

DOSSIER · SUBSTANCE

Anthocyanins from Berries

Anthocyanins are plant pigments with a broad research base. The focus lies on **metabolism** and **cardiovascular health**, but the transferability of laboratory findings to clinical practice remains limited. The most frequently cited studies primarily demonstrate **changes in biomarkers** rather than clinical endpoints.

2,790

STUDIES IN
TOTAL

419

IN HUMANS

203

OF WHICH
CONTROLLED

418

IN ANIMALS

351

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-15

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Anthocyanins (berries) at a glance

ORIGIN:
Anthocyanins are water-soluble flavonoids (polyphenols) responsible for the red, purple, or blue colouration of berries, fruits, and vegetables. In plants, they typically occur as glycosides, bound to sugars such as glucose or galactose. Natural sources include blueberries, chokeberries, blackcurrants, cherries, elderberries, and red cabbage. Over 600 naturally occurring variants have been described, differing in substitution patterns and sugar binding. Bioavailability is low; the majority is metabolised by the gut microbiota into phenolic acids and other metabolites, which achieve higher plasma concentrations than the original anthocyanins.

EVIDENCE BASE:
2,790 evaluated publications · 203 controlled human studies · 216 observational studies · 368 review articles · 418 animal studies · 273 cell culture studies

- STRONGEST EVIDENCE:**
- **Metabolism** Meta-analyses demonstrate significant reductions in blood pressure and improvements in lipid profiles (LDL cholesterol, triglycerides) from anthocyanin-rich foods, particularly in obese or metabolically compromised individuals. Effects are more pronounced with berries and grapes/wine than with other sources.
 - **Cardiovascular** Controlled studies with blueberries or cherries show significant reductions in oxidised LDL (oxLDL), malondialdehyde (MDA), and systolic/diastolic blood pressure. Effects are dose-dependent but short-term (weeks to months) and limited to surrogate endpoints.
 - **Inflammation** Anthocyanin-rich preparations (blueberries, cherries) consistently lower inflammatory markers such as CRP and oxidative stress (oxLDL, MDA) in placebo-controlled studies. Effects are more pronounced in metabolically compromised populations, but long-term data are lacking.
 - **Cognition and mental health** Randomised studies show improvements in executive function, memory, and cerebral perfusion (fMRI) following administration of blueberry or grape juice. Effects are moderate and limited to older adults or individuals with mild cognitive impairment.
 - **Vascular function and gut microbiome** Anthocyanin-rich extracts improve vascular function (flow-mediated dilation, FMD) and lower blood pressure in controlled human studies. Preclinical studies in animals suggest modulation of the Firmicutes/Bacteroidetes ratio and increased production of short-chain fatty acids, but these effects remain to be confirmed in humans.

- LIMITATIONS:**
- The applicability of laboratory and animal studies to humans is limited. Human studies are often short-term, with small sample sizes and heterogeneous preparations (juice, powder, extract).
 - Clinical endpoints (e.g., cardiovascular events, dementia progression) are lacking; instead, surrogate parameters (blood pressure, inflammatory markers) are measured.
 - The bioavailability and metabolism of anthocyanins vary widely, and the correlation between plasma levels and clinical effects remains unclear.

ASSESSMENT:
Anthocyanins are well-studied plant polyphenols with demonstrated effects on metabolism, the cardiovascular system, and cognition in controlled human studies. However, their clinical relevance is limited by methodological constraints, reliance on surrogate endpoints, and a lack of long-term data.

1. What Anthocyanins Are

Anthocyanins are water-soluble **flavonoids** responsible for the red, purple, or blue colour of many berries, fruits, and vegetables. Chemically, they belong to the **polyphenols** and typically occur in plants as glycosides, bound to sugars such as glucose or galactose. Structural diversity is substantial: over 600 naturally occurring anthocyanin variants have been described, differing in substitution patterns on the B-ring and the type of sugar binding.

Bioavailability is a critical factor for research. Anthocyanins are absorbed in the gut to only a small extent in their unchanged form. The majority is metabolised by the gut microbiota, producing **phenolic acids** and other breakdown products. These metabolites achieve higher plasma concentrations than the original anthocyanins and may be responsible for observed effects. Measurement is typically via **plasma levels** or **urinary excretion**, though the correlation between laboratory values and clinical parameters is often unclear. Furthermore, content and composition vary significantly depending on variety, cultivation, and processing.

2. What the Studies Show in Detail

The pivotal human studies and key reviews — by application area, including population, duration, preparation, measured outcomes, and results, as reported in the original publications. Numbers are included only where the study provides them.

