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Enhancing anti-diabetic properties of purple sweet potato through pre-gelatinization and yogurt fermentation: A systematic review

Peningkatan sifat anti-diabetes ubi jalar ungu melalui pre-gelatinisasi dan fermentasi yogurt: Tinjauan sistematis

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Abstract

The prevalence of diabetes mellitus in Indonesia reached 11.7% in 2023. Purple sweet potatoes contain antidiabetic bioactive compounds whose levels and bioavailability are affected by processing methods such as pre-gelatinization and fermentation. This study aimed to evaluate whether the combination of these two processes can improve the antidiabetic properties of these tubers. This systematic review followed the guidelines of PRISMA and PICO, with a literature search for 2015–2025 on PubMed, ScienceDirect, Scopus, and Web of Science. The inclusion criteria were experimental studies that evaluated the effects of pre-gelatinization or fermentation of sweet potatoes on antidiabetic indicators, while review articles were excluded. Eighteen studies met the inclusion criteria. The quality assessment of the study used ToxRTool modification (in vitro) and SYRCLE (in vivo). The results showed that fermentation was beneficial for the antidiabetic potential of these tubers, whereas the effects of pre-gelatinization varied depending on the method. Methods that have proven to be beneficial include steaming and retrogradation. The combination of these two processes shows potential synergistic effects, but the evidence is still limited. Because these findings are based on in vitro and in vivo studies, the results must be interpreted carefully.

Keywords: Diabetes mellitus, diabetes management, yogurt, fermentation, *ipomoea batatas*, pre-gelatinized starch, bioavailability

Abstrak

Prevalensi diabetes melitus di Indonesia mencapai 11,7% pada tahun 2023. Ubi jalar ungu mengandung senyawa bioaktif anti-diabetes yang kadar dan bioavailabilitasnya dipengaruhi oleh metode pengolahan seperti pre-gelatinisasi dan fermentasi. Penelitian ini bertujuan untuk mengevaluasi apakah kombinasi kedua proses tersebut dapat meningkatkan sifat anti-diabetes dari umbi-umbian ini. Tinjauan sistematis ini mengikuti pedoman PRISMA dan PICO, dengan penelusuran literatur tahun 2015–2025 pada PubMed, ScienceDirect, Scopus, dan Web of Science. Kriteria inklusi meliputi studi eksperimental yang mengevaluasi efek pre-gelatinisasi atau fermentasi ubi jalar pada indikator anti-diabetes, sedangkan artikel ulasan dikecualikan. Sebanyak 18 studi memenuhi persyaratan. Penilaian kualitas studi menggunakan modifikasi ToxRTool (in vitro) dan SYRCLE's (in vivo). Hasil penelitian menunjukkan bahwa fermentasi bermanfaat bagi potensi anti-diabetes umbi-umbian ini, sedangkan efek pre-gelatinisasi bervariasi tergantung pada metodenya. Metode yang terbukti bermanfaat adalah pengukusan dan yang melibatkan retrogradasi. Kombinasi kedua proses menunjukkan potensi efek sinergis, namun bukti masih terbatas. Karena temuan ini didasarkan pada studi in vitro dan in vivo, maka hasilnya perlu diinterpretasikan secara hati-hati.

Kata Kunci: Diabetes mellitus, manajemen diabetes, yogurt, fermentasi, *ipomoea batatas*, pati pre-gelatinisasi, bioavailabilitas

Introduction

Diabetes mellitus (DM) is a complex metabolic disease whose prevalence continues to increase globally (Antar et al., 2023; Kayode et al., 2023; Namazi et al., 2021), with the number of patients estimated to reach 693 million by 2045 (Cho et al., 2018). In Indonesia, the prevalence of this disease in the population aged ≥ 15 years increased from 10.9% in 2018 to 11.7% in 2023 (Kemenkes RI, 2019, 2023). This disease is caused by impaired secretion or performance of insulin, or a combination of both (Perkeni, 2021). This complex metabolic disorder is becoming increasingly common in various populations. Therefore, effective prevention and management efforts are required (Antar et al., 2023; Kayode et al., 2023; Namazi et al., 2021). One of the strategies that is currently gaining attention is the use of functional foods (Alkhatib et al., 2017).

One functional food ingredient with potential as an antidiabetic agent is purple sweet potato (*Ipomoea batatas* L.). This ingredient is rich in bioactive compounds, such as anthocyanins and resistant starches, which play a role in blood glucose control (Nabot et al., 2024; Rosell et al., 2024). Anthocyanins can act as antioxidants, protecting the function of β-pancreatic cells (Akomolafe et al., 2025; Nabot et al., 2024). Resistant starch plays a role in controlling blood sugar levels by slowing the absorption of blood glucose (Goff et al., 2018; Liu et al., 2022).

The modification of purple sweet potato starch through pre-gelatinization has the potential to improve its anti-diabetic properties. Pre-gelatinization involves heating starch above the gelatinization temperature, followed by hydration, causing changes in the crystalline structure of starch (Ulfa et al., 2021). Physical modifications can increase the resistant starch content (Wijaya et al., 2024), which helps control blood sugar levels (Goff et al., 2018; Liu et al., 2022). However, processing can also affect the stability of other bioactive compounds, thereby affecting the overall biological activity (Cheong et al., 2022).

Another example of an anti-diabetic functional food is yogurt. Yogurt plays a role in blood glucose regulation through nutrients, probiotic activity, and the production of fermented compounds such as SCFA (Britos et al., 2024; Salas-Salvadó et al., 2017). Yogurt consumption of 80–125 g per day is associated with a 14% reduction in the risk of type 2 diabetes (Gijsbers et al., 2016). However, the functional ability of fermented products is highly dependent on various factors, such as the fermentation process, specific type of microbes used, and composition of the product substrate (Sivamaruthi et al., 2018).

The combination of pre-gelatinization and fermentation has the potential to create synergistic effects that can enhance the anti-diabetic effects of purple sweet potatoes. Physical modifications of starch, such as pre-gelatinization, are known to increase the levels of resistant starch, which acts as a prebiotic substrate for probiotic bacteria, potentially increasing fermentation activity and providing metabolic benefits (Wijaya et al., 2024). Several literature reviews have discussed the role of purple sweet potatoes (Arisanti et al., 2023; Naomi et al., 2021) and yogurt in diabetes management (Barengolts et al., 2019; Salas-Salvadó et al., 2017). Other studies have shown that the combination of bacterial fermentation of lactic acid with physical modification of starch can increase the levels of resistant starch (Setiarto & Widhyastuti, 2017). However, these studies generally address components separately or in different food systems; thus, the potential synergistic interactions between pre-gelatinization and fermentation in a single food matrix have not been widely studied.

Based on a search of the preliminary literature in the main database, studies that specifically integrate the use of pre-gelatinized purple sweet potato starch in yogurt formulations for the management of diabetes mellitus are still very limited. Therefore, a systematic review is needed to elucidate the antidiabetic potential of purple sweet potatoes processed through pre-gelatinization and fermentation. This study aimed to evaluate whether the combination of pre-gelatinization and fermentation processes in yogurt can improve the antidiabetic properties of purple sweet potato.

