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Mango and banana derived resistant starch: Narrative review of biochemical mechanisms, human clinical evidence, and metabolic health

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Abstract

The global rise of obesity, type 2 diabetes mellitus (T2DM) and non-alcoholic fatty liver disease (NAFLD) now more commonly termed "metabolic (dysfunction)-associated fatty liver disease" (MAFLD) underscores the need for dietary carbohydrates that mitigate postprandial hyperglycaemia and insulin resistance. Tropical fruits mango (*Mangifera indica L.*) and banana (*Musa spp.*) emerge as sustainable sources of resistant starch (RS) types RS2 and RS3 alongside bioactive polyphenols. This review synthesizes biochemical, preclinical and human evidence on mango/banana-derived RS mechanisms within the gut-pancreas-liver axis, highlighting fruit-specific pathways, food matrix interactions and South Asian translational potential. Narrative synthesis of studies on RS classification, structural characterization, phytochemical profiles, glycaemic mechanisms (SCFA production, incretin secretion, epigenetic modulation), gut microbiota remodelling and human intervention trials was conducted. Evidence from mango kernel RS3, green banana RS2 and general RS meta-analyses were integrated with emphasis on Sri Lankan public health relevance. Mango yields retrograded RS3 via processing while green bananas provide native RS2 with B-type crystallinity. Both resist small intestinal digestion, promoting colonic fermentation to short-chain fatty acids (SCFAs) that activate G protein-coupled receptor 41/43 (GPR41/43), stimulate glucagon-like peptide-1 (GLP-1) and enhance insulin sensitivity via AMP-activated protein kinase (AMPK). Human trials demonstrate 15-40 g/day RS reduces fasting glucose, HbA1c and HOMA-IR, particularly in prediabetes/T2DM. However, evidence for mango- and banana-derived RS is predominantly indirect, based on whole fruit consumption studies and general RS meta-analyses rather than trials using isolated mango or banana RS. Nonetheless, mango and banana-derived RS exemplify sustainable functional food ingredients for glycaemic control through complementary structural forms (RS2 and RS3) and phytochemical synergies. Well-powered randomized controlled trials using standardized fruit RS with continuous glucose monitoring endpoints are needed, alongside sustainable byproduct utilization strategies for South Asian metabolic disease prevention.

Keywords: Resistant Starch, Mango, Banana, Glycaemic Control, Short-Chain Fatty Acids, T2DM, Gut Microbiota, polyphenols

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Introduction

The increasing incidence of obesity, T2DM and NAFLD worldwide has fuelled the search for types of dietary carbohydrates that can provide energy without having a deleterious effect on postprandial hyper-glycemia or insulin resistance. Beyond the absolute amount of carbohydrate intake, the quality of these macronutrients, especially with respect to their susceptibility or resistance to digestion, is considered the key determining factor in their metabolic effects. The physiological definition of resistant starch (RS) encompasses starch and starch degradation products that escape digestion in the small intestine. Through delayed glucose release and colonic fermentation to short-chain fatty acids (SCFAs), The RS regulates nutrition, microbiology and metabolic regulation (Bindels et al., 2015; Bonsembiante et al., 2021; Higgins, 2004).

Currently cereals and tubers are mainly considered for studies relevant to RS. However, tropical fruits offer underexploited yet culturally and agriculturally significant sources. Mango and banana are among the most widely cultivated fruits in South Asia, Africa and Latin America. Both fruits are significant contributors to caloric intake, rural livelihoods and food security across these regions. Notably, these two fruits generate RS in different structural forms conditional on maturity and processing (Agustiniano-Osornio et al., 2005; Khang et al., 2024; Koula et al., 2025; Kringel et al., 2020; Lagunes-Delgado et al., 2022; Liang et al., 2024; Moongngarm et al., 2014).