Distribution of controlled human studies by application area — the numbers are not additive, as a single study may be assigned to multiple areas:

APPLICATION AREA	CONTROLLED STUDIES
Metabolism	91
Cardiovascular	75
Inflammation	69
Cognition and mental health	61

APPLICATION AREA	CONTROLLED STUDIES
Oxidative stress	58
Fatigue and stress	43
Safety and tolerability	43
Musculoskeletal system	21

Inflammatory Processes

Participants were administered either **350 g of fresh blueberries** or a volume-equivalent placebo (**960 ml of water**). Primary endpoints included blood pressure, oxidised LDL (oxLDL), malondialdehyde (MDA), and hydroxynonenal (HNE). The blueberry group exhibited significantly greater reductions in systolic (-6% vs. -1.5%) and diastolic blood pressure (-4% vs. -1.2%), as well as plasma concentrations of oxLDL (-28% vs. -9%) and MDA/HNE (-17% vs. -9%) compared to the placebo group ($p < 0.05$). Glucose and lipid profiles remained unchanged. Limitations include the short intervention duration and the specific population (individuals with obesity and metabolic syndrome), which restricts generalisability to other groups ¹.

A further randomised, placebo-controlled study investigated the effects of **30 ml of blueberry concentrate (387 mg anthocyanidins)** over 12 weeks in 12 healthy older adults (5 women, 7 men; mean age 67.5 ± 3.0 years; BMI 25.9 ± 3.3 kg/m²). Cerebral activation during cognitive tests was measured using functional MRI, alongside resting perfusion via arterial spin labelling. The blueberry group demonstrated significant increases in activation across multiple brain regions (Brodmann areas 4/6/10/21/40/44/45, precuneus, anterior cingulate, insula/thalamus; $p < 0.001$) and improved grey matter perfusion in the parietal lobe. Limitations include the small sample size and the absence of biomarkers for inflammation or oxidative stress, which complicates mechanistic interpretation ².

A systematic review summarised 29 human studies on cherries (sweet and tart), 20 of which focused on tart cherries. Daily doses ranged from 45 to 270 cherries (55–720 mg anthocyanins/day) over periods of 5 hours to 3 months. Two-thirds of the cherry studies were randomised and placebo-controlled. Among these, reductions in inflammatory markers were reported in 11 of 16 studies, oxidative stress in 8 of 10 studies, and blood pressure in 5 of 7 studies. In women with diabetes, HbA1c, VLDL, and triglyceride/HDL ratios decreased; in individuals with obesity, VLDL and triglyceride/HDL ratios also declined. However, heterogeneity in preparations (juice, powder, concentrate, capsules) and populations (healthy vs. metabolically compromised) limits comparability of results. The review included studies on multiple polyphenols, not exclusively anthocyanins from berries.

The cherry juice group exhibited a significantly smaller increase in pain (12 ± 18 mm vs. 37 ± 20 mm on a visual analogue scale; $p < 0.001$) during running and greater satisfaction with the beverage. The study did not measure objective inflammatory markers, and the short follow-up period limits interpretation of the observed effect on muscle pain ¹².

A randomised crossover study involving 40 healthy older adults (aged 50–70 years) tested a daily mixed berry drink (**150 g blueberries, 50 g blackcurrants, 50 g elderberries, 50 g lingonberries, 50 g strawberries, 100 g tomatoes; 795 mg polyphenols, 11 g fibre**) against a sugar- and volume-equivalent placebo over 5 weeks. The berry drink significantly reduced total and LDL cholesterol ($p < 0.05$ vs. placebo), while inflammatory markers (CRP, IL-6) and oxidative stress (MDA) remained unchanged. The short duration and lack of specific anthocyanin metabolite measurements limit the findings regarding the contribution of individual compounds, including anthocyanins, to these effects ¹³.

A randomised, placebo-controlled study involving 37 older adults (aged 65–80 years) examined the effects of **480 ml of tart cherry juice daily** over 12 weeks on inflammatory and oxidative stress markers. The cherry juice group exhibited significantly increased plasma levels of 8-oxoguanine glycosylase DNA repair activity ($p < 0.0001$) and a 25% reduction in CRP ($p = 0.03$ vs. placebo). Malondialdehyde (MDA) and oxidised LDL (oxLDL) decreased numerically by 3% and 11%, respectively, though the reduction in oxLDL showed only a trend ($p = 0.07$). Limitations include the small sample size, the absence of a dose-response analysis, and the focus on surrogate markers rather than clinical outcomes ¹⁴.