Methods

This study was a systematic literature review. The review process was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The completed PRISMA 2020 checklist is provided as a supplementary file to ensure the transparency and completeness of the reporting. This review was conducted based on a predefined protocol; however, the protocol was not registered in the PROSPERO database prior to the review.

Literature searches were conducted in four main databases: PubMed, ScienceDirect, Scopus, and Web of Science. The keywords used for the searches were as follows:

- ("sweet potato" OR "*Ipomoea batatas*") AND ("diabetes" OR "anti-diabetes" OR "glucose") AND ("in vivo" OR "in vitro" OR "clinical trial" OR "randomized controlled trial")
- ("Sweet potato" OR "*Ipomoea batatas*") AND ("pre-gelatinization" OR "pre-gelatinization" OR "gelatinization" OR "gelatinization")
- ("sweet potato" OR "*Ipomoea batatas*") AND ("spray drying" OR "drum drying" OR "extrusion")
- ("sweet potato" OR "*Ipomoea batatas*") AND ("fermented" OR "fermented" OR "yogurt")

Covidence was used for screening to ensure a systematic and transparent selection process. The screening process began with title and abstract screening in the first stage. In the second stage, a complete text screening was conducted to identify studies that met the predetermined criteria. The studies included in this review met the following inclusion criteria:

- Open-access research articles published between 2015 and 2025.
- P (Population): Experimental, in vitro, in vivo, or clinical studies.
- I (Intervention): Fermentation and/or pre-gelatinization of sweet potatoes or purple sweet potatoes and consumption of these products.
- C (Comparison): Control products without intervention (unfermented/unfermented) or comparison between different concentrations of sweet potato or purple potato.
- O (Results): Indicators of anti-diabetic potential (functional compounds, enzymatic activity associated with carbohydrate metabolism, blood glucose levels, and glycemic indices).

Studies will be excluded if they:

- Literature review article.
- Sweet potato or purple sweet potato was used in combination with other ingredients without separate analysis of the effects of sweet potato or purple sweet potato.
- Using microorganisms other than lactic acid bacteria.

The quality of the research was adjusted according to the study design included. A modified toxicological data Reliability Assessment Tool (ToxRTool) was used for in vitro studies. This modification was made due to the limitations of quality assessment tools specifically designed for in vitro experimental studies in the field of food. ToxRTool was chosen because it covers various aspects of risk bias, although it was originally developed for toxicology studies. Therefore, some criteria were adjusted to be relevant to the analysis of food bioactive composition and compounds. Studies were categorized as reliable without restriction if they obtained a score of 15–18, reliable with restriction if they obtained a score of 11–14, and not reliable if they obtained a score of <11 (Kandhare et al., 2019). Meanwhile, in the in vivo study, a risk of bias assessment was carried out using the Systematic Review Center for Laboratory Animal Experimentation (SYRCLE's) Risk of Bias Tool. The assessment was carried out for each domain and categorized as low, high, or unclear risk (Nistor et al., 2019). The results of the research quality assessment and limitations identified in each study are presented systematically in the limitations column in Tables 1–4.

The review process was carried out by one principal investigator under the supervision of two co-authors to maintain the objectivity and validity of the results. The authors declare no conflicts of interest among the researchers. Any differences of opinion or disagreement that existed during the selection and analysis process were resolved through discussion until an agreement was reached. Data were synthesized using a structured narrative synthesis approach. The included studies were systematically grouped by processing method and the level of evidence.