Mango pulp and kernels are rich sources of RS3 following cooking–cooling or heat–moisture treatments, whereas green bananas and their byproducts are natural sources of RS2. In these two cases, RS occurs alongside other bioactive compounds with demonstrated capacity to modulate carbohydrate digestion, gut microbiota composition, inflammation and insulin signalling (Liang et al., 2024; Maldonado-Celis et al., 2019; Pelissari et al., 2013; Rashed et al., 2022). By synthesizing two bodies of literature frequently treated in isolation, this review proposes a unified framework for tropical fruit-derived RS as functional food ingredients for metabolic health.

Methodology

Literature search strategy

A structured literature search was conducted to identify relevant studies for this narrative review. Search terms combined MeSH (Medical subject heading) terms and free-text keywords such as ‘resistant starch’, ‘mango starch’, ‘banana starch’, ‘unripe banana’, ‘mango kernel’, ‘glycaemic control’, ‘postprandial glucose’, ‘SCFA (Short-chain fatty acids)’, ‘gut microbiota’, ‘gut-liver axis’, ‘GLP-1 (Glucagon like peptide-1)’, ‘AMPK (AMP-activated protein kinase)’, ‘type 2 diabetes’ and ‘tropical fruits.’ Boolean operators such as AND, OR and NOT were applied to refine results. The search was limited to English-language peer-reviewed articles published from database inception through January 2026. Additional hand-searching of reference lists from relevant reviews and primary studies was performed to identify additional relevant peer-reviewed studies and seminal works.

Inclusion and exclusion criteria

Studies were included if they (1) Investigated RS classification, sources or mechanisms (2) Examined mango or banana-derived resistant starch (RS2/ RS3) content, processing effects, phytochemical profiles, or metabolic outcomes (3) Reported biochemical, physiological, microbiota or clinical data relevant to glycaemic control, insulin sensitivity, SCFA production or gut-liver axis modulation and (4) Included human, animal or in vitro studies. Exclusion criteria comprised non-English publications, conference abstracts without full text, studies lacking quantitative data on RS or glycaemic endpoints and reviews without primary data analysis. No restrictions were applied to study design, population or geography, prioritizing tropical fruit relevance.

Data synthesis

Evidence was analysed thematically based on types of resistant starch, source of tropical fruits, underlying biochemical processes, and outcomes. Since this paper is not a systematic review, but a narrative review, there was no need for any screening using PRISMA criteria, quantitative analysis, or risk-of-bias evaluation. This research aimed at integrating evidence about the use of resistant starch derived from mangoes and bananas and their potential roles in glycaemic control and metabolic health.

Ethics statement

Ethical approval was not required for this study as it is a review of published literatures.

Discussion

Resistant starch: classification and relevance to tropical fruits

Resistant starch (RS) is broadly defined as the fraction of starch that escapes digestion in the small intestine and reaches the colon intact. On the basis of their physicochemical properties and resistance mechanisms, starches are classified into five distinct categories (Table 1). RS1 refers to physically inaccessible starch, protected by intact cell walls or protein matrices coarsely ground grains are the most common example. RS2 describes native, ungelatinised granular starch characterised by B- or C-type crystallinity; raw banana, raw potato and high-amylose maize starch all fall into this category. Retro gradation of cooked and subsequently cooled starch produces RS3, the retrograded form that reassembles into densely packed crystalline structures during cooling. RS4 covers chemically modified starches such as cross-linked and octenyl succinate variants, while RS5 refers to amylose–lipid inclusion complexes, typically formed with fatty acids such as stearic acid (Birt et al., 2013).

Within this framework, mango and banana occupy quite different positions. Green banana starch is classified as RS2. The starch granules resist enzymatic breakdown because of their compact B-type crystalline arrangement and relatively high amylose content. Ripening changes this substantially endogenous amylases become active and progressively convert RS into free sugars, so by the time a banana is fully ripe its RS content has dropped sharply. This is why unripe

bananas, banana flour and byproducts such as peel and pseudostem are the preferred RS2 sources for any food application. Mango presents a different picture. The ripe pulp holds comparatively little RS, but the kernel does and because the starch there is amylose-rich, it retrogrades readily when thermally processed. Autoclaving, cooking–cooling cycling and extrusion all promote RS3 formation from mango kernel starch, sometimes dramatically. Evans et al. (2014) and Birt et al. (2013) documented this processing-dependent increase in resistant fraction. The two fruits therefore offer complementary rather than overlapping RS sources: one native and structurally stable, the other process-generated and retrograded.

