International Journal of Science, Strategic Management and Technology
Volume **02** Issue **05** May-**2026** | ISSN: **3108-1762 (Online)** | Impact Factor: 3.8
An International, Peer-Reviewed, Open Access Scholarly Journal Indexed in recognized academic databases

A Review of Oziva ACV-Moringa Effervescent Tablets and its Potential Role in PCOS, Diabetes, and Hypertension

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https://doi.org/10.55041/ijsmt.v2i5.322

Cite this Article: Zahoor, I., Ansari, M., Kumar, N., Sharma, A. K. & Kaur, R. (2026). A Review of Oziva ACV-Moringa Effervescent Tablets and its Potential Role in PCOS, Diabetes, and Hypertension. International Journal of Science, Strategic Management and Technology, *02*(05). https://doi.org/10.55041/ijsmt.v2i5.322

ABSTRACT

The increasing prevalence of metabolic disorders such as obesity, insulin resistance, type 2 diabetes, and PCOS has driven interest in plant-based nutraceuticals with improved delivery systems. *Moringa oleifera* and apple cider vinegar (ACV) are widely recognized for their antioxidant, anti-inflammatory, and metabolic benefits. benefits. Recent advances have enabled their formulation into effervescent tablets, improving solubility, palatability, and user compliance compared to traditional forms. This review evaluates the scientific basis of *moringa*–ACV effervescent formulations, including products such as OZiva's metabolic blends. These systems enhance delivery. very thorough, rapid dispersion, and may overcome limitations of conventional methods. ACV and *moringa* intake. Mechanistically, their effects are linked to improved glucose metabolism, reduced inflammation, and antioxidant activity via pathways such as AMPK and NF-κB. However, despite strong mechanistic support, clinical evidence for combined formulations remains limited. This review highlights their therapeutic potential, formulation advantages, and safety considerations, while emphasizing the need for well-designed clinical trials to validate them.

Keywords: *Apple Cider Vinegar, Moringa Oleifera, Effervescent Tablets, Insulin Resistance, PCOS, Hypertension, Metabolic Syndrome, Functional Beverages*.

1. Introduction & Background

Metabolic diseases include type 2 diabetes, insulin resistance, and obesity. Metabolic syndrome, dyslipidaemia, and T2DM are important global health issues because of their ubiquity and have witnessed a significant increase in the last few decades (1). Effective pharmaceutical medications are available, such as statins, GLP-1 receptor agonists, and metformin, but adherence is often limited long-term by problems with adherence, side effects, and cost (2). This has resulted in a growing interest in the use of plants and nutraceutical-derived bioactives as supportive strategies for metabolic health, mainly because of their improved tolerability and multitargeted activity (3). Among them, moringa oleifera and apple cider vinegar (ACV) are the most studied nutraceuticals in this context (4). ACV is rich in acetic acid and has been reported in the literature to ameliorate postprandial glycemia, enhance insulin sensitivity, and regulate energy metabolism via activation of AMP-activated protein kinase (AMPK) (5). Meta-analyses have shown that regular consumption of vinegar may result in small reductions in body weight, fasting glucose, and lipids (6). Hypoglycaemic, anti-inflammatory, and antioxidant effects are associated with bioactive compounds like quercetin, chlorogenic acid, and glucosinolates in *Moringa oleifera* (7). These substances work by modifying the Nrf2 and NF-κB pathways, which reduces oxidative stress and enhances metabolic performance. ACV is mainly directed towards energy metabolism and glucose management, while moringa is directed towards anti-inflammatory and antioxidant properties. OZiva® ACV–Moringa effervescent tablets contain a modern form of these compounds. The ingredients in general include standardized ACV powder (~750 mg, ~6% acetic acid) and moringa extract. Some variants also contain other additives such as cinnamon (8). The effervescent route of administration improves palatability, increases dissolution, and may reduce gastrointestinal irritation compared to liquid vinegar (9). Functional supplement forms have also been associated with increased user

adherence (10). However, despite strong mechanistic support, formulation-specific clinical evidence is still lacking. Little information is available on effervescent forms, bioequivalency, and long-term safety, and most studies focus on specific constituents (11).

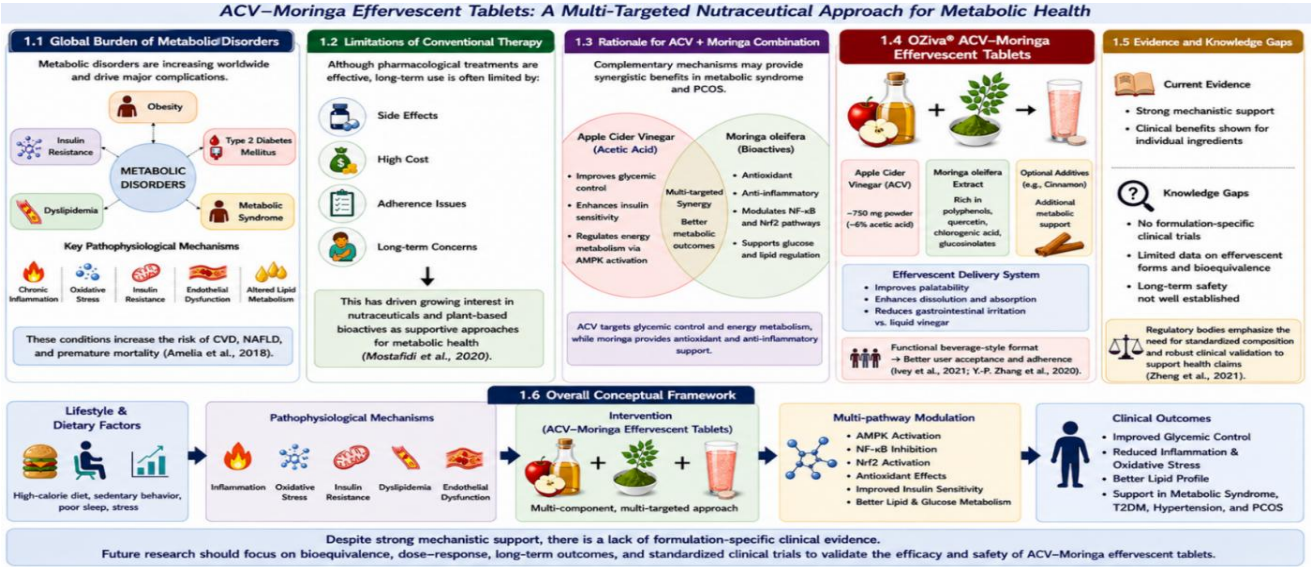

Figure 1. ACV-Moringa Effervescent Tablets for metabolic health

2. Phytochemistry, mechanism, and clinical evidence of apple cider vinegar.

2.1 Phytochemical Profile and Fermentation Process: Apple sugars are fermented by yeast to produce ethanol, which is then oxidized to acetic acid by species of Acetobacter to make apple cider vinegar (ACV). The mixture usually contains 4–6% acetic acid, which is the main active ingredient that produces the metabolic effects of the final product. ACV also contains amino acids, trace minerals, polyphenols (gallic acid, catechins, and chlorogenic acid), and organic acids (lactic acid and malic acid) (12). These substances may exert anti-inflammatory effects and antioxidant activity through modulation of oxidative stress pathways (13).

2.2 Mechanisms of action on metabolic regulation

2.2.1 Glycaemic control and insulin sensitivity: Numerous studies have been conducted on the role of ACV in glycaemic control. Acetic acid improves insulin sensitivity by increasing peripheral glucose absorption and reducing hepatic gluconeogenesis (14). This effect is achieved by stimulating AMP-activated protein kinase (AMPK), which controls the metabolism of carbohydrates and fats. ACV also delays gastric emptying, thus reducing postprandial glucose surges and slowing carbohydrate absorption (15). Clinical evidence suggests improvement in markers of insulin resistance and fasting glucose, especially in patients with T2DM.