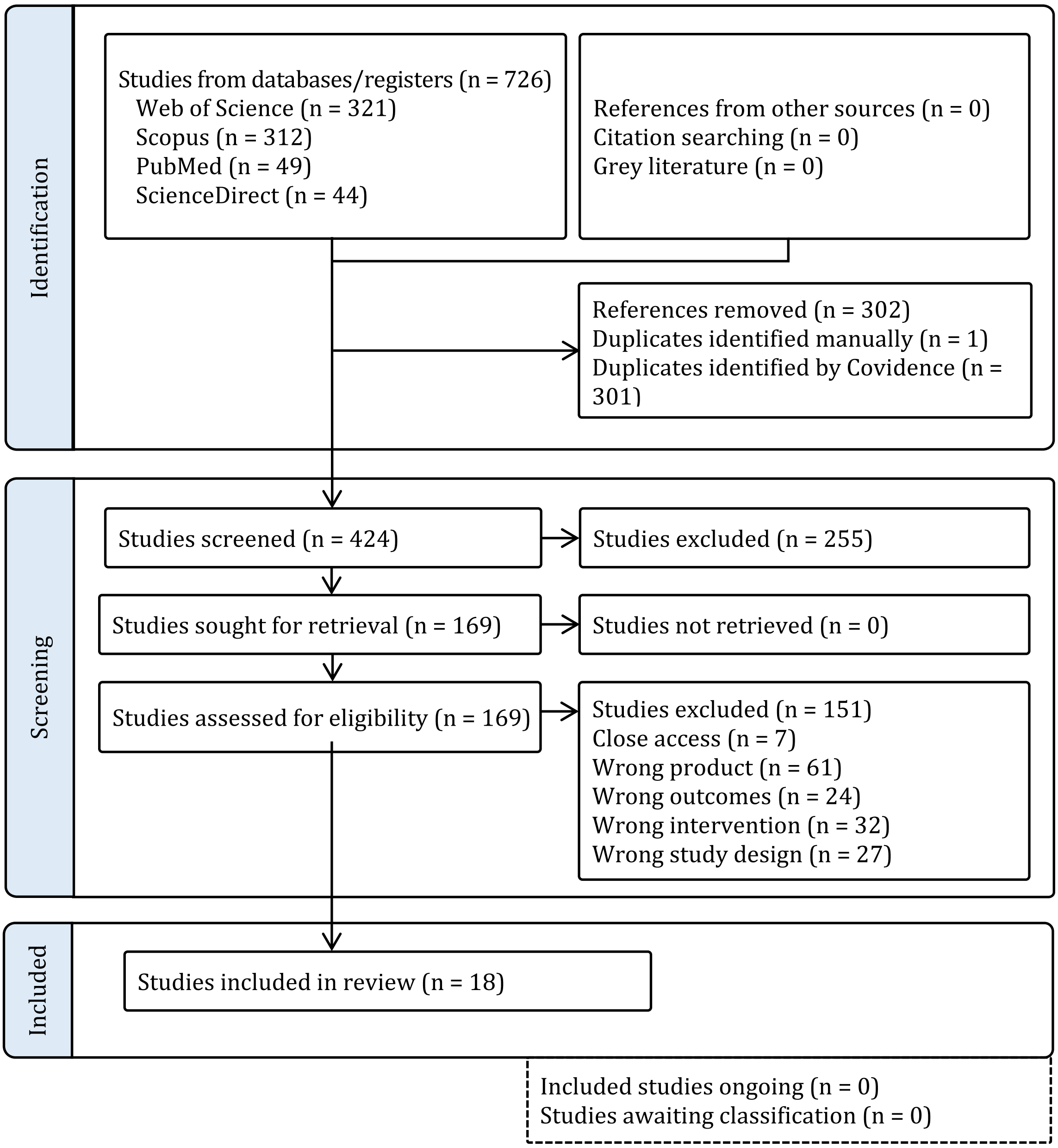

Figure 1. PRISMA flow diagram

Result and Discussion

Data Synthesis

The literature selection process was performed using the PRISMA protocol, as shown in Figure 1. Initially, 726 research articles were identified based on keyword searches in four scientific databases. After a rigorous screening process involving a review of titles and abstracts, removal of duplicates, and a full-text feasibility assessment, 18 studies were included in the final dataset for analysis. Among these selected studies, three focused on the effects of purple sweet potato interventions in a mouse model of diabetes, providing insight into its antidiabetic efficacy in vivo. Eight studies discussed the pre-gelatinization effects on sweet potatoes. Three studies examined the effects of fermentation on sweet potatoes. The remaining four studies investigated the addition of purple sweet potatoes to fermented dairy products.

The selected studies consisted of only in vitro and in vivo studies, with no clinical studies in humans. Of the 18 selected studies, there were 14 in vitro studies and 4 were in vivo studies. The results of the in vitro study using the modified ToxRTool showed that all of them were classified as "reliable with restriction." For in vivo studies, assessments using SYRCLE's tool showed that most had a low risk of bias in terms of baseline characteristics, incomplete outcome data, and selective outcome reporting. However, there are unclear risks in other domains, especially those related to randomization and blinding. This information was not clearly stated in the study.

Anti-diabetic Potential of Purple Sweet Potato

Purple sweet potatoes have been identified as food ingredients with anti-diabetic effects (Arisanti et al., 2023; Noreen et al., 2024). The antidiabetic effects of this tuber have been evaluated in a mouse model of diabetes using various forms and preparations, as summarized in Table 1. Akomolafe et al. (2025) examined the effect of steamed purple sweet potato on diabetic rats at a dose of 58.6 g/100 g body weight for two weeks. In another study, Gofur et al. (2024) intervened in diabetic mice by administering 400 mg/kg of purple sweet potato extract orally. Mi et al. (2024) analyzed the influence of anthocyanin extraction from purple sweet potatoes administered to male diabetic rats at doses of 227.5, 455, or 910 mg/kg body weight for ten consecutive days.

The three studies showed that interventions using purple sweet potato products can provide significant antidiabetic effects. This effect is reflected in the reduction of fasting blood glucose levels and increase in glucose metabolism. In addition, studies have reported the inhibition of carbohydrate-digesting enzymes, including α-amylase and α-glucosidase, which play an important role in slowing glucose absorption in the gut. This intervention also increases antioxidant capacity by regulating antioxidant enzymes. In addition, there was a reduction in tumor necrosis factor-alpha (TNF-α) levels and improvement in the lipid profile and liver function. The administration of anthocyanins derived from these tubers can improve the diversity of the gut microbiota and modulate the structure of microbial communities (Akomolafe et al., 2025; Gofur et al., 2024; Mi et al., 2024).

Table 1. Effect of purple sweet potato product intervention on a model of diabetic mice

References	Study Design	Products	Intervention	Outcomes	Limitations
Akomolafe et al. (2025)	In vivo	Boiled purple white fleshy sweet potato	58.6 g/100 g body weight for 2 weeks (diabetic rats)	Increased liver glycogen levels and antioxidant parameters; Reduced α-amylase and α-glucosidase activity, fasting blood glucose levels, ROS and malondialdehyde levels after intervention	Limitations in reporting on randomization and blinding
Gofur et al. (2024)	In vivo	Purple sweet potato extract	400 mg/kg body weight (diabetic rats)	Improves glucose levels, lipid profile, and liver function; Lowers the proinflammatory cytokine TNF-α in the liver after intervention	Limitations in reporting on randomization and blinding
Mi et al. (2024)	In vivo	Anthocyanins from purple sweet potatoes	910 mg/kg body weight for 10 days (diabetic male rats)	Reduced blood glucose levels, increases serum antioxidant enzymes, and improves the diversity and balance of the gut microbiota after intervention	Limitations in reporting on randomization and blinding

The results of this study show that the bioactive compounds present in purple sweet potatoes are beneficial for diabetes management (Akomolafe et al., 2025; Gofur et al., 2024; Mi et al., 2024). The antidiabetic activity of this tuber is due to the presence of anthocyanins, phenolics, dietary fiber, and resistant starches. These components work synergistically to regulate blood glucose levels and improve insulin sensitivity (Rosell et al., 2024).

Purple sweet potatoes contain over 20 different types of anthocyanins (Noreen et al., 2024). This compound can inhibit carbohydrate digestive enzymes, such as α-glucosidase and α-amylase, thereby slowing glucose digestion and absorption (Kozłowska & Nitsch-Osuch, 2024; Noman et al., 2025). Anthocyanins can also modulate key receptors and genes involved in glycemic regulation, including GLUT4, PPAR, GLP-1R, and FFAR1 (Mi et al., 2024). In addition, this compound can support the balance of the intestinal microbiota by inhibiting the growth of pathogenic bacteria and functioning as an antioxidant (Akomolafe et al., 2025; Mi et al., 2024; Nabot et al., 2024).

In individuals with diabetes mellitus, hyperglycemic conditions can lead to increased free radical production. Excessive production of free radicals can trigger oxidative stress. This oxidative load causes damage to pancreatic β-cells, interferes with insulin secretion, and interferes with various metabolic processes (Akomolafe et al., 2025; Nabot et al., 2024).

Antioxidants play a role in blood sugar control. Antioxidants can neutralize free radicals, thereby reducing cellular oxidative damage and maintaining pancreatic β-cell function. In addition, antioxidants contribute to increased insulin sensitivity and help suppress chronic inflammation commonly associated with diabetes mellitus (Akomolafe et al., 2025; Nabot et al., 2024). This protective ability is not only possessed by anthocyanin compounds but also by other bioactive compounds found in purple sweet potatoes, such as caffeic acid, chlorogenic acid, ferulate, naringenin, and quercetin (Rosell et al., 2024).

Purple sweet potatoes are a source of complex carbohydrates with a low glycemic index and contain resistant starch and dietary fiber (Gofur et al., 2024). Resistant starch is a type of starch that passes through the small intestine without being digested and is then fermented by the microbiota in the colon. This type of starch can modulate the imbalance of the gut microbiota, reduce inflammation, and regulate the activity of enzymes involved in glucose metabolism (Liu et al., 2022). Dietary fiber is also crucial in reducing glycemic indicators, such as HbA1c. These effects are mediated through various pathways, including delayed glucose uptake, increased insulin sensitivity, and modulation of the gut microbiota (Goff et al., 2018).