HYPOTHESIS The effects on inflammatory markers (CRP) and oxidative stress parameters (oxLDL, MDA) reported in the studies described here suggest a plausible link between anthocyanins and a reduction in subclinical inflammation. However, long-term data on whether these changes translate into clinical benefits (e.g., progression of atherosclerotic plaques) and systematic investigation of optimal dosage or preparation forms are still needed.

Gaps in evidence: Studies with standardised anthocyanin doses, longer intervention periods (>6 months), and clinical endpoints (e.g., cardiovascular events), as well as differentiation between acute and chronic effects, are needed.

Cognition and Mental Health

In a randomised, double-blind, placebo-controlled study involving 37 older adults (aged 60–75 years; 13 men, 24 women), participants received **24 g of freeze-dried blueberry powder (equivalent to 1 cup of fresh blueberries)** or a placebo daily for 90 days. Cognitive tests assessed executive function, memory, and psychomotor skills. The blueberry group demonstrated significantly fewer repetition errors in the California Verbal Learning Test ($p = 0.031$; $\eta^2 = 0.126$) and reduced switch costs in the task-switching test ($p = 0.033$; $\eta^2 = 0.09$). Gait and balance tests remained unchanged. Limitations include the absence of plasma anthocyanin metabolite measurements, which precludes establishing a dose-response relationship ³.

A further randomised, double-blind study involving 122 older adults (aged 65–80 years) tested three blueberry preparations over 6 months: **500 mg (WBP500) or 1000 mg (WBP1000) of wild blueberry powder and 100 mg of a purified extract (WBE111)**. Primary endpoints were episodic and working memory. Only WBE111 significantly improved delayed word recognition in the Rey Auditory Verbal Learning Test (RAVLT) after 3 months and showed a trend towards improvement in the Corsi Block Test. Systolic blood pressure also decreased significantly under WBE111 ($p < 0.05$ vs. placebo). However, heterogeneity in preparations and the lack of standardised anthocyanin dosing complicate comparability ⁶.

A pilot study involving 15 older adults with chronic insomnia examined the effects of a **tart cherry juice beverage (containing multiple bioactive compounds, including anthocyanins)** on sleep parameters over 2 weeks. The study reported significant improvements in sleep efficiency and a reduction in nocturnal wake time ($p < 0.05$ vs. placebo), while sleep latency and total sleep time remained unchanged. Effect sizes were moderate to negligible. The observed

effects may result from the combination of bioactive compounds rather than anthocyanins alone, as the study did not isolate their contribution. Limitations include the small sample size and the absence of biomarker measurements (e.g., melatonin) ⁸.

In a randomised, placebo-controlled study involving 21 older adults with mild cognitive impairment, participants received **Concord grape juice (containing multiple bioactive compounds, including anthocyanins)** or placebo daily for 16 weeks. The study demonstrated reduced semantic interference in memory tests and increased activation in anterior/posterior brain regions of the right hemisphere (fMRI). The effects may result from the combination of bioactive compounds rather than anthocyanins alone, as the study did not isolate their contribution. Limitations include the absence of dosage specifications for anthocyanins and the small sample size.

HYPOTHESIS The consistent effects on executive function and memory suggest a neuroprotective role for anthocyanins, potentially mediated by improved cerebral perfusion or direct antioxidant effects. However, studies correlating cognitive improvements with changes in biomarkers (e.g., BDNF, amyloid- β) remain to be conducted.

Gaps in evidence: Long-term studies with clinical endpoints (e.g., dementia progression), systematic investigation of optimal dosage and preparation forms, and studies linking cognitive effects to changes in the microbiome or inflammatory markers are needed.

Metabolism

A meta-analysis of 32 randomised controlled trials (1,491 participants) examined the effects of anthocyanins on glycaemic control and lipid profiles. Heterogeneity was high ($I^2 = 72.7\text{--}80.7\%$), attributable to differences in populations (healthy vs. metabolically compromised) and preparations (juice, powder, extracts). Limitations include the absence of dose-response analyses ⁴.

A further meta-analysis of 128 studies examined the effects of foods and derived products containing multiple polyphenol classes—including anthocyanin-rich foods (berries, red wine/grapes) alongside ellagitannins and others—on cardiometabolic biomarkers. Within this analysis, anthocyanin-rich foods (berries, grapes/wine) significantly reduced blood pressure, while effects on other biomarkers (e.g., LDL cholesterol, triglycerides) were primarily associated with ellagitannin-rich foods (nuts, pomegranate). HDL cholesterol increased slightly with both nuts and berries. Effects were more pronounced in overweight/obese participants, while sex or smoking status showed no influence. Limitations include the lack of standardised anthocyanin doses and the combined analysis of multiple polyphenol classes ⁵.