2.2.2 Lipid Metabolism and AMPK Activation: ACV decreases triglyceride production by enhancing fatty acid oxidation and reducing lipogenesis via AMPK activation (16). Experimental studies demonstrate reductions in visceral fat and fat deposition in the liver. Human studies show modest improvements in cholesterol and triglycerides (17) (18).

2.2.3 Anti-Obesity Effects: Numerous animal studies have demonstrated that supplementation with acetic acid reduces fat formation. In human trials body weight, BMI, and waist circumference decrease slightly; meta-analyses demonstrate statistically significant but modest reductions in weight and cardiometabolic markers, suggesting ACV as a supportive rather than primary weight loss intervention.

2.3 Clinical Evidence and Meta-Analysis: For 8–12 weeks, clinical trials usually utilize 15–30 mL/day of ACV to measure body weight, lipid profile, fasting glucose, and HbA1c (19). Improvements in triglycerides, total cholesterol, and glycaemic management are suggested by meta-analytical data. However, the qualities and the composition of vinegar are different, and the heterogeneity of the studies remains considerable due to differences in dosage, duration and demographic characteristics. Importantly, most of the studies used liquid vinegar, which limits the direct application to pill or effervescent formulation (20).

2.4 Limitations of the Current Evidence: Despite the encouraging findings, the current evidence has limitations (21). These include the small sample size, short duration of the studies, and lack of long-term data. In addition, the variation in

acetic acid concentration and the lack of bioequivalence studies between the liquid and tablet dosage forms further limit the generalization power. ACV should therefore be viewed as an adjunct therapy to support metabolic disorder management, not as a stand-alone treatment (22).

3. Clinical evidence, human trials, dose standardization, safety profile, and critical appraisal (2020-2025)

3.1 Clinical Trials Evidence of Apple Cider Vinegar in Man: Evidence for apple cider vinegar (ACV) benefits for metabolic health has been corroborated by recent human trials and meta-analyses. A systematic review published in Frontiers in Nutrition in 2025 found that daily vinegar intake of 15–30 mL for 8–12 weeks led to significant improvement in insulin resistance (HOMA-IR) and reductions in fasting plasma glucose (23) (4). Similarly, a 2025 meta-analysis published in Nutrients found that waist circumference and body weight decreased little but significantly (~−1.2 kg) in overweight people (24) (2). Prior clinical studies have demonstrated that frequent consumption of vinegar leads to improved postprandial glycaemic responses and a slight reduction in HbA1c (9). However, variability in formulation, dose, and study methodology leads to heterogeneity that limits the conclusions that can be drawn.

3.2 ACV–Moringa Combined Formulations: Existing Evidence: With mounting evidence at the ingredient level, and clinical studies Physical assessment of the ACV-Moringa mixture combination is insufficient. There are some registered clinical trials ongoing, but peer-reviewed data is still not available (25)(25). Therefore, the present claims for such formulations are mainly established on extrapolation rather than direct clinical validation (21).

3.3 Considerations for dose standardization and formulation: Clinical studies have demonstrated that an ACV dose of 15 to 30 mL per day (≈750–1500 mg acetic acid equivalent) is effective. Effervescent pills aim to standardize this dosage and to improve compliance and palatability. Clinical dosages of *Moringa oleifera* are 500–2000 mg per day but the active phytochemicals are sometimes inconsistent (26). Effervescent formulations may improve solubility and decrease gastrointestinal irritation in comparison to liquid vinegar, although bioavailability is unknown (27).

3.4 Safety Profile and Adverse Effects: ACV is generally safe in moderate doses, but excessive consumption may lead to gastrointestinal upset, loss of dental enamel, and, in rare cases, hypokalaemia. However, a safety assessment states that long-term overconsumption may cause stomach discomfort (10). Few side effects have been reported and *moringa* supplementation appears to be well tolerated.

3.5 Critical Appraisal and Research Gaps: Despite the positive results, there are a number of limitations. One big concern is the disconnect between product-level validation and ingredient-level evidence. Most ACV studies are conducted with liquid formulations and in *moringa* studies there is sometimes a lack of phytochemical consistency, making extrapolation to effervescent (13).

4. Market Trends, Regulatory Landscape, and Translational Commercial Context

4.1 Growth of the Nutraceutical and Functional Markets: The launch of ACV-Moringa effervescent tablets is a sign of the tremendous growth of the global nutraceutical industry, driven by an increase in metabolic disorders and a growing desire for plant-based, preventive healthcare. One of the fastest-growing segments is botanical preparations for metabolic health (11). Approaches of "food as medicine" are gaining popularity among consumers, particularly for weight management and glycaemic control (28). Effervescent dosage forms can improve solubility, palatability, and compliance as compared to traditional dosage forms, thus increasing market attractiveness (27,29).

4.2 Scientific Drivers of Consumer Demand: There is a growing body of scientific evidence that is supporting the popularity of the ACV-Moringa products. Meta-analyses indicate that vinegar intake has a small effect on lipids and glycaemic control (9) (10) , primarily through AMPK activation (30). Similarly, *Moringa oleifera* is recognized for its anti-inflammatory, glucose-lowering, and antioxidant effects owing to its rich phytochemical composition (6,31).

4.3 Translational Value of Effervescent Delivery

Effervescent formulations improve the dissolution, absorption potential and gastrointestinal tolerance especially, for acidic substances, like ACV. They enhance flavour and convenience and also address compliance problems related to liquid vinegar (32). The ACV-Moringa effervescent tablets are the combination of the pharmaceutical formulation technology and the nutraceutical innovation (27).

4.4 Governance and Evidence Requirements

Market expansion notwithstanding, the regulatory requirements remain strict. For health claims, authorities such as the FDA, FSSAI, and EFSA demand safety validation, consistent composition, and verified clinical data (33–35). For ACV–Moringa formulations, this entails consistent acetic acid levels, validated *moringa* bioactives, and long-term safety data.

4.5 Branding and Market Sustainability Evidence-Based

Scientific validation is becoming more and more critical for long-term commercial success. Standardized formulas and clinical support with clear labelling show more customer trust and sustainability among evidence-based products. Regulators and consumers could question nutraceutical claims without solid data (36).

5. Clinical Implications and Positioning of Therapeutic and Safety Perspectives

5.1 Glycaemic Regulation and Metabolic Support:

Clinical trials have shown that ACV can modestly improve insulin and glucose sensitivity (9), mainly by activating AMPK (30). *Moringa oleifera* may also enhance glucose control by enhancing insulin secretion and decreasing oxidative stress (31).

Clinical implication: Effervescent tablets of ACV and *Moringa* can be used as adjuvant treatment for metabolic syndrome, insulin resistance, and prediabetes (37).

5.2 Lipid Profile and Cardiovascular Health: Intake of vinegar is associated with lower triglyceride and total cholesterol levels, and *moringa* has antioxidant and lipid-lowering effects.

Positioning: It may improve cardiometabolic health in mild dyslipidemia but cannot replace conventional treatments (38).

5.3 Antioxidant and Anti-inflammatory Effects: The polyphenols of *moringa* and phenolic components of ACV help to reduce inflammation and oxidative stress (13). But most of the evidence remains preclinical and needs further validation in humans.

5.4 Weight Management and Satiety: ACV may cause mild weight loss (~1-2 kg) and increase satiety through delayed gastric emptying.

Interpretation: Positive benefits and should be combined with lifestyle and nutrition changes.

5.5 Safety and risk considerations: ACV and *moringa* are usually well tolerated for short periods of use (6) But: Excessive ACV consumption can lead to dental erosion and gastrointestinal upset (15).

- Hypokalemia has been described in isolated cases.
- Possible interactions with medicines used to treat diabetes.
- There is a lack of data on the long-term safety of combination formulations (33).

5.6 Practical Therapeutic Positioning: ACV-Moringa effervescent tablets should be marketed as a dietary supplement to lifestyle modification, a preventive nutraceutical for at-risk individuals, and an adjunct to metabolic support (39). They are not to be used as a substitute for pharmaceutical medication for the treatment of diabetes or cardiovascular disease (40,41).