In individuals with diabetes mellitus, the gut microbiota tends to show decreased bacterial diversity. Notably, there were reductions in butyrate-producing bacteria and beneficial probiotic species. This imbalance is associated with impaired glucose metabolism and increased systemic inflammation (Mi et al., 2024; Fliegerová et al., 2024). Purple sweet potato anthocyanin interventions in diabetic male mice have been shown to optimize gut microbiota diversity and balance. This can be seen from the decrease in the ratio of Firmicutes/Bacteroidetes (15.9 – 38.9%) and an increase in the abundance of beneficial bacteria, including *Lachnospiraceae Clostridium*, *Butyricimonas*, and *Akkermansia,* which are known to play a role in SCFA production and maintenance of metabolic health (Mi et al., 2024).

The Impact of Pre-gelatinization on the Starch Structure and Anti-Diabetic Potential of Purple Sweet Potato

The use of purple sweet potatoes in various food applications is still limited because of their physicochemical characteristics, which include low solubility and high retrogradation tendency (Ulfa et al., 2021; Yang et al., 2025). One strategy to overcome this limitation is pre-gelatinization, a starch modification process that involves heating starch above its gelatinization temperature in the presence of moisture (Ulfa et al., 2021). This modification increases viscosity and gel-forming capacity, making it more suitable for various food product developments (Yang et al., 2025).

Pre-gelatinization can be performed using various methods. These methods can produce starch with different physicochemical characteristics, depending on the processing conditions and equipment used (He et al., 2023b; Ye & Baik, 2023). Three main techniques can be used to produce pre-gelatinized starch: drum drying, extrusion, and spray drying (Ye & Baik, 2023). In practical applications, gelatinization of starch can also be achieved by boiling, steaming, and moist heat processing (Yang et al., 2025). The effect of the pre-gelatinization process on the antidiabetic components of this tuber is presented in Table 2.

Several studies have explored the impact of pre-gelatinization on the characteristics of processed sweet potatoes. When starch is heated in the presence of excess water, partial or complete breakdown of the crystal zone in starch grains and result in a reorganization of the hydrogen bond tissue and changes in the components on the starch (Dos Santos et al., 2019; Ulfa et al., 2021)

The cooking and drying processes improve the digestibility of the flour (Dereje et al., 2020). Bedin et al. (2023) processed raw purple sweet potatoes by cooking them in an airfilled pressure cooker for 17 min to produce purple sweet potato pulp. This process results in higher sugar levels while reducing the resistant starch in the product. These changes can potentially increase the glycemic response, making them less profitable in the context of product development for the management of diabetes mellitus.

However, different results were observed during pre-gelatinization involving retrogradation. Pre-gelatinization, which includes retrogradation, has been shown to increase amylose and resistant starch content. These changes are caused by the transformation of the crystal pattern during low-temperature retrogradation. This transformation shows the presence of reassociations in amylose and the formation of a more regular double-helical structure in the crystal domain (Zheng et al., 2016). This increase in resistant starch levels is a form of type 3 resistant starch, which is a form of resistant starch that appears due to retrogradation after heat treatment and cooling (He et al., 2023b).

Increasing levels of resistant starch have the potential to provide benefits in the management of diabetes mellitus. This type of starch is indigestible; therefore, it is fermented in the colon by probiotic bacteria (He et al., 2023). The metabolism of resistant starch lasts 5-7 hours after consumption, suppressing the glycemic response and insulin levels (Fathurrizqiah & Panunggal, 2015).

Pre-gelatinized purple sweet potato flour obtained through steaming and brief immersion in cold water showed a higher dietary fiber content (9.76 g/100 g) than raw flour (8.11 g/100 g) (Pichaiyongvongdee et al., 2025). This may be due to structural modifications of starch grains and partial disintegration of cell walls, which can improve the accessibility and digestibility of dietary fiber components (Pichaiyongvongdee et al., 2025; Ulfa et al., 2021).

The pre-gelatinization process also influences the content of compounds that act as antioxidants. Total phenolic, flavonoid, anthocyanin, and antioxidant activities have been reported to increase after the pre-gelatinization process involving steaming (Cakrawati et al., 2021; Pichaiyongvongdee et al., 2025; Ruttarattanamongkol et al., 2016). Thermal treatment can induce disturbances in the cell structure within the tuber tissue, thereby leading to the release and extraction of these compounds (Pichaiyongvongdee et al., 2025; Ruttarattanamongkol et al., 2016).

Table 2. Effect of the pre-gelatinization process on the anti-diabetic components of sweet potatoes

References	Study Design	Pre-gelatinized Product		Outcomes	Limitations
		Ingredients	Method		
Bedin et al. (2023)	In vitro	Raw purple sweet potatoes	Heat pressure (17 minutes)	Higher glucose, starch and rapidly digestible starch; lower slow digestible and resistant starch rather than raw flour	Inadequate description of material identification
Cakrawati et al. (2021)	In vitro	Raw purple sweet potatoes	– Steamed (30 minutes) – Dried (40 °C for 24 hours)	Higher phenolic, flavonoid, monomer anthocyanins and antioxidant capacity rather than raw flour	Inadequate description of material identification
Dos Santos et al. (2019)	In vitro	Sweet potato starch	Spray drying or extrusion	Amylose is not significantly affected	Potential bias and inadequate description of sample preparation
García-Martínez et al. (2024)	In vitro	Raw purple sweet potato	– Blanched (10 minutes) – Dried (55±5°C) – Extruded – Heating (90±5°C for 1 hour)	Lower antioxidant activity rather than raw purple sweet potato	Inadequate description of material identification

References	Study Design	Pre-gelatinized Product		Outcomes	Limitations
		Ingredients	Method		
Pichaiyongvongdee et al. (2025)	In vitro	Raw purple sweet potatoes	– Steamed (100°C for 10 minutes) – Soaked in cold water (90 seconds) – Dried (50°C for 15-20 hours)	Higher dietary fiber, phenolic, anthocyanin and antioxidant activity rather than raw flour	Inadequate description of material identification
Ruttarattanamongkol et al. (2016)	In vitro	Raw purple sweet potatoes	– Steamed (10 minutes) – Drum dryer (95 °C and 5 rpm)	Higher phenolic, anthocyanin and antioxidant activity rather than raw flour	Potential bias
Ulfa et al. (2021)	In vitro	Sweet potato starch	– Heated (59.53°C for 15 minutes) – Dried (50°C for 24 hours)	Higher starch and amylose rather than native starch	Inadequate description of material identification
Zheng et al. (2016)	In vitro	Purple sweet potato starch	– Heated (110°C for 40 minutes) – Stored (4°C for overnight) – Dried (60°C for 16 hours)	Higher amylose and starch resistant rather than native starch	Inadequate description of material identification and sample preparation

Different results have been observed for purple sweet potatoes processed through extrusion. The DPPH radical scavenging activity was 39.8±2.1 µmol TE/g DM and ABTS 28.2±1.7 µmol TE/g DM in raw purple sweet potatoes. However, in sweet potato extrudates, the DPPH was only 10.9±0.4 µmol TE/g DM and ABTS 15.5±0.2 µmol TE/g DM. Intense thermal and mechanical treatment during extrusion can lead to the degradation of phenolic compounds. This leads to a decrease in the antioxidant activity (García-Martínez et al., 2024).