Fermentation behaviour also differs between the two types. RS2 ferments slowly, releasing SCFAs gradually across a longer colonic segment. RS3 ferments at an intermediate rate but tends to produce more pronounced effects on postprandial blood glucose. What complicates any simple comparison is the food matrix. Soluble fibre and polyphenols present in both mango and banana appear to interact with RS, and some studies suggest the combined effect on glucose homeostasis exceeds what RS alone would predict (Baptista et al., 2024; Birt et al., 2013; Kaur et al., 2004). Whether this represents true synergy or simply additive contributions remains an open question.

Table 1: Types of resistant starch (RS)

Designation	Description	Example
RS1	Physically inaccessible starch	Coarsely ground or whole-kernel grains
RS2	Granular starch with the B- or C-type crystalline structure	High-amylose maize starch, raw potato, raw banana starch
RS3	Retrograded starch	Cooked and cooled starchy foods
RS4	Chemically modified starches	Cross-linked starch and octenyl succinate starch
RS5	Amylose-lipid complex	Stearic acid-complexed high-amylose starch

RS1, type I resistant starch; RS2, type II resistant starch; RS3, type III resistant starch; RS4, type IV resistant starch; RS5, type V resistant starch(Birt et al., 2013).

Nutritional and phytochemical profiles of mango and banana

Ripe mango pulp is not a starch-rich tissue moderate amounts are present alongside dietary fibre and phenolic compounds, particularly mangiferin, quercetin and gallic acid derivatives. The kernel is where starch concentrates. Mango kernels are routinely discarded in processing, yet their high amylose content makes them unusually well-suited to RS3 production. As shown in Table 2, native kernel starch yields approximately 5–15 g RS per 100 g dry weight; after heat-moisture treatment or extrusion this rises to 25–45 g. Processed mango pulp follows a similar trajectory, from 2–8 g natively to 15–40 g following retro gradation-inducing treatments. The trade-off is predictable: as RS content rises, rapidly digestible starch fractions fall, which lowers the glycaemic impact of the food matrix overall.

Mangiferin deserves specific attention here. It is a C-glucosyl xanthone found across mango tissues pulp, peel, kernel and leaf. and its biological activities are particularly relevant to glucose metabolism. Mangiferin is a competitive inhibitor of both α-amylase and α-glucosidase, the principal enzymes responsible for carbohydrate hydrolysis in the small intestine. Slowing these

enzymes delays glucose absorption from starch, a mechanism that operates alongside and independently of the physical resistance provided by RS3 (Akhter et al., 2024; Kaur et al., 2004; Maldonado-Celis et al., 2019; Mieles-Gómez et al., 2023). Antioxidant and anti-inflammatory properties add further layers to mangiferin's physiological relevance, and its anticancer and epigenetic effects have been studied separately (Selvakumar et al., 2022). Together, these activities position mango as more than a starch source the phytochemical and RS fractions appear to act on overlapping metabolic targets.

Green banana carries a far higher native RS2 load than mango. Table 2 shows 30–75 g per 100 g dry weight in green banana flour, increasing to 40–80 g after autoclaving or cooking–cooling cycles. Banana peel and pseudostem, typically treated as agricultural waste, contain 15–35 g native RS and up to 50 g following processing (Akhter et al., 2024; Moongngarm et al., 2014; Phillips et al., 2021). These numbers support valorisation of banana byproducts within circular food systems. Non-starch polysaccharides add to the dietary fibre content, while the phytochemical profile spans phenolic acids, flavonoids, sterols, saponins and alkaloids.