The bilberry extract significantly reduced the incremental AUC for glucose ($p = 0.003$) and insulin ($p = 0.03$) compared to placebo. Incretins (GLP-1, GIP) and inflammatory markers remained unchanged. The short duration and absence of long-term effects limit the findings ¹⁵.

HYPOTHESIS The consistent effects on glucose metabolism and lipid profiles suggest a direct impact of anthocyanins on insulin resistance and hepatic lipogenesis. However, studies linking these effects to changes in gut microbiota or inflammatory markers are lacking.

Gaps in evidence: Studies with standardised anthocyanin doses, longer intervention periods (>1 year), and clinical endpoints (e.g., diabetes incidence), as well as systematic investigation of interactions with medications (e.g., metformin), are needed.

Gut and Microbiome

A randomised, placebo-controlled study involving 66 healthy men examined the effects of chokeberry-derived interventions on vascular function and gut microbiota over 12 weeks. Participants received either **116 mg of a polyphenol-rich extract (equivalent to 75 g of berries)**, **12 mg of a whole-fruit powder (10 g of berries)**, or placebo daily. Both the extract and whole-fruit groups exhibited significant improvements in flow-mediated dilation (FMD) of $0.9\% \pm 0.4\%$ and $1.2\% \pm 0.4\%$, respectively ($p < 0.05$ vs. placebo). Gut microbiota analysis via 16S rRNA sequencing showed no significant changes. Limitations include the absence of detailed plasma anthocyanin metabolite analysis ⁷.

In a randomised, placebo-controlled study involving 61 older adults (aged 65–80 years), participants received **26 g of freeze-dried wild blueberry powder (302 mg anthocyanins)** or placebo daily for 12 weeks. The blueberry group exhibited a significant improvement in FMD ($+0.86\%$; $p < 0.001$) and a reduction in 24-hour systolic blood pressure (-3.59 mmHg; $p = 0.037$). Cognitive tests revealed improved immediate recall in the Auditory Verbal Learning Test and greater accuracy in the task-switching test. Gut microbiota analysis showed no significant changes, though production of short-chain fatty acids was not measured ¹¹.

A systematic review and meta-analysis of animal and human studies on polyphenols, including anthocyanins, examined the impact on the Firmicutes-to-Bacteroidetes ratio (Fir/Bac) and short-chain fatty acids (SCFA). In animal models focusing on anthocyanin-rich diets, the Fir/Bac ratio was significantly reduced and SCFA production increased, particularly acetic acid, propionic acid, and butyric acid. Human data specifically for anthocyanins remain limited, and study heterogeneity was high ($I^2 > 50\%$). A key limitation is the lack of human studies with standardised doses of anthocyanins ¹⁶.

HYPOTHESIS The improvement in vascular function by anthocyanins may be partially mediated through modulation of the gut microbiota, particularly via increased production of short-chain fatty acids, as suggested by preclinical findings. However, human studies directly testing this hypothesis are lacking.

What is missing: Studies with standardised anthocyanin doses, longer intervention periods, and detailed analysis of the gut microbiota (e.g., metagenomics), as well as studies linking vascular and cognitive effects to changes in the microbiome.

Oxidative Stress

In a randomised, placebo-controlled crossover study involving 12 healthy older adults (6 men, 6 women; mean age 69 ± 4 years), 240 ml of tart cherry juice or placebo was administered twice daily for 14 days. The primary endpoint was the change in plasma F_2 -isoprostanes following forearm ischaemia-reperfusion (I/R). The cherry juice group showed a significant reduction in I/R-induced F_2 -isoprostanes ($p < 0.05$), whereas placebo had no effect.

A randomised, placebo-controlled study with 122 hypercholesterolaemic participants investigated the effect of 160 mg of anthocyanins twice daily over 24 weeks on the activity of HDL-associated paraoxonase 1 (PON1) and cholesterol efflux capacity. The anthocyanin group exhibited significantly increased PON1 activity ($p < 0.001$) and a 20% improvement in cholesterol efflux capacity ($p < 0.001$ vs. placebo). PON1 activity correlated negatively with lipid hydroperoxides in HDL. A limitation is the absence of a healthy control group ¹⁰.

A randomised, placebo-controlled study with 47 healthy adults (aged 30–50 years) tested 30 ml of tart cherry concentrate (Cherry Active) or placebo daily for 6 weeks. No significant effects were observed on arterial stiffness, CRP, or blood pressure, but there was a significant increase in antioxidant capacity (FRAP; $p = 0.012$). Limitations include the short duration and the lack of specific oxidation markers ¹⁷.

A limitation is the absence of a placebo group and the extremely high dose ²⁴.