6. OZiva ACV–Moringa Effervescent Products: Product Profiling and Market Differentiation

6.1 Product Category Overview: Apple cider vinegar (ACV) has evolved from its traditional liquid form to a more convenient nutraceutical form in the shape of effervescent tablets (42). OZiva has purposefully positioned its ACV-Moringa products in the Indian market as a holistic solution for metabolic health and not as a single-ingredient supplement. This change is a sign of broader trends in nutraceutical innovation, where multi-component formulas are developed to simultaneously target various metabolic pathways (43). ACV is produced by a two-step fermentation where carbohydrates are converted to ethanol by yeast and then oxidized to acetic acid. Acetic acid has numerous metabolic benefits, especially in controlling glycaemic and lipid metabolism, based on clinical and meta-analytical data (44). However, the high acidity and flavour of liquid vinegar often limit long-term compliance. Effervescent delivery methods overcome these limitations, resulting in better palatability, increased dissolution, and uniform gastrointestinal dispersion, encouraging long-term adherence (45). OZiva formulas deliver more than ACV by adding *moringa oleifera* and other botanicals like cinnamon bark, guggul resin, and in some types, Gymnema sylvestre. This polyherbal approach simultaneously targets glycaemic control, appetite regulation, lipid metabolism, and oxidative stress, which is in line with a system-based approach to metabolic health (9).

6.1 OZiva ACV Moringa Green Apple for Craving Control: Ingredient Architecture & Label Composition: This formulation is specially formulated to help control hunger and cravings. It usually comprises an effervescent base (sodium bicarbonate and citric acid) and stevia as a non-glycemic sweetener, alongside 750 mg of ACV (standardized to approximately 6% acetic acid), *moringa* leaf extract, cinnamon bark extract, and guggul resin. Crucially, the lack of maltodextrin prevents an additional glycemic load and aligns with the metabolic health positioning (46).

Mechanistic Explanations

The formulation is based on complementary mechanisms:

- Acetic acid (ACV) acts to activate AMP-activated protein kinase (AMPK), promoting oxidation and reduction of lipogenesis (23).
- Clinical analyses support vitamin supplementation for reductions in fasting glucose and triglycerides (47).
- Bioactives such as quercetin and chlorogenic acid present in *Moringa oleifera* have antioxidant and glucose-lowering effects, and many clinical studies have shown modest improvements in glycaemic parameters (48).

Cinnamon extract has been shown to improve insulin sensitization by enhancing insulin receptor signalling and GLUT4 translation.

- Guggul resin contains guggulsterones, which may influence lipid metabolism through nucleus receptor modulation, though evidence to the contrary is variable (49).

6.2 OZiva Metabolic ACV-Moringa Effervescent Tablets: While the ingredients used in this formulation are similar, they are highlighted with a focus on metabolic lipid utilization and metabolic efficacy.

6.3 Flavour Variations and Consumer Acceptance: The variants such as green apple and lemon masala differ mainly in terms of flavour but have similar active ingredients. It is important to diversify flavour to ensure long-term adherence, as palatability is a strong predictor of continued use of the supplement. Research in functional foods shows optimization of taste greatly improves compliance and user satisfaction (50). Formulations of effervescent properties help in compliance through oral improvisation (51).

6.4 OZiva ACV Moringa Hot Mix Effervescent Tablets: With the addition of *Gymnema sylvestre,* this variant is also beneficial for glycaemic control. Gymnemic acids are known to reduce glucose absorption in the intestine and can increase the activity of pancreatic β-cells (52). Clinical research suggests that glycaemic indicators may improve for people with type 2 diabetes (53).

The addition of gymnema improves the glycaemic management profile of the formulation, and the hot-water delivery format may increase user comfort and dissolution efficiency, especially in colder climates (54).

6.5 Long-Term Compliance and Multi-Pack Strategy: OZiva also offers options for packaging like 15-60 tablets, which is the average intervention period of 8-12 weeks seen in scientific trials. Larger pack sizes may improve adherence, and continued intake is needed to achieve measurable metabolic goals (12).

6.6 Comparative Differentiation from Generic ACV Products: OZiva's ACV-Moringa formulations offer a number of unique features:

➢ **Effervescent Delivery Technology:** Effervescent methods help with dispersion, improve taste, and may encourage users to take the product more regularly than traditional liquid vinegar or capsules.

➢ **Multi-Botanical Synergy:** OZiva formulations contain multiple bioactives, while traditional ACV treatments contain only acetic acid:

- ACV to control blood sugar and cholesterol
- *Moringa's* anti-inflammatory and antioxidant properties (48).
- *Cinnamon* for Insulin Sensitivity
- *Guggul* as a lipid modulator (49).
- *Gymnema* for sugar management (53).
- This polyherbal approach increases the possible therapeutic spectrum and mechanistic (55)

3. Clean-Label Positioning: Stevia over high-glycaemic excipients such as maltodextrin supports health claims relating to metabolism and meets consumer demand for low-sugar formulations.

4. Consumer-centric Design: Unlike traditional vinegar consumption, effervescent nutraceuticals improve taste, ease of use, and integration into daily hydration routines, increasing real-world usability and adherence.

7. Clinical and Mechanistic Assessment of *Moringa oleifera* and Apple Cider Vinegar in Type 2 Diabetes Mellitus, Hypertension,andPolycysticOvarySyndrome

7.1 Diabetes Type 2 (T2DM)

7.1.1 Global Burden and Molecular Pathophysiology: T2DM is a major metabolic disease of worldwide significance. It is characterized by insulin resistance, progressive β-cell dysfunction, oxidative stress, and chronic low-grade inflammation. Chronic hyperglycemia leads to micro- and macrovascular complications through endothelial dysfunction, inflammatory signalling, and advanced glycation end products (AGEs). At the molecular level, impaired insulin receptor substrate (IRS-1) signalling reduces the activity of PI3K, which limits the translocation of GLUT-4 and uptake of glucose by peripheral tissues. At the same time, the dysregulated expression of PEPCK and FOXO1 increases hepatic gluconeogenesis. Inflammatory mediators such as TNF-α and IL-6 are examples of insulin resistance exacerbators (56)**.** Given the multifactorial pathogenesis, multi-target nutraceutical strategies, such as the combination of acetic acid with polyphenol-rich botanicals, are increasingly being investigated as adjunctive treatments.

7.1.2 Apple Cider Vinegar for T2DM

7.1.2.1 Mechanism of molecular action: The major active ingredient of ACV is acetic acid, which activates AMP-activated protein kinase (AMPK), a key regulator of cellular energy metabolism. AMPK activation increases glucose uptake by skeletal muscle, decreases hepatic gluconeogenesis, and increases fatty acid oxidation. These effects are less pronounced but show molecular similarities with metformin. Vinegar may also reduce postprandial glucose excursions by delaying gastric emptying. This dual mechanism supports its function in glycaemic regulation (14).

7.1.2.2 Evidence From Randomized Controlled Trials and Meta-Analyses: Meta-analytical data support metabolic advantages of ACV. Subsequent to supplementing with vinegar, a full review discovered significant reductions in fasting plasma glucose, small reductions in HbA1c, and improvements in triglyceride levels. Additional pooled analyses confirm the improvements in glycaemic and lipid parameters, especially in subjects with high baseline glucose. But heterogeneity is influenced by variation in study design, vinegar composition, and duration.

7.2.3 Postprandial Glycemic Control and Cardiovascular Risk: Postprandial hyperglycemia is an independent contributor to endothelial dysfunction and cardiovascular risk. It has been shown that eating vinegar before a carbohydrate-rich meal helps to blunt the post-meal glucose spikes. There is no long-term data on cardiovascular outcomes, though reduced variability in blood glucose levels may indirectly decrease oxidative stress and vascular damage (57)**.**

7.1.2.4 Critical Appraisal: The evidence for ACV in T2DM shows strong mechanistic plausibility and consistent improvement in short-term glycaemic control. Limitations were small sample sizes, short duration of interventions (≤12 weeks), and lack of studies on standardized formulations, especially effervescent tablets.

Research gap: No large-scale RCTs on standardized ACV effervescent formulations.