The Impact of Fermentation on the Anti-Diabetic Potential of Purple Sweet Potato

The fermentation process may contribute to the antidiabetic properties of purple sweet potatoes. Incorporating this type of tuber into fermented dairy products has the potential to alter the anti-diabetic characteristics of the product. The effects of fermentation on the anti-diabetic components of sweet potatoes are presented in Table 3, while the effects of the addition of this tuber on the anti-diabetic potential of fermented dairy products are presented in Table 4.

In vitro studies

Studies have shown that fermentation may contribute to an increase in the antioxidant activity of purple sweet potatoes (Tong et al., 2024). This improvement is linked to an increase in phenolic and flavonoid levels through various mechanisms (Lee et al., 2021; Pan et al., 2023; Tong et al., 2024). During fermentation, microorganisms produce specific enzymes that decompose non-phenolic complex compounds into simpler phenolic compounds. Microorganisms can also produce secondary metabolites that contribute to increased total phenolic levels. In addition, microbial activity causes cell wall degradation, allowing previously bound bioactive compounds to be released (Mahardani & Yuanitas, 2021; Tong et al., 2024).

The results of this review show that the fermentation process affects anthocyanin and antioxidant activity (Lee et al., 2021; Tong et al., 2024). There was a decrease in anthocyanin levels caused by degradation due to the activity of the enzyme β-glucosidase produced by LAB. This enzyme hydrolyzes anthocyanins into simpler phenolic compounds (Tong et al., 2024). In addition, there is a decrease in pH due to the fermentation process, causing a division of glycosidic bonds in anthocyanins and the formation of anthocyanidins. This compound exhibits higher reactivity as an antioxidant than anthocyanins (Fitria & Wikandari, 2024). Although the fermentation process leads to a decrease in anthocyanin levels, it increases the bioaccessibility and bioavailability of anthocyanins (Tong et al., 2024). Thus, even though the anthocyanin content decreases, this compound still contributes to the increased antioxidant activity in fermented purple sweet potato products.

Table 3. Effect of fermentation on the anti-diabetic components of sweet potatoes

References	Study Design	Products	Microorganisms	Outcomes	Limitations
Lee et al. (2021)	In vitro	Fermented purple sweet potato extract	*Lactobacillus*	Higher phenolic and flavonoid; lower anthocyanin rather than unfermented extract	Inadequate description of material identification and sample preparation
Pan et al. (2023)	In vitro	Fermented sweet potato porridge	*Lactobacillus plantarum* or *Lactobacillus acidophilus*	Higher phenol; lower soluble dietary fiber and total sugar rather than unfermented porridge	Inadequate description of material identification
Tong et al. (2024)	In vitro	Fermented purple sweet potato juice	*Lactobacillus rhamnosus* GDMCC 1.1732 or *Streptococcus thermophilus* GDMCC 1.1808	Higher phenolic and flavonoid content, antioxidant capacity, bioavailability and bioaccessibility of phenolics and anthocyanins; lower anthocyanin content rather than unfermented juice	Inadequate description of material identification and sample preparation

Table 4. Effect of adding purple sweet potatoes on the anti-diabetic potential of fermented milk products

References	Study Design	Products	Microorganisms	Outcomes	Limitations
Júnior et al. (2024)	In vitro	Greek yogurt with 4% lyophilized purple fleshy sweet potato powder	*Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp bulgaricus*	Higher anthocyanin, phenolic and antioxidant activity rather than greek yogurt	-
Kilinç et al. (2025)	In vitro	Set yogurt with 2% lyophilized purple fleshy sweet potato powder	*Lactobacillus delbrueckii subsp. Bulgaricus* and *Streptococcus thermophilus*	Higher antioxidant activity and phenolic rather than yogurt set	Inadequate description of material
Supadil et al. (2024)	In vitro	Probiotic milk with 6% purple sweet potato flour	*Pediococcus acidilactici BK01*	Higher antioxidant activity rather than probiotic milk	Inadequate description of materials and presentation of the results
Khairani et al. (2022)	In vivo	Yogurt with 30% purple sweet potato puree	*Lactobacillus bulgaricus ATCC 11842, Lactobacillus acidophilus ATCC 4356,* and *Bifidobacterium longum*	Decreased levels of TNF-α and IL-6 in high-fat diet rats after 8 weeks of treatment	Limitations in reporting on randomization and blinding

The carbohydrate component of this tuber can be used as a substrate to support the growth of lactic acid bacteria (Tong et al., 2024). During the initial phase of fermentation, the starch of this tuber undergoes enzymatic hydrolysis, breaking down into glucose, fructose, and maltose. This simple sugar serves as an energy source for microbial growth and metabolic activity during fermentation. Consequently, the glucose content of the product decreased. However, this mechanism also causes a decrease in water-soluble dietary fiber. This is because these components are also fermented and metabolized by these microorganisms.(Pan et al., 2023).

The addition of purple sweet potato to fermented dairy products appears to increase the number of bioactive compounds with antioxidant activity. The addition of this ingredient can increase the total phenolic content and become a source of anthocyanins in yogurt production. The amount of these compounds increased with the number of sweet potatoes used. The high content of these various bioactive compounds in purple sweet potato yogurt provides greater antioxidant activity than yogurt that does not contain this tuber (Júnior et al., 2024; Kilinç et al., 2025; Supadil et al., 2024).

In vivo study

Khairani et al. (2022) examined the effects of purple sweet potato-fortified yogurt on oxidative stress in rats fed a high-fat diet for 8 weeks. The results showed that the purple sweet potato yogurt intervention significantly lowered the levels of pro-inflammatory cytokines, namely, TNF-α and IL-6, in the model. These findings are important because chronic inflammation characterized by increased TNF-α and IL-6 has been widely associated with impaired insulin signaling and the development of insulin resistance (Mahgoub et al., 2023)

Evaluating the Synergistic Effects of Pre-gelatinization and Fermentation on the Anti-Diabetic Potential of Purple Sweet Potato

The literature search conducted in this study did not reveal any studies that directly examined the effect of the combination of pre-gelatinization and fermentation processes on the anti-diabetic activity of purple sweet potatoes. However, based on the literature review that has been conducted, the combination of these two processes presents a promising approach to increase the antidiabetic potency of purple sweet potato. This increase in potency is primarily related to changes in the content of anthocyanins, phenolic compounds, dietary fiber, and resistant starches.

Pre-gelatinization disrupts the crystalline regions of starch, causing structural disruption in starch grains (He et al., 2023b; Ulfa et al., 2021; Ye & Baik, 2023). These physical modifications can affect the composition of the material, with results varying depending on the pre-gelatinization method. In the process involving Steaming increases the dietary fiber content of the flour produced. In addition, an increase in resistant starch can occur during retrogradation. These resistant dietary fibers and starches can act as prebiotics, supporting the survival of bacteria used in yogurt fermentation (He et al., 2019a; He et al., 2023b).