Quercetin and structurally related flavonols stand out among banana's polyphenols for their antidiabetic activity. They inhibit carbohydrate-digesting enzymes in a manner broadly comparable to mangiferin in mango, reducing the rate of glucose appearance in the circulation following a starchy meal. AMPK (AMP-activated protein kinase) activation is another documented pathway, relevant to both insulin sensitivity and lipid metabolism. When RS2 and these flavonols are co-delivered within the native banana matrix, preliminary evidence suggests the glycaemic benefits may be greater than either component alone immediate blunting of postprandial peaks combined with gradual improvements in insulin sensitivity over weeks of consumption (Agama-Acevedo et al., 2025; Arias-Córdova et al., 2021; De Mesa et al., 2025; Liang et al., 2024; Moongngarm et al., 2014; Munir et al., 2024; Phillips et al., 2021). Confirming this interaction in controlled trials using isolated banana RS remains a clear research gap.

Table 2: Resistant starch content in Mango and Banana Sources (g/100g dry weight)

Source	RS type	Native RS	Processed RS
Green Banana Flour	RS2	30-75	40-80*
Banana Peel/ pseudo stem	RS2	15-35	25-50*
Mango kernel starch	RS3	5-15	25-45**
Mango pulp (processed)	RS3	2-8	15-40**

*Autoclaving/cooling cycles; **Heat-moisture treatment/extrusion. Values represent typical ranges from previous studies and may vary depending on the cultivar, ripeness, processing conditions and analytical methodology (Akhter et al., 2024; Evans et al., 2014; Moongngarm et al., 2014; Phillips et al., 2021).

Biochemical and physiological mechanisms linking resistant starch to glycaemic control

Both mango-and banana-derived RS resist hydrolysis by pancreatic α-amylase lowering the rate and extent of glucose absorption in the small intestine. This delayed digestion lowers postprandial glucose peaks and insulin demand. Retrograded starch granules and polyphenol–enzyme interactions jointly hinder enzymatic access to Mango, whereas the compact granular

structure of RS2 plays a dominant role in banana (Adedayo et al., 2016; Arias-Córdova et al., 2021; Ble-Castillo et al., 2017).

As the undigested RS reaches the colon, it is fermented by saccharolytic bacteria such as *Bifidobacterium, Lactobacillus, Roseburia* and *Faecalibacterium*. Fermentation yields SCFAs-acetate, propionate and butyrate which act as metabolic signalling molecules. Butyrate serves as the primary energy source for colonocytes and enhances gut barrier integrity while propionate influences hepatic gluconeogenesis and acetate contributes to peripheral energy metabolism (Baptista et al., 2024; Bindels et al., 2015; Hutabarat et al., 2018; Zheng et al., 2026).

SCFAs bind to G-protein–coupled receptors on enteroendocrine cells, stimulating secretion of incretins such as glucagon-like peptide-1 (GLP-1) and peptide YY. GLP-1 enhances glucose-stimulated insulin secretion, suppresses glucagon release and delays gastric emptying, collectively improving glycaemic control. Resistant starch-induced incretin responses represent a key mechanism linking colonic fermentation to systemic glucose regulation (Agama-Acevedo et al., 2025; Bindels et al., 2015; Topping & Clifton, 2001).

Beyond receptor-mediated effects, SCFAs inhibit histone deacetylases, influencing gene expression related to insulin signalling, inflammation and lipid metabolism. Reduced expression of pro-inflammatory cytokines and improved insulin receptor substrate signalling have been observed in resistant starch interventions. Banana and mango polyphenols further attenuate oxidative stress and inflammatory pathways, reinforcing insulin sensitivity (Baptista et al., 2024; Bindels et al., 2015; Maldonado-Celis et al., 2019).