7.2 T2DM and *Moringa oleifera*

7.2.1 Phytochemical and Mechanistic Basis: *Moringa oleifera* leaves are a good source of bioactive compounds, including quercetin, chlorogenic acid, kaempferol, and isothiocyanates. These compounds have antioxidant, anti-inflammatory, and glucose-lowering effects. Mechanistically, *moringa* protects β-cell function by inhibiting the carbohydrate-degrading enzymes (α-amylase and α-glucosidase), augmenting insulin secretion, and reducing oxidative stress. Moreover, modulation of NF-κB signalling reduces the release of inflammatory cytokines (58)**.**

7.2.2 Clinical Evidence in T2DM: Clinical trials are supporting the metabolic benefits of *moringa*. In a randomized controlled trial, 2 g of *moringa* leaf powder every day significantly reduced fasting glucose, HbA1c and lipid parameters. Other studies suggest supplementation improves inflammatory markers and insulin resistance (HOMA-IR) (59)**.**

7.3 Hypertension

7.3.1 Pathophysiological Background: Hypertension is characterized by endothelial dysfunction, decreased availability of nitric oxide, activation of the renin-angiotensin-aldosterone system (RAAS), and oxidative stress. Additional factors contributing to vascular stiffness and sympathetic overactivity include insulin resistance.

7.3.2 ACV and Blood Pressure: Meta-analyses suggest that vinegar consumption may result in small reductions in systolic blood pressure (~3–6 mmHg). Proposed mechanisms include activation of AMPK, improvement of endothelial function, and reduction of oxidative stress. But hypertension-specific trials are still few and far between

7.3.3 *Moringa* and Vascular Function: Antioxidant properties of *moringa* may reduce oxidative stress and improve vascular elasticity. Data from experiments and clinical studies indicate that endothelial function and arterial stiffness improve

7.4 Polycystic Ovarian Syndrome or PCOS

7.4.1 Pathophysiological Overview: PCOS is defined by insulin resistance, hyperandrogenism, chronic inflammation, and ovarian dysfunction. Hyperinsulinemia also increases the production of androgens, leading to infertility and irregular periods.

7.4.2 ACV in PCOS: Acetic acid activates AMPK, which opens the possibility of insulin-sensitizing effects relevant to PCOS, although there is little direct clinical evidence supporting this (30)**.**

7.4.3 PCOS and *Moringa*: Preliminary research suggests that *moringa* may improve inflammatory markers and insulin resistance. Limited data exist due to small sample sizes, lack of standardized procedures, and lack of reproductive outcome measures.

7.5 Strength of Evidence – Comparison

Table 1: Comparative Strength of Evidence

Condition	Evidence Strength	Mechanistic Support	Clinical Trial Quality
T2DM	Moderate	Strong	Moderate
Hypertension	Low–Moderate	Moderate	Limited
PCOS	Low	Theoretical	Very Limited

The evidence base is strongest for T2DM and remains for PCOS. largely exploratory

7.6 Translational Relevance to Effervescent ACV-Moringa Formulations: Effervescent delivery systems offer several practical advantages such as improved palatability, standardized dosing, reduced mucosal irritation, and improved dissolution. These features may improve compliance and facilitate regular consumption.

8. Safety, Adverse Effects, Toxicological Evaluation, and Herb-Drug Interactions of Apple Cider Vinegar and Moringa oleifera

8.1 Importance of Safety Evaluation in Nutraceutical Formulations:

Although nutraceuticals are of natural origin, they require rigorous safety evaluation, especially when intended for long-term use in chronic diseases such as type 2 diabetes mellitus (T2DM), hypertension, obesity, and polycystic ovary syndrome (PCOS). Gastrointestinal tolerance, electrolyte balance, hepatic and renal safety, endocrine effects, and potential herb-drug interactions need to be evaluated for continuous consumption. Meta-analysis data suggests that apple cider vinegar (ACV) can reduce fasting glucose and triglycerides, implying biologically active effects that may interfere with pharmacological therapies. Similarly, Moringa oleifera exhibits hypoglycemic and lipid-modulating properties, which calls for a structured toxicological evaluation. The additive pharmacodynamic effects in combination formulations (e.g., ACV-Moringa effervescent tablets) further emphasize the need for safety evaluation (60)**.**

8.2 Apple Cider Vinegar (ACV) Safety Profile

8.2.1 Gastrointestinal Effects: ACV typically contains 4-8% acetic acid, and over-intake may cause gastric irritation, nausea, esophageal discomfort, and delayed gastric emptying. While delayed gastric emptying improves glycaemic control, it may exacerbate symptoms in gastroparetic patients. Effervescent formulations have the potential to reduce mucosal irritation by prediluting acetic acid in water and limiting direct contact (6)**.**

8.2.3 Electrolytes and hypokalemia Disturbance: Rare cases of hypokalemia and decreased bone mineral density have been reported with excess long-term consumption of vinegar. Proposed mechanisms include increased renal excretion of potassium and mild metabolic acidosis. However, controlled trials have not shown significant electrolyte disturbances at standard doses. For instance, no clinical metabolic studies (9).

No clinically significant changes in serum potassium were observed. Caution is, however, advised in patients with renal impairment, electrolyte imbalance or those on diuretics.

8.2.4 Hepatic safety: In short-term clinical studies (8–12 weeks), significant elevations in liver enzymes are not reported with ACV supplementation. However, data on long-term hepatic safety remain limited.

8.2.5 Drug Interactions: ACV may interact additively due to its glucose-lowering effect with antidiabetic medications such as insulin, sulfonylureas, and metformin, potentially increased risk of hypoglycemia. Interactions with

antihypertensive drugs & potassium-depleting diuretics. tics can also be theoretically possible. Evidence of reductions in fasting glucose supports cautious co-administration **(Vazquez-Cervantes et al. 2021).**

Research gap: Lack of formal pharmacokinetic and herb-drug interaction studies.

8.3 Toxicological Assessment of Moringa oleifera

8.3.1 General Safety Profile: Moringa oleifera leaves are consumed widely and generally considered safe. Clinical evaluations have shown good tolerability of the leaf powder up to 8 g/day doses, with only mild gastrointestinal effects, such as diarrhea, flatulence, or discomfort, being reported (61)**.**

8.3.2 Hepatic and Renal Safety: Supplementation has not been linked to significant hepatotoxicity in human studies, with no significant elevation of liver enzymes in metabolic populations. Animal studies have suggested potential hepatic effects only at doses far in excess of typical human intake, indicating a relatively wide safety margin. However, data on long-term safety in humans are limited.

8.3.4 Herb–Drug Interactions: *Moringa's* hypoglycemic effect can potentiate the action of antidiabetic drugs, and care should be taken to avoid hypoglycemia. The vitamin K content may also have a theoretical interaction with anticoagulant therapy, but the clinical evidence is limited.

8.4 Safety of Combined ACV–Moringa Formulations: Currently, there are no large-scale randomized controlled trials investigating the long-term safety of combined ACV-Moringa effervescent formulations. Possible additive effects are enhanced glucose lowering, mild hypotensive responses, and gastrointestinal sensitivity. ACV has shown evidence of glycaemic effects, and moringa has shown evidence of metabolic activity. The combined formulations may increase both the therapeutic and adverse effects..

A major limitation is the absence of formulation-specific pharmacovigilance data.

8.5 Safety Concerns and Dose Dependence: The usual clinical doses are 15 to 30 mL per day of ACV and 2 to 8 grams per day of moringa leaf powder. Effervescent tablets generally provide a lower, standardized, equivalent dose, which may be better tolerated and safety margins. However, the majority of the available data is limited to short-term interventions (8 to 12 weeks), and the effects of long-term exposure are unclear.

8.6 Special Needs Populations

8.6.1 Pregnancy and Lactation: Clinical data are not sufficient to recommend use or avoidance of this drug in pregnancy and lactation.

8.6.2 Chronic kidney disease: Caution is advised in patients with renal impairment due to rare reports of hypokalemia associated with high vinegar intake (9)**.**

8.6.3 Elderly People with Polypharmacy: The risk of herb-drug interactions is greater, and therefore careful monitoring of supplementation is imperative.

