 43(12): 4716-4734.
https://doi.org/10.1007/s00344-024-11428-2

Wang H.D., Wang X., Bi L., Wang Y., Fan J., Zhang F., Hou X., Cheng M., Hu W., Wu L., and Xiang Y., 2019, Multi-objective optimization of water and fertilizer management for potato production in sandy areas of northern China based on TOPSIS, Field Crops Research, 240: 55-68.
https://doi.org/10.1016/j.fcr.2019.06.005

Wichrowska D., Rolbiecki R., Rolbiecki S., Sadan H.A., Figas A., Jagosz B., Atılgan A., and Pál-Fám F., 2021, Effect of drip fertigation with nitrogen application on bioactive compounds and the nutritional value of potato tubers before and after their long-term storage, Agriculture, 11(11): 1076.
https://doi.org/10.3390/agriculture11111076

Wu X. and Xiao J., 2024, Response and adaptive mechanism of flavonoids in pigmented potatoes at different altitudes, Plant and Cell Physiology, 65(7): 1184-1196.
https://doi.org/10.1093/pcp/pcae045

Xu X., Chen X., Man Q., Li W., Wang L., Liu X., Chen J., and Cui J., 2025, Multi-omics, network pharmacology, and molecular docking provide insights into the genetic basis, bioactive, and potential antioxidant mechanisms in potato (*Solanum tuberosum* L.) flesh, Scientia Horticulturae, 345: 114148.
https://doi.org/10.1016/j.scienta.2025.114148

Yang L., Xia Y., Junejo S.A., and Zhou Y., 2018, Composition, structure and physicochemical properties of three coloured potato starches, International Journal of Food Science & Technology, 53(10): 2325-2334.
https://doi.org/10.1111/ijfs.13824

Yusuf M., Miller M.D., Stefaniak T.R., Haagenson D., Endelman J.B., Thompson A.L., and Shannon L.M., 2024, Genomic prediction for potato (*Solanum tuberosum*) quality traits improved through image analysis, The Plant Genome, 17(4): e20507.
https://doi.org/10.1002/tpg2.20507

Zarzecka K., Ginter A., Gugała M., and Durakiewicz W., 2024, Nutritional value of coloured flesh potato tubers in terms of their micronutrient content, Agronomy, 14(7): 1537.
https://doi.org/10.3390/agronomy14071537

Zhang F., Chen M., Fu J., Zhang X., Li Y., Shao Y., Xing Y., and Wang X., 2023, Coupling effects of irrigation amount and fertilization rate on yield, quality, water and fertilizer use efficiency of different potato varieties in Northwest China, Agricultural Water Management, 287: 108446.
https://doi.org/10.1016/j.agwat.2023.108446

Zhang H., Chen X., Xue C., Zhang W., Li F., Teng A., Zhang C., Lei L., and Ba Y., 2024a, Dry matter accumulation, water productivity and quality of potato in response to regulated deficit irrigation in a desert oasis region, Plants, 13(14): 1927.
https://doi.org/10.3390/plants13141927

Zhang Z., Cai B., Guo Y., Na T., and Guo Y., 2024b, The impact of different nitrogen levels on the tuber yield and anthocyanin synthesis of purple potatoes, Agriculture, 14(1): 125.
https://doi.org/10.3390/agriculture14010125

Zheng S. and Zhang Y., 2013, Effects of different altitudes on yield, quality and anthocyanin content of purple potato (*Solanum tuberosum* L.), Southwest China Journal of Agricultural Sciences, 26(4): 1420-1423.

Zhong W., Yang J., Liang F., and Ma Q., 2025, Integrated transcriptomic and metabolomic analyses reveal optimized cultivation strategies for purple potatoes (*Solanum tuberosum* L.), Frontiers in Plant Science, 16: 1675151.
https://doi.org/10.3389/fpls.2025.1675151

Zhou B., Yuan J., Liang L., Zhang F., and Wang Y., 2025, Genotype × environment interactions for potato yield and quality traits: Identification of ideotypes adapted in different ecological regions of Northwest China, BMC Plant Biology, 25(1): 737.
https://doi.org/10.1186/s12870-025-06741-1