Gut microbiota, gut–liver axis and NAFLD

The gut–liver axis describes bidirectional communication between intestinal microbiota and hepatic metabolism via portal circulation, bile acids and immune signalling. Disruption of this axis contributes to insulin resistance and NAFLD. Resistant starch intake significantly reshapes gut microbiota composition, favouring SCFA-producing taxa and reducing endotoxin-producing bacteria. Concomitant strengthening of the intestinal epithelial barrier limits translocation of lipopolysaccharide (LPS) into the portal circulation, thereby attenuating hepatic inflammation. Studies across resistant starch sources in animals demonstrate the reduction of hepatic triglyceride accumulation, downregulation of lipogenic genes and upregulation of fatty acid oxidation pathways. (Ni et al., 2023; Zhu et al., 2022).

Resistant starch exerts many of its metabolic benefits indirectly through profound remodelling of the gut microbiota and downstream gut–liver axis signalling. Unlike digestible starches, resistant starch reaches the colon intact, where it serves as a selective substrate for saccharolytic bacteria. Both banana-derived RS2 and mango-derived RS3 consistently increase the abundance of butyrate-producing taxa such as *Faecalibacterium prausnitzii*, *Roseburia spp*. and *Eubacterium rectale*, while also promoting the growth of *Akkermansia muciniphila*, a mucin-degrading bacterium strongly associated with improved metabolic health (Bindels et al., 2015; Pugh et al., 2023).

Fermentation of resistant starch leads to elevated production of SCFAs, particularly acetate, propionate and butyrate. Butyrate plays a central role in maintaining intestinal epithelial integrity by serving as the primary energy source for colonocytes and enhancing tight junction protein expression (occludin, claudin-1and ZO-1). Strengthening of the gut barrier reduces translocation of lipopolysaccharide (LPS) into the circulation, thereby attenuating metabolic endotoxemia. Reduced LPS-TLR4 signalling dampens downstream NF-κB–mediated inflammatory cascades that otherwise impair insulin receptor signalling in liver and skeletal muscle (Arias-Córdova et al., 2021; Baptista et al., 2024; Bindels et al., 2015; Pugh et al., 2023; Topping & Clifton, 2001; Zhu et al., 2022).

Propionate derived from resistant starch fermentation is transported to the liver via the portal vein, where it modulates hepatic gluconeogenesis by inhibiting cholesterol synthesis and influencing substrate flux through the tricarboxylic acid cycle. Acetate, while more systemically distributed, contributes to peripheral lipid metabolism and appetite regulation through central mechanisms. Together, these SCFAs act as endocrine-like metabolites that connect colonic fermentation with whole-body glucose homeostasis.

Human evidence for glycaemic effects

Direct trials using isolated mango resistant starch remain limited. Evidence from whole mango consumption and mango-based products nonetheless provides useful indirect evidence. Clinical studies in prediabetic or overweight adults have demonstrated lower fasting glucose levels and improvements in insulin sensitivity, with reduced postprandial glucose responses and no weight gain noteworthy given the natural sugar content of mango. These findings indicate that the fruit matrix, resistant starch and polyphenols may collectively underpin the observed metabolic benefits (Basiri et al., 2025; Evans et al., 2014; Pett et al., 2025; Pinneo et al., 2020).

Studies examining green banana flour or banana-enriched food products consistently report improvements in postprandial glycaemia, satiety and lipid profiles. Although sample sizes are often modest, findings are concordant with evidence from broader RS research, demonstrating reductions in fasting glucose, insulin levels and markers of insulin resistance over intervention periods of weeks to months (Agama-Acevedo et al., 2025; Bindels et al., 2015; Munir et al., 2024; Pugh et al., 2023). Meta-analyses of randomized controlled trials across resistant starch sources show that daily intakes of 20-40 g of resistant starch reduce fasting glucose levels. They also help lower postprandial glucose excursions and markers of insulin resistance. These effects are more significant in individuals with impaired glucose tolerance or type 2 diabetes (T2DM) (Agama-Acevedo et al., 2025; Pugh et al., 2023).