9. OZiva-Based Moringa–ACV Effervescent Tablets: Market, Product Differentiation, and Translational Positioning

9.1 Global Nutraceuticals Market Context:

The emergence of apple cider vinegar (ACV) supplements is indicative of broader trends within the nutraceutical industry, with effervescent formats and functional liquids slowly replacing traditional capsules. The switch is driven by improved bioavailability, convenience and consumer interest in targeted health solutions. The global nutraceutical industry is expected to grow at a CAGR of over 8% through 2030. This move to more sophisticated distribution methods is also supported by scientific research. Consumers like formats that are easy to consume, multi-ingredient combinations, and condition-specific formulas. In line with this trend, ACV has developed from liquid vinegar to modern dosage forms such as candies and effervescent tablets. Market Landscape, Product Differentiation, and Translational Positioning of OZiva-

BasedMoringa–ACVEffervescentTablets(62).

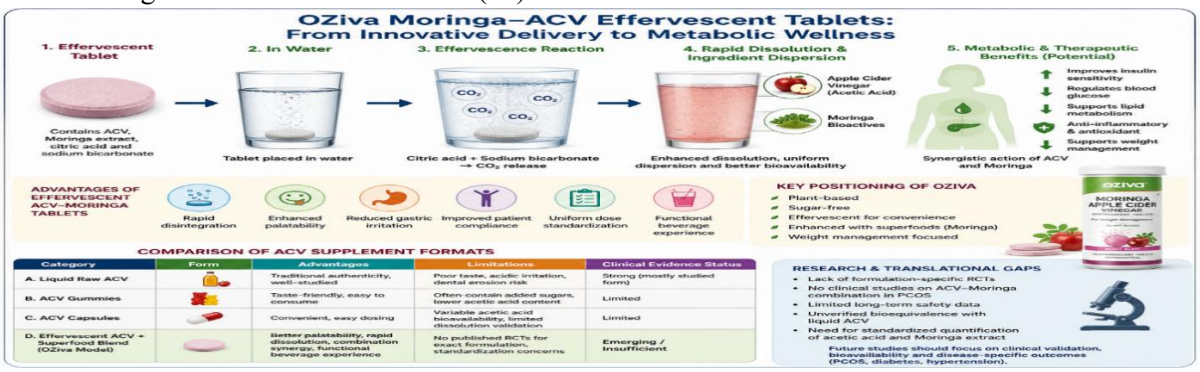

Figure 2. The mechanism of effervescent tablet dissolution

9.3 ACV Supplement Evolution: The traditional use of ACV as a diluted liquid was restricted by inconsistent dosage, unpleasant taste, and acidity-induced irritation. These problems are addressed in modern formulations like effervescent tablets, gummies, and capsules (6)**.** Moderate glycaemic effects have been demonstrated in clinical studies, but most of the research is based on liquid vinegar rather than tablet formulations. There is therefore a gap between the clinical evidence and the products on the market.

9.4 OZiva's Formulation Strategy: OZiva's effervescent ACV tablets are sugar-free, plant-based, and infused with *moringa*; it is a convenient functional beverage for weight
management. This is consistent with present nutrition trends emphasizing plant-based branding, clean-label products, and specific health benefits (18)**.**

9.5 Product Differentiation in ACV Market

Table 2. Product Differentiation in the ACV Market

Category	**Format**	**Advantages**	**Limitations**
Liquid ACV	Traditional	Authentic, minimally processed	Poor taste, acidity issues
Gummies	Palatable	Easy to consume	Added sugars, less efficacy
Capsules	Convenient	Simple dosing	Variable bioavailability
Effervescent +Superfood (OZiva)	Functional beverage	Better taste, synergy, convenience	Limited clinical validation

There are no clinical trials specific to OZiva's formulation, but it does stand out in terms of palatability and synergy of multiple ingredients.

9.6 Growth of Women's Health and PCOS: Supplements for PCOS are becoming more and more popular. The anti-inflammatory properties of moringa further strengthen the theoretical basis of the action of ACV in improving insulin sensitivity. However, there are no direct clinical trials for the ACV–moringa combination in PCOS; thus, the present claims are mechanistically plausible but not clinically substantiated.

9.7 Trend and Consumer Behaviour of Functional Beverages: Functional beverages are becoming more and more popular, and effervescent nutraceuticals are a great addition. Research has shown that consumers are attracted to liquid supplements and find them effective, leading to better compliance. This trend is also supported by sensory experience and perceptions of health with respect to hydration (63)**.**

9.8 Regulatory and Standardization Issues: Commercial ACV products are often not well standardized, with unclear levels of botanical extracts and acetic acid. The lack of pharmacokinetics and dose-response data further impacts reliability and safety. Thus, products with the same labels may be very different in composition and effectiveness (15)**.**

9.9 Critical Market Assessment: OZiva leads in combination formulation, clean-label positioning, and innovative delivery. Cons Are you sure it is the same as liquid ACV? There are no clinical studies on this formulation. Long-term safety data is lacking.

9.10 Translational Research Opportunities: Future studies should concentrate on bioavailability, clinical validation, and disease-specific outcomes such as PCOS, diabetes, and hypertension. "This is a great opportunity for industry and academia to collaborate."

10. Integrated Molecular and Metabolic Mechanistic Pathways of ACV–Moringa Combination

10.1 Mechanistic Basis of Apple Cider Vinegar and Metabolic Control: The primary mechanism of action of apple cider vinegar (ACV) is the activation of AMP-activated protein kinase (AMPK), a key regulator of cellular energy balance, through acetic acid. Activation of this leads to increased glucose uptake, decreased gluconeogenesis, and increased insulin sensitivity (6). Acetic acid raises the AMP/ATP ratio, resulting in AMPK phosphorylation, which then inhibits lipogenesis, increases β-oxidation, and reduces fatty acid production. Thus, ACV acts directly on the metabolic disorders at the level of the cellular energy regulation.

10.2 Modulation of the gut microbiome: Acetic acid may also modulate the gut microbiota composition and thus influence metabolic health. It helps produce short-chain fatty acids (SCFAs) that stimulate GLP-1 release, which helps with glucose homeostasis, better insulin sensitivity, and appetite regulation. These effects are mediated by free fatty acid receptors (FFAR2/3), suggesting that ACV may act in part via the gut-metabolic axis (6)**.**

10.3 Molecular mechanisms of Moringa oleifera: Quercetin, chlorogenic acid, and isothiocyanates are some of the bioactive substances in Moringa oleifera with potent anti-inflammatory and antioxidant properties. These compounds modulate crucial signalling pathways, including Nrf2 activation and NF-κB inhibition, leading to reduced oxidative stress and improved insulin signalling and metabolic balance. These pathways improve its contribution to the regulation of inflammation-induced metabolic abnormalities (6)**.**

10.4 Synergistic Pathway Integration (ACV + Moringa): ACV and moringa act synergistically to alter complementary biochemical pathways providing a multi-targeted synergistic effect.

Table 3. Synergistic Pathway Integration (ACV + *Moringa*)

Pathway	**ACV Effect**	***Moringa* Effect**	**Combined Outcome**
AMPK activation	direct activation	Indirect support	Enhanced metabolic regulation
Oxidative stress	Mild reduction	Strong antioxidant action	Reduced ROS burden
Inflammation	Moderate Effect	NF-κB Inhibition	Lower chronic inflammation
Lipid metabolism	Improved	Improved	Synergistic lipid lowering
Gut hormones	GLP-1 modulation	Microbiome support	Better appetite & insulin control

10.5 Relevance to PCOS and metabolic syndrome polycystic ovaries:

PCOS is associated with metabolic dysfunction, which is characterized by insulin resistance, oxidative stress, chronic inflammation, and hormonal imbalance. Targeting of metabolic pathways is significant, as insulin resistance is a major feature of the pathophysiology of PCOS. Mechanistically, the combination is promising for the treatment of PCOS, as ACV may increase insulin sensitivity and *moringa* may decrease oxidative stress, inflammation, and glucose utilization (6)**.** However, there are no direct human studies done on this combination so far. It is important to note, that molecular plausibility does not mean clinical efficacy.