However, thermal treatments, such as pressure cooking, have been reported to elevate sugar content (Bedin et al., 2023). This is not expected in products for diabetes mellitus, as it can negatively impact blood glucose control. Fermentation can be a solution to this issue. Microorganisms can utilize simple sugars as energy sources during fermentation, thus contributing to a decrease in sugar levels in products (Pan et al., 2023). Thus, although pre-gelatinization can increase sugar levels, the fermentation process has the potential to reduce these levels.

From a clinical perspective, a combined processing approach to reduce the sugar content of products may be beneficial for developing foods for diabetes mellitus. Reducing simple sugars can help reduce post-meal blood glucose fluctuations and improve overall glycemic control. However, the magnitude of this effect requires further validation in human clinical studies.

The pre-gelatinization process involving steaming has also been shown to increase total phenolic and flavonoid levels, although it can be accompanied by a decrease in anthocyanin content (Pichaiyongvongdee et al., 2025; Ruttarattanamongkol et al., 2016). Fermentation can further improve the bioaccessibility and bioavailability of these compounds through the activity of lactic acid bacteria (Lee et al., 2021; Pan et al., 2023; Tong et al., 2024). This suggests that the combination of these two processes not only increases the amount of bioactive compounds but also their availability for absorption by the body.

Nevertheless, the results of this review should be interpreted with caution, given the heterogeneity between studies. Variations in the study design, treatment type, treatment method, and measured parameters may affect the reported results and limit direct comparisons between studies. In addition, the available research is still dominated by in vitro and in vivo studies in animals, with the absence of human studies. This limitation indicates that the available evidence is preliminary, not fully generalizable, and limited to clinical evidence in humans.

Conclusion

The pre-gelatinization and fermentation processes of yogurt have the potential to increase the anti-diabetic potential of purple sweet potato. The effect of pre-gelatinization on antidiabetic compounds varies depending on the method used, with steaming and retrogradation showing greater potential. In contrast, fermentation tends to lower sugar levels and increase the bioaccessibility and bioavailability of bioactive compounds. However, the available evidence remains limited.

Further research can be conducted on yogurt products incorporating pre-gelatinized purple sweet potato, followed by an evaluation of the bioactive compound content, nutrient composition, and sensory reception. Next, in vivo studies are required to assess the antidiabetic activity. Human clinical studies can be performed to evaluate metabolic responses such as insulin responses.

References

Akomolafe, S. F., Ajayi, O. O., Agboola, O. E., & Adewale, O. O. (2025). Comparative evaluation of the antidiabetic potential of three varieties of Ipomoea batatas L. *Toxicology Reports*, *14*, 102015. https://doi.org/10.1016/j.toxrep.2025.102015

Alkhatib, A., Tsang, C., Tiss, A., Bahorun, T., Arefanian, H., Barake, R., Khadir, A., & Tuomilehto, J. (2017). Functional foods and lifestyle approaches for diabetes prevention and management. *Nutrients*, *9*(12), 1–18. https://doi.org/10.3390/nu9121310

Antar, S. A., Ashour, N. A., Sharaky, M., Khattab, M., Ashour, N. A., Zaid, R. T., Roh, E. J., Elkamhawy, A., & Al-karmalawy, A. A. (2023). Diabetes mellitus: Classification, mediators, and complications; A gate to identify potential targets for the development of new effective treatments Samar. *Biomedicine & Pharmacotherapy*, *168*, 115734. https://doi.org/10.1016/j.biopha.2023.115734

Arisanti, C. I. S., Wirasuta, I. M. A. G., Musfiroh, I., Ikram, E. H. K., & Muchtaridi, M. (2023). Mechanism of Anti-Diabetic Activity from Sweet Potato (Ipomoea batatas): A Systematic Review. *Foods*, *12*(14), 1–16. https://doi.org/10.3390/foods12142810

Barengolts, E., Smith, E. D., Reutrakul, S., Tonucci, L., & Anothaisintawee, T. (2019). The effect of probiotic yogurt on glycemic control in type 2 diabetes or obesity: A meta-analysis of nine randomized controlled trials. *Nutrients*, *11*(3), 6–8. https://doi.org/10.3390/nu11030671

Bedin, A. C., Bach, D., da Silva Junges, M. F., Lacerda, L. G., & Demiate, I. M. (2023). Influence of Cooking Method on the in Vitro Digestibility of Starch from Sweet Potato Roots. *Brazilian Archives of Biology and Technology*, *66*, 1–11. https://doi.org/10.1590/1678-4324-2023230872

Britos, S., González, A. F., Marcó, F. F., Katz, M., Schuldberg, J., Torresani, M. E., & Vinderola, G. (2024). Yogurt, in the context of a healthy diet, for the prevention and management of diabetes and obesity: a perspective from Argentina. *Frontiers in Nutrition*, *11*, 1373551. https://doi.org/10.3389/fnut.2024.1373551

Cakrawati, D., Srivichai, S., & Hongsprabhas, P. (2021). Effect of steam-cooking on (Poly)phenolic compounds in purple yam and purple sweet potato tubers. *Food Research*, *5*(1), 330–336. https://doi.org/10.26656/fr.2017.5(1).407

Cheong, J. J., Ahmad, F., & Tengku Rozaina, T. M. (2022). Effects of cooking methods on physicochemical properties, antioxidant properties and sensory acceptability of purple sweet potato (Ipomoea batatas). *Food Research*, *6*(6), 257–266.

https://doi.org/10.26656/fr.2017.6(6).1008

Cho, N. H., Shaw, J. E., Karuranga, S., Huang, Y., da Rocha Fernandes, J. D., Ohlrogge, A. W., & Malanda, B. (2018). IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Research and Clinical Practice*, *138*, 271–281. https://doi.org/10.1016/j.diabres.2018.02.023

Dereje, B., Girma, A., Mamo, D., & Chalchisa, T. (2020). Functional properties of sweet potato flour and its role in product development: a review. *International Journal of Food Properties*, *23*(1), 1639–1662. https://doi.org/10.1080/10942912.2020.1818776

Dos Santos, T. P. R., Franco, C. M. L., Mischan, M. M., & Leonel, M. (2019). Improvement in spray-drying technology for preparation of pregelatinized cassava starch. *Food Science and Technology (Brazil)*, *39*(4), 939–946. https://doi.org/10.1590/fst.10418

Fathurrizqiah, R., & Panunggal, B. (2015). Kandungan Pati Resisten, Amilosa, dan Amilopektin Snack Bar Sorgum sebagai Alternatif Makanan Selingan bagi Penderita Diabetes Mellitus Tipe 2. *Journal of Nutrition College*, *4*(2), 562–569. https://doi.org/10.14710/jnc.v4i4.10163