Comparative perspectives of mango and banana derived resistant starch

Comparative analysis of mango and banana resistant starch reveals important differences in their origin, composition and translational potential. Green banana is a naturally rich source of RS2, which is present in the native starch granule and therefore requires minimal processing prior to consumption. In contrast, mango-derived resistant starch is predominantly obtained from kernels or processed pulp, where thermal treatments such as cooking-cooling cycles, autoclaving or heat-moisture treatment promote the formation of RS3. Consequently, banana-based resistant

starch may be more readily incorporated into dietary interventions, whereas mango resistant starch provides an opportunity for value addition to agricultural by-products.

The phytochemical profiles of the two fruits also differ. Mango contains substantial quantities of mangiferin and related phenolic compounds that exhibit antioxidant and carbohydrate enzyme-inhibitory activities. Banana contains flavonoids, phenolic acids and non-starch polysaccharides that contribute to antioxidant and metabolic benefits. Although both fruits appear to improve glycaemic control through common mechanisms involving delayed starch digestion, SCFA production and improved insulin sensitivity, the supporting evidence is stronger for banana-derived resistant starch. Human intervention studies involving green banana flour and banana-based products are more numerous, whereas direct clinical evidence for mango-derived resistant starch remains limited and often relies on studies of whole mango consumption. These observations highlight the need for additional randomized controlled trials specifically evaluating mango resistant starch preparations (Agama-Acevedo et al., 2025).

Evidence from human intervention studies

Human clinical studies investigating banana and mango-derived resistant starch uniformly demonstrate improvements in markers of glycaemic control. However, results can vary depending on the dose, the study duration and the participant's metabolic status. Acute intervention studies show that meals enriched with unripe banana flour or mango-resistant starch preparations significantly reduce postprandial blood glucose excursions and insulin responses compared to refined carbohydrate controls.

Direct trials using isolated mango resistant starch are limited. However, studies of whole mango consumption and mango-based products provide useful indirect evidence. For example, Evans et al. (2014) conducted a pilot study in which obese adults consumed 10 g/day of freeze-dried mango pulp (whole mango powder) for 12 weeks and showed significantly reduced fasting blood glucose without weight gain. This is indirect evidence for mango-derived resistant starch, as the study did not use isolated mango RS; rather, it used whole mango powder containing RS, polyphenols, fibre, and natural sugars. Therefore, the observed benefits may reflect the combined effects of these components, not RS alone. Clinical studies in prediabetic or overweight adults have also reported lower fasting glucose levels and improvements in insulin sensitivity, with reduced postprandial glucose responses and no weight gain (Basiri et al., 2025; Pett et al., 2025; Pinneo et al., 2020). These findings indicate that the fruit matrix, resistant starch and polyphenols may play an important role.

Through dietary modulation ranging from 4 to 12 weeks report reductions in fasting plasma glucose, improved homeostatic model assessment of insulin resistance (HOMA-IR) and consistent decline in glycated haemoglobin (HbA1c), mainly in individuals with impaired glucose tolerance or type 2 diabetes. Dose–response relationships suggest that daily resistant starch intakes of 15–40 g are necessary to achieve clinically meaningful effects, though tolerance and gastrointestinal comfort vary among individuals (Arias-Córdova et al., 2021; Pugh et al., 2023).

This evidence suggests that the differences in baseline gut microbiota composition which is specific to each individual strongly influence metabolic responsiveness to resistant starch

supplementation. Subjects with higher baseline abundance of "butyrate-producing bacteria" tend to exhibit greater improvements in insulin sensitivity. This highlights the importance of personalized nutrition approaches (Arias-Córdova et al., 2021; Basiri et al., 2025).