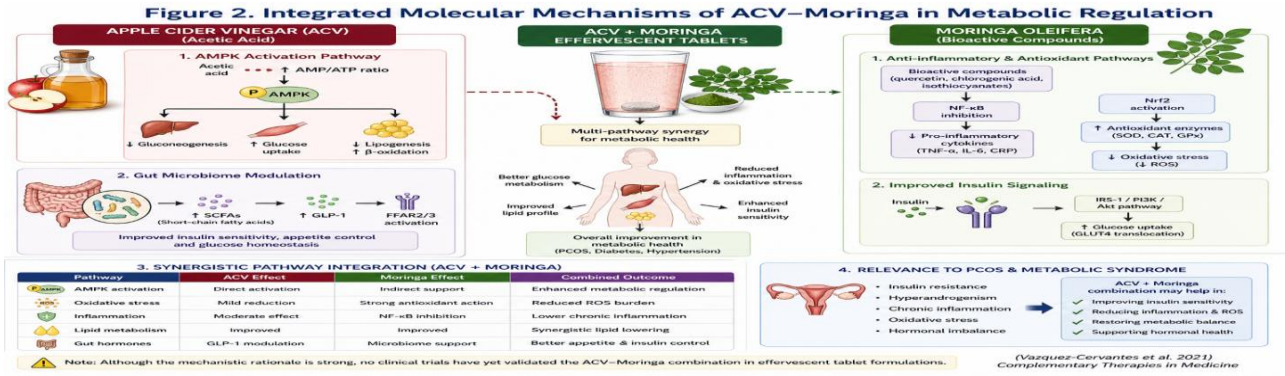

Figure 3. Integrated molecular mechanisms of ACV-Moringa on metabolic regulation

11. Research Gaps and Future Trial Design

11.1 No Standardization: Most commercial products do not report the exact concentration of acetic acid. Polyphenol measurement and standardized *moringa* extract percentage. This gap in regulation reduces reproducibility. Future studies should quantify the levels of isothiocyanates, quercetin, total phenolic content, and acetic acid (mg/tablet)

11.2. Randomized Controlled Trial Design: A double-blind placebo-controlled study was designed comparing ACV-moringa effervescent tablets, liquid ACV, and placebo for 12-24 weeks in women with PCOS or prediabetes. Other important outcomes would be insulin resistance, glucose control, and HbA1c plus lipid profiles, inflammatory markers, and hormonal changes as well as liver, kidney, and electrolyte safety monitoring (64)**.**

11.3 Long-term Safety Surveillance Gap: Most trials are less than 12 weeks. Long-term (>1 year) evaluation of chronic metabolic disorders is necessary. Nutraceutical pharmacovigilance registries are still immature.

11.4 Market Claims vs. Evidence Gap

Table 4: Market Claims vs Evidence Gap

Marketing Claims	**Scientific Evidence Gap**
“Fat burner"	Limited clinical evidence to support significant fat loss effects
“PCOS solution”	No formulation-specific RCTs are validating efficacy in PCOS management.
“Detox”	Lacks a clear scientific definition, and no RCT evidence supports detoxification claims.

12. Integrated clinical and translational view

12.1 Scientific Integration Apple Cider Vinegar and *Moringa Oleifera*: A Multi-Pathway Approach to Metabolic Control Moringa has anti-inflammatory and antioxidant properties by activating the NF-κB and Nrf2 pathways, and ACV improves insulin sensitivity and glucose metabolism by activating AMPK. The combination achieved is synergistic and mechanistically plausible.

12.2 Relevance to Metabolic Disorders: ACV causes a slight improvement in glycaemic management in diabetes and prediabetes. This combination may be beneficial for hypertension involving oxidative stress and PCOS in which insulin resistance and inflammation are important contributors. But the evidence is only for the individual constituents, not the composition as a whole.

12.3 Effervescent delivery significance: Effervescent tablets can enhance palatability, dissolution and decrease stomach discomfort, thereby increasing compliance.(5)**.**

12.4 Safety issues: ACV and *moringa* are generally safe to consume and have mild gastrointestinal side effects when taken in moderation. reported stomach problems. There are few long-term safety studies, and excessive consumption may lead to discomfort or electrolyte imbalance abnormalities (6).

12.5 Evidence Gaps: Inconsistent standardization of active chemicals and no randomized trials specific to a particular formulation. Future studies should be directed to standardization of dose and clinical validation for long-term outcomes. There is no sufficient evidence at this time to support claims such as detoxification or fat loss (55)**.**

Conclusion

An example of a modern nutraceutical approach is *Moringa* apple cider vinegar (ACV) effervescent pills that combine traditional plant bioactives and practical delivery methods. Tenable mechanisms support their prospective benefits, with acetic acid enhancing metabolic regulation through AMPK activation and *Moringa oleifera* providing antioxidant and anti-inflammatory actions relevant to disorders including insulin resistance and PCOS. The effervescent format is also more palatable and user-compliant, keeping up with current consumer trends. The trend toward multi-ingredient plant-based solutions can be seen in products such as Oziva's metabolic ACV-moringa blend. Some of the major evidence gaps that remain include lack of formulation-specific clinical trials, lack of long-term safety data and the uncertainty of bioequivalency with liquid ACV. Their therapeutic efficacy needs to be demonstrated by further extensive studies and standardizations.

Conflict of interests: The authors have declared that there is no conflict of Interest.

Declaration: During the preparation of this article, Ai refinement tools are used to correct grammatical errors but original content is not Ai generated.

References

1. Amelia D, Santoso B, Purwanto B, Miftahussurur M, Joewono HT, Budiono. Effects of Moringa oleifera on Insulin Levels and Folliculogenesis in Polycystic Ovary Syndrome Model with Insulin Resistance. Immunol Endocr Metab Agents Med Chem [Internet]. 2018 Sep 19;18(1):22–30. Available from: http://www.eurekaselect.com/165147/article
2. Abou-Khalil R, Andary J, El-Hayek E. Apple cider vinegar for weight management in Lebanese adolescents and young adults with overweight and obesity: a randomised, double-blind, placebo-controlled study. BMJ Nutr Prev Heal. 2024 Jun;7(1):61–7.
3. Mostafidi M, Sanjabi MR, Shirkhan F, Zahedi MT. A review of recent trends in the development of the microbial safety of fruits and vegetables. Trends Food Sci Technol. 2020 Sep;103:321–32.
4. Hadi A, Pourmasoumi M, Najafgholizadeh A, Clark CCT, Esmaillzadeh A. The effect of apple cider vinegar on lipid profiles and glycemic parameters: a systematic review and meta-analysis of randomized clinical trials. BMC Complement Med Ther. 2021 Dec 29;21(1):179.
5. Serati-Nouri H, Mahmoudnezhad A, Bayrami M, Sanajou D, Tozihi M, Roshangar L, et al. Sustained delivery efficiency of curcumin through ZSM-5 nanozeolites/electrospun nanofibers for counteracting senescence of human adipose-derived stem cells. J Drug Deliv Sci Technol. 2021 Dec;66:102902.
6. Vazquez-Cervantes GI, Ortega DR, Blanco Ayala T, Pérez de la Cruz V, Esquivel DFG, Salazar A, et al. Redox and Anti-Inflammatory Properties from Hop Components in Beer-Related to Neuroprotection. Nutrients. 2021 Jun 10;13(6):2000.
7. Oyeniran OH, Ademiluyi AO, Oboh G. Comparative study of the phenolic profile, antioxidant properties, and inhibitory effects of Moringa (*Moringa oleifera* Lam.) and Almond (*Terminalia catappa* Linn.) leaves on acetylcholinesterase and monoamine oxidase activities in the head region of Fruitfly (*Drosophila melanogaster* Meigen) in vitro. J Food Biochem. 2021 Mar 21;45(3).
8. Danie Ray HR, Chandra C, Pratama R, Abdurahman MN, Lesmana R. The Potentiality of Moringa Oleifera to Increase Human Performance. Int J Hum Mov Sport Sci. 2023 Feb;11(1):58–64.
9. Ivey KL, Nguyen X-MT, Tobias DK, Song R, Rogers GB, Ho Y-L, et al. Dietary yogurt is distinct from other dairy foods in its association with circulating lipid profile: Findings from the Million Veteran Program. Clin Nutr ESPEN. 2021 Jun;43:456–63.
10. Zhang Y-P, Hu R-X, Han M, Lai B-Y, Liang S-B, Chen B-J, et al. Evidence Base of Clinical Studies on Qi Gong: A Bibliometric Analysis. Complement Ther Med. 2020 May;50:102392.
11. Zheng X, Zhang X-G, Liu Y, Zhu L-P, Liang X-S, Jiang H, et al. Arjunolic acid from Cyclocarya paliurus ameliorates nonalcoholic fatty liver disease in mice via activating Sirt1/AMPK, triggering autophagy and improving gut barrier function. J Funct Foods. 2021 Nov;86:104686.
12. Khezri SS, Saidpour A, Hosseinzadeh N, Amiri Z. Beneficial effects of Apple Cider Vinegar on weight management, Visceral Adiposity Index and lipid profile in overweight or obese subjects receiving restricted calorie diet: A randomized clinical trial. J Funct Foods. 2018 Apr;43:95–102.
13. Bodor Z, Benedek C, Urbin Á, Szabó D, Sipos L. Colour of honey: can we trust the Pfund scale? – An alternative