Fitria, M. N., & Wikandari, P. R. (2024). Study on Antioxidant Activity of Purple Sweet Potato (Ipomoea batatas) Juice Fermented with Lactobacillus plantarum B1765. 1744, 846–853. https://doi.org/10.29303/jpm.v19i5.7286

Fliegerová, K. O., Mahayri, T. M., Sechovcová, H., Mekadim, C., Mrázek, J., Jarošíková, R., Dubský, M., & Fejfarová, V. (2024). Diabetes and gut microbiome. *Frontiers in Microbiology*, *15*(January), 1–18. https://doi.org/10.3389/fmicb.2024.1451054

García-Martínez, R. M., Rodiles-López, J. O., & Martínez-Flores, H. E. (2024). Nutritional Value and Antioxidant Capacity of Mexican Varieties of Sweet Potato (Ipomoea batatas L.) and Physicochemical and Sensory Properties of Extrudates. *Polish Journal of Food and Nutrition Sciences*, *74*(4), 376–386. https://doi.org/10.31883/pjfns/195146

Gijsbers, L., Ding, E. L., Malik, V. S., De Goede, J., Geleijnse, J. M., & Soedamah-Muthu, S. S. (2016). Consumption of dairy foods and diabetes incidence: A dose-response meta-analysis of observational studies. *American Journal of Clinical Nutrition*, *103*(4), 1111–1124. https://doi.org/10.3945/ajcn.115.123216

Goff, H. D., Repin, N., Fabek, H., Khoury, D. El, & Gidley, M. J. (2018). Bioactive Carbohydrates and Dietary Fibre Dietary fi bre for glycaemia control : Towards a mechanistic understanding. *Bioactive Carbohydrates and Dietary Fibre*, *14*, 39–53. https://doi.org/10.1016/j.bcdf.2017.07.005

Gofur, A., Arifah, S. N., Atho'illah, M. F., Ardiansyah, E., Sa'adah, N. A. M., Pratiwi, C. K. A., Mawarti, K., Witjoro, A., Lestari, S. R., Mas'udah, S., & Lelitawati, M. (2024). Evaluation of antioxidant properties from purple tubers and their ability to improve glucose and lipid metabolism in streptozotocin-induced diabetic rats. *Phytomedicine Plus*, *4*(2), 100542. https://doi.org/10.1016/j.phyplu.2024.100542

He, J., Han, Y., Liu, M., Wang, Y., Yang, Y., & Yang, X. (2019). Effect of 2 types of resistant starches on the quality of yogurt. *Journal of Dairy Science*, *102*, 3956–3964. https://doi.org/10.3168/jds.2018-15562

He, R., Li, S., Zhao, G., Zhai, L., Qin, P., & Yang, L. (2023). Starch Modification with Molecular Transformation, Physicochemical Characteristics, and Industrial Usability: A State-of-the-Art Review. *Polymers*, *15*, 2935. https://doi.org/https://doi.org/10.3390/polym15132935

Júnior, P. C. da C., Silva, M. T. de C., Barbosa, M. I. M. J., & Ferreira, E. H. da R. (2024). Application of lyophilized purple-fleshed sweet potato powder as a multifunctional ingredient in Greek yogurt. *Ciencia Rural*, *54*(3). https://doi.org/10.1590/0103-8478cr20220688

Kandhare, A. D., Thakurdesai, P. A., Wangikar, P., & Bodhankar, S. L. (2019). A systematic literature review of fenugreek seed toxicity by using ToxRTool : evidence from preclinical and clinical studies. *HLY*, *5*(4), e01536. https://doi.org/10.1016/j.heliyon.2019.e01536

Kayode, A. A. A., Adebodun, G. O., Fabunmi, D. I., & Kayode, O. T. (2023). Role of functional foods in the management of diabetes mellitus: a concise review. *Bioactive Molecules and Pharmaceuticals*, *2*(7), 29–42. https://doi.org/10.31989/bmp.v2i7.1132

Kemenkes RI. (2019). *Laporan Nasional Riskesdas 2018*.

Kemenkes RI. (2023). *Survei Kesehatan Indonesia (SKI)*.

Khairani, A. F., Atik, N., Rahman, P. H. A., Rohmawaty, E., Noviyanti, C., Santika, R., Arimathea, J., & Shalannandia, W. A. (2022). Purple Sweet Potato Yogurt Affects Lipid Metabolism and Reduces Systemic Inflammation and Oxidative Stress in High Fat Diet Mice. *Indonesian Biomedical Journal*, *14*(3), 252–260. https://doi.org/10.18585/inabj.v14i3.1921

Kilinç, M., Akarca, G., & Denizkara, A. J. (2025). Effect of Lyophilised Sweet Potato on the Quality and Nutritional Characteristics of Set Yogurt. *Food Science & Nutrition*, *13*, e70111. https://doi.org/10.1002/fsn3.70111

Kozłowska, A., & Nitsch-Osuch, A. (2024). Anthocyanins and Type 2 Diabetes: An Update of Human Study and Clinical Trial. *Nutrients*, *16*(11), 1674. https://doi.org/10.3390/nu16111674

Lee, S. G., Chae, J., Kim, D. S., Lee, J. B., Kwon, G. S., Kwon, T. K., & Nam, J. O. (2021). Enhancement of the Antiobesity and Antioxidant Effect of Purple Sweet Potato Extracts and Enhancement of the Effects by Fermentation. *Antioxidants*, *10*, 888. https://doi.org/10.3390/antiox10060888

Liu, J., Lu, W., Liang, Y., Wang, L., Jin, N., Zhao, H., Fan, B., & Wang, F. (2022). Research Progress on Hypoglycemic Mechanisms of Resistant Starch: A Review. *Molecules*, *27*, 7111. https://doi.org/10.3390/molecules27207111

Mahardani, O. T., & Yuanitas, L. (2021). Senyawa Fenolik Dan Aktivitas Antioksidan. *UNESA Journal of Chemistry*, *10*(1), 64–78. https://doi.org/10.26740/ujc.v10n1.p64-78

Mahgoub, M. O., Ali, I. I., Adeghate, J. O., Tekes, K., Kalász, H., & Adeghate, E. A. (2023). An Update on the Molecular and Cellular Basis of Pharmacotherapy in Type 2 Diabetes Mellitus. *International Journal of Molecular Sciences*, *24*(11). https://doi.org/10.3390/ijms24119328

Mi, W., Hu, Z., Zhao, S., Wang, W., Lian, W., Lu, P., & Shi, T. (2024). Purple sweet potato anthocyanins normalize the blood glucose concentration and restore the gut microbiota in mice with type 2 diabetes mellitus. *Heliyon*, *10*(11), e31784. https://doi.org/10.1016/j.heliyon.2024.e31784

Nabot, M., Garcia, C., Seguin, M., Ricci, J., Brabet, C., & Remize, F. (2024). Bioactive Compound Diversity in a Wide Panel of Sweet Potato (Ipomoea batatas L.) Cultivars: A Resource for Nutritional Food Development. *Metabolites*, *14*, 523. https://doi.org/10.3390/metabo14100523