Discussion

Despite the promising findings reported across experimental and clinical studies, several limitations should be considered when interpreting the available evidence. Many human intervention studies investigating resistant starch involve relatively small sample sizes, short study durations and heterogeneous participant populations. Differences in resistant starch source, processing method, dosage and study design make direct comparison between studies challenging. Furthermore, many investigations assess surrogate metabolic markers such as fasting glucose, HOMA-IR and postprandial glycaemic responses rather than long-term clinical outcomes. Direct evidence specifically evaluating mango-derived resistant starch remains limited compared with banana-derived resistant starch. Consequently, some mechanistic conclusions are extrapolated from studies involving resistant starch from other botanical sources or whole-fruit interventions. In addition, individual differences in gut microbiota composition may influence responsiveness to resistant starch supplementation, contributing to variability in reported outcomes.

This narrative review also has limitations. The literature search was restricted to English-language publications and did not include formal systematic review procedures such as PRISMA-based screening or risk-of-bias assessment. Therefore, while the review provides an integrated overview of current knowledge, the findings should be interpreted as a narrative synthesis rather than a quantitative evaluation of evidence quality. As this review was conducted by a single author, article selection, interpretation and thematic synthesis were not independently verified, which may increase the possibility of subjective bias despite efforts to maintain a balanced assessment of the literature.

Safety, dosage & standardization

The RS demonstrates a favourable safety profile up to 40 g/day, though mild accumulation of gas (also known as flatulence) or bloating may occur during initial adaptation. Hence gradual dose escalation is recommended. Mango and banana allergies are rare. Traditional processing methods are safe, but nano-structured RS requires toxicity evaluation. Cultivar and ripeness variability demands standardized analytical methods for research and commercial use (Agama-Acevedo et al., 2025; Baptista et al., 2024; Pugh et al., 2023).

Translational and sustainability perspectives

From a long-term viability analysis, mango kernels and banana peels represent abundant agricultural byproducts with high RS potential. Their bioconversion into RS -rich flours or functional ingredients aligns metabolic health promotion with waste reduction and value addition. Regions such as Sri Lanka which have high mango and banana production and rising metabolic disease prevalence are well positioned to lead community-based intervention trials and product development. *Mangifera indica* and the Sri Lankan endemic *Mangifera zeylanica* have

demonstrated diverse pharmacological activities, including anticancer and epigenetic effects, supporting their broader therapeutic potential in South Asian populations (Selvakumar et al., 2022). In educational and research settings, these fruit systems offer accessible models for teaching carbohydrate chemistry, enzymology, microbiota analysis and functional food development, bridging biochemistry and public health nutrition (Akhter et al., 2024; Liang et al., 2024; Pugh et al., 2023).

Future perspectives and translational potential

Mango kernels and banana peels are abundant agricultural byproducts across Sri Lanka, offering sustainable RS sources suitable for development into functional flours that align bioactive preservation with non-communicable disease prevention. Well-designed community-based trials evaluating 15–40 g/day of standardized mango or banana RS using continuous glucose monitoring, HbA1c and markers of antioxidant status are warranted, alongside assessment of inter-individual variability in response (Akhter et al., 2024; Liang et al., 2024; Pugh et al., 2023).

Conclusion

Banana- and mango-derived RS represent promising functional food components capable of improving glycaemic regulation through multiple complementary mechanisms. Current evidence indicates that these effects are mediated through delayed carbohydrate digestion and glucose absorption, modulation of gut microbiota composition, SCFA-mediated hormonal signalling including GLP-1 secretion and epigenetic regulation of metabolic pathways associated with insulin sensitivity and hepatic glucose metabolism. While banana-derived RS currently possesses stronger clinical support, mango-derived RS offers considerable potential through the valorisation of underutilized agricultural by-products. Collectively, available evidence supports the inclusion of fruit-derived RS as a sustainable nutritional strategy for improving glucose homeostasis and reducing metabolic disease risk. Nevertheless, larger well-designed randomized controlled trials using standardized RS preparations are required to confirm efficacy, establish optimal dosage ranges and clarify long-term metabolic outcomes.

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Conflict of interest statement

The author declares no conflicts of interest.

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