graphical tool covering the whole visible spectra. LWT. 2021 Sep;149:111859.
14. Jafarirad S, Elahi M-R, Mansoori A, Khanzadeh A, Haghighizadeh M-H. The improvement effect of apple cider vinegar as a functional food on anthropometric indices, blood glucose and lipid profile in diabetic patients: a randomized controlled clinical trial. Front Clin Diabetes Healthc. 2023 Nov 13;4.
15. Groer M, Miller EM, Sarkar A, Dishaw LJ, Dutra S V., Youn Yoo J, et al. Predicted Metabolic Pathway Distributions in Stool Bacteria in Very-Low-Birth-Weight Infants: Potential Relationships with NICU Faltered Growth. Nutrients. 2020 May 8;12(5):1345.
16. Hassan MA, Xu T, Tian Y, Zhong Y, Ali FAZ, Yang X, et al. Health benefits and phenolic compounds of Moringa oleifera leaves: A comprehensive review. Phytomedicine. 2021 Dec;93:153771.
17. Daly RC, Rosenbaum AN, Dearani JA, Clavell AL, Pereira NL, Boilson BA, et al. Heart-After-Liver Transplantation Attenuates Rejection of Cardiac Allografts in Sensitized Patients. J Am Coll Cardiol. 2021 Mar;77(10):1331–40.
18. Orste L, Krumina A, Kilis E, Adamsone-Fiskovica A, Grivins M. Individual responsibilities, collective issues: The framing of dietary practices in Latvian media. Appetite. 2021 Sep;164:105219.
19. Ceci R, Maldini M, La Rosa P, Sgrò P, Sharma G, Dimauro I, et al. Comparative Metabolomic Analysis of Moringa oleifera Leaves of Different Geographical Origins and Their Antioxidant Effects on C2C12 Myotubes. Int J Mol Sci. 2024 Jul 25;25(15):8109.
20. Jin D, Jin S, Zhou T, Sheng G, Gao P, Li G. Effects of Moringa oleifera supplementation on immune and nutritional biomarkers in adults living with HIV: a systematic review and meta-analysis. Front Nutr. 2025 Sep 8;12.
21. Alanazi IS, Altyar AE, Zaazouee MS, Elshanbary AA, Abdel-Fattah A-FM, Kamel M, et al. Effect of moringa seed extract in chlorpyrifos-induced cerebral and ocular toxicity in mice. Front Vet Sci. 2024 Apr 10;11.
22. Ceci R, Maldini M, La Rosa P, Sireno L, Antinozzi C, Olson ME, et al. The Effect of Moringa oleifera Leaf Extract on C2C12 Myoblast Proliferation and Redox Status Under Oxidative Insult. Antioxidants. 2024 Nov 28;13(12):1460.
23. Arjmandfard D, Behzadi M, Sohrabi Z, Mohammadi Sartang M. Effects of apple cider vinegar on glycemic control and insulin sensitivity in patients with type 2 diabetes: A GRADE-assessed systematic review and dose–response meta-analysis of controlled clinical trials. Front Nutr. 2025 Jan 30;12.
24. Castagna A, Ferro Y, Noto FR, Bruno R, Aragao Guimaraes A, Pujia C, et al. Effect of Apple Cider Vinegar Intake on Body Composition in Humans with Type 2 Diabetes and/or Overweight: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Nutrients. 2025 Sep 19;17(18):3000.
25. Divya S, Pandey VK, Dixit R, Rustagi S, Suthar T, Atuahene D, et al. Exploring the Phytochemical, Pharmacological and Nutritional Properties of Moringa oleifera: A Comprehensive Review. Nutrients. 2024 Oct 9;16(19):3423.
26. Abd El-Hack ME, Alqhtani AH, Swelum AA, El-Saadony MT, Salem HM, Babalghith AO, et al. Pharmacological, nutritional and antimicrobial uses of Moringa oleifera Lam. leaves in poultry nutrition: an updated knowledge. Poult Sci. 2022 Sep;101(9):102031.
27. Beji O, Gillis RB, Dinu V, Jiwani SI, Gyasi-Antwi P, Fisk ID, et al. Exploration of temperature and shelf-life dependency of the therapeutically available Insulin Detemir. Eur J Pharm Biopharm. 2020 Jul;152:340–7.
28. Zhang B, Xu Y, Liu S, Lv H, Hu Y, Wang Y, et al. Dietary Supplementation of Foxtail Millet Ameliorates Colitis-Associated Colorectal Cancer in Mice via Activation of Gut Receptors and Suppression of the STAT3 Pathway. Nutrients. 2020 Aug 7;12(8):2367.
29. Muzammil S, Neves Cruz J, Mumtaz R, Rasul I, Hayat S, Khan MA, et al. Effects of Drying Temperature and Solvents on In Vitro Diabetic Wound Healing Potential of Moringa oleifera Leaf Extracts. Molecules. 2023 Jan 11;28(2):710.
30. Iida A, Wang Z, Hondo E, Sehara-Fujisawa A. Generation and evaluation of a transgenic zebrafish for tissue-specific expression of a dominant-negative Rho-associated protein kinase-2. Biochem Biophys Res Commun. 2020 Apr;525(1):8–13.
31. Cameli P, Bargagli E, Bergantini L, d'Alessandro M, Giugno B, Gentili F, et al. Alveolar Nitric Oxide as a Biomarker of COVID-19 Lung Sequelae: A Pivotal Study. Antioxidants. 2021 Aug 25;10(9):1350.
32. Sharma P, Wichaphon J, Klangpetch W. Antimicrobial and antioxidant activities of defatted Moringa oleifera seed meal extract obtained by ultrasound-assisted extraction and application as a natural antimicrobial coating for raw chicken sausages. Int J Food Microbiol. 2020 Nov;332:108770.