Namazi, N., Esmaeili, S., Ahmadikhatir, S., Razi, F., Nasli-Esfahani, E., & Larijani, B. (2021). Nutrition and Diet Therapy in Diabetes Mellitus: A Roadmap based on available evidence. *Journal of Diabetes and Metabolic Disorders*, *20*, 1913–1918. https://doi.org/10.1007/s40200-021-00876-2

Naomi, R., Bahari, H., Yazid, M. D., Othman, F., Zakaria, Z. A., & Hussain, M. K. (2021). Potential effects of sweet potato (Ipomoea batatas) in hyperglycemia and dyslipidemia — A systematic review in diabetic retinopathy context. *International Journal of Molecular Sciences*, *22*(19), 1–21. https://doi.org/10.3390/ijms221910816

Nistor, M., Schmidt, M., Graul, I., Rakers, F., & Schiffner, R. (2019). A Systematic Review of Neuroprotective Strategies in the Management of Hypoglycemia. *Cvd*. https://doi.org/10.3390/ijms20030550

Noman, A. M., Sultan, M. T., Maaz, M., Mazhar, A., Tariq, N., Imran, M., Hussain, M., Mujtaba, A., Abdelgawad, M. A., Mostafa, E. M., Ghoneim, M. M., Selim, S., & Al Jbawi, E. (2025). Nutraceutical Potential of Anthocyanins: A Comprehensive Treatise. *Food Science and Nutrition*, *13*(5), 1–22.

https://doi.org/10.1002/fsn3.70164

Noreen, S., Niazi, M. K., Shehzadi, S., Ikram, A., Arshad, M. T., & Gnedeka, K. T. (2024). Extend the emphasis to encompass sweet potatoes health advantages, industrial applications, and nutritional qualities. *CYTA - Journal of Food*, *22*(1). https://doi.org/10.1080/19476337.2024.2390994

Pan, L., Zhang, C. J., Bai, Z., Liu, Y. Y., Zhang, Y., Tian, W. Z., Zhou, Y., Zhou, Y. Y., Liao, A. M., Hou, Y. C., Yu, G. H., Hui, M., & Huang, J. H. (2023). Effects of different strains fermentation on nutritional functional components and flavor compounds of sweet potato slurry. *Frontiers in Nutrition*, *10*, 1241580. https://doi.org/10.3389/fnut.2023.1241580

Perkeni. (2021). Pedoman Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 Dewasa di Indonesia 2021.

Pichaiyongvongdee, S., Rattanapun, B., Singkong, W., Chysirichote, T., Rasamipaiboon, N., & Phongsopa, J. (2025). The Effects of Preprocessing and Drying Methods on the Quality of a Nutritious Dried Soup Product Derived from Purple Sweet Potatoes and Chinese Kale Leaves. *Current Research in Nutrition and Food Science*, *13*(1), 271–289. https://doi.org/10.12944/CRNFSJ.13.1.18

Rosell, M. de los Á., Quizhpe, J., Ayuso, P., Peñalver, R., & Nieto, G. (2024). Proximate Composition, Health Benefits, and Food Applications in Bakery Products of Purple-Fleshed Sweet Potato (Ipomoea batatas L.) and Its By-Products: A Comprehensive Review. *Antioxidants*, *13*, 954. https://doi.org/10.3390/antiox13080954

Ruttarattanamongkol, K., Chittrakorn, S., Weerawatanakorn, M., & Dangpium, N. (2016). Effect of drying conditions on properties, pigments and antioxidant activity retentions of pretreated orange and purple-fleshed sweet potato flours. *Journal of Food Science and Technology*, *53*(4), 1811–1822. https://doi.org/10.1007/s13197-015-2086-7

Salas-Salvadó, J., Guasch-Ferré, M., Díaz-López, A., & Babio, N. (2017). Yogurt and diabetes: Overview of recent observational studies. *The Journal of NutritionJournal of Nutrition*, *147*(7), 1452S-1461S. https://doi.org/10.3945/jn.117.248229

Setiarto, R. H. B., & Widhyastuti, N. (2017). Pengaruh Fermentasi Bakteri Asam Laktat dan Siklus Pemanasan Bertekanan-Pendinginan Terhadap Kadar Pati Resisten Tepung Ubi Jalar Ungu (Ipomea Batatas Var Ayamurasaki) Termodifikasi. *Warta Industri Hasil Pertanian*, *34*(1), 26. https://doi.org/10.32765/wartaihp.v34i1.4069

Sivamaruthi, B. S., Kesika, P., Prasanth, M. I., & Chaiyasut, C. (2018). A mini review on antidiabetic properties of fermented foods. *Nutrients*, *10*(12), 1–18. https://doi.org/10.3390/nu10121973

Supadil, D., Melia, S., & Juliyarsi, I. (2024). Impact of Adding Different Sweet Potato Flour Types (Ipomoea Batatas L.) at Various Percentages on the Antioxidant Activity and Microbiological Quality of Probiotic Fermented Milk (Pediococcus acidilactici BK01). *Advances in Animal and Veterinary Sciences*, *12*(10), 1903. https://dx.doi.org/10.17582/journal.aavs/2024/12.10.1903.1910

Tong, Y., Wang, Z., Tong, Q., & Liu, Y. (2024). Effects of Lactic Acid Bacteria Fermentation and In Vitro Simulated Digestion on the Bioactivities of Purple Sweet Potato Juice. *Foods*, *13*, 4094. https://doi.org/10.3390/foods13244094

Ulfa, G. M., Putri, W. D. R., Fibrianto, K., & Widjanarko, S. B. (2021). Optimization studies on pre-gelatinized sweet potato starch influenced by temperature and time. *Food Research*, *5*(2), 25–30. https://doi.org/10.26656/fr.2017.5(S2).017

Wijaya, A., Muhandri, T., Hasanah, U., & Setiarto, R. H. B. (2024). Physical, Chemical, Fermentation and Enzymatic Modification Technology to Increase Resistant Starch and Improve Prebiotic Properties of High Carbohydrate Foods. *Reviews in Agricultural Science*, *12*, 377–400. https://doi.org/https://doi.org/10.7831/ras.12.0_377

Yang, S., Hu, W., Qiao, S., Song, W., & Tan, W. (2025). Advances in Processing Techniques and Determinants of Sweet Potato Starch Gelatinization. *Foods*, *14*, 545. https://doi.org/10.3390/foods14040545

Ye, S. J., & Baik, M. Y. (2023). Characteristics of physically modified starches. *Food Science and Biotechnology*, *32*(7), 875–883. https://doi.org/10.1007/s10068-023-01284-3

Zheng, Y., Wang, Q., Li, B., Lin, L., Tundis, R., Loizzo, M. R., Zheng, B., & Xiao, J. (2016). Characterization and prebiotic effect of the resistant starch from purple sweet potato. *Molecules*, *21*(7). https://doi.org/10.3390/molecules21070932