33. Hu Y, Winter V, Gänzle M. In vitro digestibility of commercial and experimental isomalto-oligosaccharides. Food Res Int. 2020 Aug;134:109250.
34. Han Z, Shi R, Sun D-W. Effects of novel physical processing techniques on the multi-structures of starch. Trends Food Sci Technol. 2020 Mar;97:126–35.
35. Mengucci C, Ferranti P, Romano A, Masi P, Picone G, Capozzi F. Food structure, function and artificial intelligence. Trends Food Sci Technol. 2022 May;123:251–63.
36. Brand J, Valentin D, Kidd M, Vivier MA, Næs T, Nieuwoudt HH. Comparison of pivot profile© to frequency of attribute citation: Analysis of complex products with trained assessors. Food Qual Prefer. 2020 Sep;84:103921.
37. Bennour N, Mighri H, Bouhamda T, Mabrouk M, Apohan E, Yesilada O, et al. *Moringa oleifera* leaves: could solvent and extraction method affect phenolic composition and bioactivities? Prep Biochem Biotechnol. 2021 Nov 2;51(10):1018–25.
38. Yang M, Tao L, Wang Z-L, Li L-F, Zhao C-C, Shi C-Y, et al. Effects of UV/H2O2 degradation on Moringa oleifera Lam. leaves polysaccharides: Composition, in vitro fermentation and prebiotic properties on gut microorganisms. Food Chem X. 2024 Jun;22:101272.
39. Yang M, Tao L, Kang X-R, Li L-F, Zhao C-C, Wang Z-L, et al. Recent developments in Moringa oleifera Lam. polysaccharides: A review of the relationship between extraction methods, structural characteristics and functional activities. Food Chem X. 2022 Jun;14:100322.
40. Liu A, Han A, Chai L. Assessing the Nutrient Adequacy in China's Food Supply from 1965 to 2018. Nutrients. 2021 Aug 9;13(8):2734.
41. Fan LZ, Kheifets S, Böhm UL, Wu H, Piatkevich KD, Xie ME, et al. All-Optical Electrophysiology Reveals the Role of Lateral Inhibition in Sensory Processing in Cortical Layer 1. Cell. 2020 Feb;180(3):521-535.e18.
42. Sharma K, Kumar M, Waghmare R, Suhag R, Gupta OP, Lorenzo JM, et al. Moringa (Moringa oleifera Lam.) polysaccharides: Extraction, characterization, bioactivities, and industrial application. Int J Biol Macromol. 2022 Jun;209:763–78.
43. Attia SL, Odhiambo SA, Mogaka JN, Ondondo R, Schadler A, McQuerry K, et al. Impact of Maternal Moringa oleifera Leaf Supplementation on Milk and Serum Vitamin A and Carotenoid Concentrations in a Cohort of Breastfeeding Kenyan Women and Their Infants. Nutrients. 2024 Oct 9;16(19):3425.
44. Ghadimi M, Najafi A, Sharifi SD, Mohammadi-Sangcheshmeh A, Mehr MR-A. Effects of dietary Moringa oleifera leaf extract on semen characteristics, fertility, and hatchability in aged broiler breeder roosters. Poult Sci. 2024 Apr;103(4):103491.
45. Rotella R, Soriano JM, Llopis-González A, Morales-Suarez-Varela M. The Impact of Moringa oleifera Supplementation on Anemia and other Variables during Pregnancy and Breastfeeding: A Narrative Review. Nutrients. 2023 Jun 8;15(12):2674.
46. Díaz-Prieto LE, Gómez-Martínez S, Vicente-Castro I, Heredia C, González-Romero EA, Martín-Ridaura M del C, et al. Effects of Moringa oleifera Lam. Supplementation on Inflammatory and Cardiometabolic Markers in Subjects with Prediabetes. Nutrients. 2022 May 5;14(9):1937.
47. Tehrani SD, Keshani M, Rouhani MH, Moallem SA, Bagherniya M, Sahebkar A. The Effects of Apple Cider Vinegar on Cardiometabolic Risk Factors: A Systematic Review and Meta-analysis of Clinical Trials. Curr Med Chem. 2025 Mar;32(11):2257–74.
48. Yuanfeng W, Gongnian X, Jianwei M, Shiwang L, Jun H, Lehe M. Dietary sulforaphane inhibits histone deacetylase activity in B16 melanoma cells. J Funct Foods. 2015 Oct;18:182–9.
49. Iio A, Ohguchi K, Inoue H, Maruyama H, Araki Y, Nozawa Y, et al. Ethanolic extracts of Brazilian red propolis promote adipocyte differentiation through PPARγ activation. Phytomedicine. 2010 Oct;17(12):974–9.
50. Worch T, Piqueras-Fiszman B. Contributions to assess the reproducibility and the agreement of respondents in CATA tasks. Food Qual Prefer. 2015 Mar;40:137–46.
51. Gómez-Martínez S, Díaz-Prieto LE, Vicente Castro IV, Jurado C, Iturmendi N, Martín-Ridaura MC, et al. Moringa oleifera Leaf Supplementation as a Glycemic Control Strategy in Subjects with Prediabetes. Nutrients. 2021 Dec 24;14(1):57.
52. Nova E, Redondo-Useros N, Martínez-García RM, Gómez-Martínez S, Díaz-Prieto LE, Marcos A. Potential of

Moringa oleifera to Improve Glucose Control for the Prevention of Diabetes and Related Metabolic Alterations: A Systematic Review of Animal and Human Studies. Nutrients. 2020 Jul 10;12(7):2050.
53. Glatthaar-Saalmüller B, Rauchhaus U, Rode S, Haunschild J, Saalmüller A. Antiviral activity in vitro of two preparations of the herbal medicinal product Sinupret® against viruses causing respiratory infections. Phytomedicine. 2011 Dec;19(1):1–7.
54. Aljazzaf B, Regeai S, Elghmasi S, Alghazir N, Balgasim A, Hdud Ismail IM, et al. Evaluation of Antidiabetic Effect of Combined Leaf and Seed Extracts of Moringa oleifera (Moringaceae) on Alloxan-Induced Diabetes in Mice: A Biochemical and Histological Study. Oxid Med Cell Longev. 2023 May 12;2023:1–21.
55. Sozen Yanik I, Kesim B, Ersu B, Koc Vural U. Do effervescent vitamin tablets affect the surface roughness, microhardness, and color of human enamel and contemporary composite resins? J Prosthodont. 2024 Sep;33(S1):35–46.
56. Watanabe S, Okoshi H, Yamabe S, Shimada M. Moringa oleifera Lam. in Diabetes Mellitus: A Systematic Review and Meta-Analysis. Molecules. 2021 Jun 9;26(12):3513.
57. Jasaputra DK, Lucretia T, Ray HRD, Kwee L, Gunawan D, Edwinanto L, et al. Moringa oleifera Leaves Extract Alters Exercise-Induced Cardiac Hypertrophy Adaptation. Pakistan J Biol Sci. 2022 Mar 15;25(3):210–7.
58. Owens FS, Dada O, Cyrus JW, Adedoyin OO, Adunlin G. The effects of Moringa oleifera on blood glucose levels: A scoping review of the literature. Complement Ther Med. 2020 May;50:102362.
59. Khammassi M, Isacco L, Pereira B, Damaso AR, Matlosz P, Maruszczak K, et al. Cardiometabolic efficacy of multidisciplinary weight loss interventions is not altered in adolescents with obesity initially diagnosed or with a persistent metabolic syndrome. Nutr Res. 2021 Feb;86:79–87.
60. Ding Q, Xue D, Ren Y, Xue Y, Shi J, Xu Z, et al. Apple Cider Vinegar Powder Mitigates Liver Injury in High-Fat-Diet Mice via Gut Microbiota and Metabolome Remodeling. Nutrients. 2025 Jun 28;17(13):2157.
61. Martinez Y, Ausina V, Llena C, Montiel JM. Scientific evidence on the efficacy of effervescent tablets for cleaning removable prostheses. A systematic review and meta-analysis. J Prosthet Dent. 2024 Jun;131(6):1071–83.
62. Moon H, Lertpatipanpong P, Hong Y, Kim C-T, Baek SJ. Nano-encapsulated quercetin by soluble soybean polysaccharide/chitosan enhances anti-cancer, anti-inflammation, and anti-oxidant activities. J Funct Foods. 2021 Dec;87:104756.
63. Martini N. Apple cider vinegar. J Prim Health Care. 2021 Jun 30;13(2):191–2.
64. Valdes DS, So D, Gill PA, Kellow NJ. Effect of Dietary Acetic Acid Supplementation on Plasma Glucose, Lipid Profiles, and Body Mass Index in Human Adults: A Systematic Review and Meta-analysis. J Acad Nutr Diet. 2021 May;121(5):895–914.