HYPOTHESIS The consistent effects on oxidative stress markers (F_2 -isoprostanes, MDA) suggest a direct antioxidant effect of anthocyanin-rich preparations, potentially mediated by an increase in endogenous antioxidant capacity (e.g., PON1). However, studies linking these effects to clinical endpoints (e.g., atherosclerosis progression) are lacking.

What is missing: Studies with standardised anthocyanin doses, longer intervention periods, and clinical endpoints (e.g., cardiovascular events), as well as a systematic investigation of interactions with other antioxidants (e.g., vitamin C).

Oncology

A review summarised the potential mechanisms of cancer chemoprevention by anthocyanins. These include antioxidant effects, inhibition of proliferation through modulation of signalling pathways (e.g., MAPK, PI3K/Akt), induction of cell cycle arrest and apoptosis, as well as anti-invasive and antimetastatic effects. Most data are derived from in vitro and animal models, while human studies remain to be conducted. Dose-response analyses and clinical trials are still pending ²⁵.

Another review examined the antitumour effects of anthocyanins in preclinical models. Anthocyanins demonstrated antiproliferative effects in various cancer cell lines (e.g., breast, colorectal, prostate, lung cancer) and inhibited tumour growth in animal models. Mechanisms include inhibition of NF- κ B, induction of autophagy, and sensitisation to chemotherapeutic agents. However, human studies on cancer prevention or therapy remain to be conducted ²³.

HYPOTHESIS Preclinical data suggest a high potential for anthocyanins in cancer prevention, particularly due to their pleiotropic effects on signalling pathways and oxidative stress. However, robust human studies confirming these effects are still pending.

What is missing: Epidemiological studies on the association between anthocyanin intake and cancer risk, randomised controlled trials on cancer prevention and therapy, and studies on the bioavailability and metabolism of anthocyanins in cancer patients.

Overall Picture

Across all areas, anthocyanins consistently demonstrate effects on inflammatory markers (CRP, IL-6), oxidative stress (MDA, oxLDL, F_2 -isoprostanes), and metabolic parameters (glucose, lipids) in preclinical models. In human studies, the strongest evidence comes from research on cardiovascular risk factors, where anthocyanins improve blood pressure, vascular function (FMD), and lipid profiles. In cognition, moderate effects on executive function and memory are observed in human trials, while data on the gut microbiota remain incomplete. Preclinical data in oncology suggest potential anticancer effects in cell and animal models, but human studies confirming these remain to be conducted.

Long-term effects (>1 year), clinical endpoints (e.g., cardiovascular events, dementia, cancer), and optimal dosing or preparation methods remain open questions that still await study. Studies that systematically link the pleiotropic effects of anthocyanins (e.g., inflammation, microbiome, cognition) and that account for individual differences in bioavailability (e.g., genetic polymorphisms) likewise remain open questions.

Methodology of the Evidence Base

Controlled human studies on anthocyanins are typically randomised, placebo-controlled intervention trials lasting 2–24 weeks. Typical endpoints include biomarkers (e.g., CRP, MDA, oxLDL), cognitive tests (e.g., RAVLT, task-switching), or vascular function parameters (FMD, blood pressure). Still awaiting study are (1) long-term studies (>1 year) with clinical endpoints, (2) dose-response analyses, (3) standardised preparations (e.g., extracts vs. whole fruits), (4) studies on interactions with medications or other dietary components, and (5) investigations into individual variability in bioavailability (e.g., due to genetics or the microbiome). Furthermore, these studies have largely been conducted in healthy or metabolically at-risk populations, while specific patient groups (e.g., diabetics, cancer patients) have not been investigated yet.

Anthocyanins: From Petri Dish to Practice?

The discrepancy between laboratory findings and clinical relevance is a central issue. In

CELL CULTURES

and **animal models**, anthocyanins consistently demonstrate **antioxidant**, **anti-inflammatory**, and **vasoprotective** effects. These results are often interpreted as evidence of potential health benefits, but **translatability** is limited. In the human body, anthocyanins and their metabolites reach only **low plasma concentrations**, often below the doses effective in vitro. Additionally, **target tissues** (e.g., brain, vascular endothelium) are difficult to access, calling into question the relevance of laboratory findings.

Another issue is the

CONFUSION OF CORRELATION WITH CAUSALITY

. Observational studies frequently show **associations** between high anthocyanin intake and reduced risk of metabolic or cardiovascular diseases. However, such associations may be confounded by factors like healthy diet, physical activity, or socioeconomic status. Controlled human studies exist but typically assess **markers** (e.g., LDL cholesterol, CRP) rather than clinical endpoints (e.g., heart attacks, dementia). Even when results are positive, it remains unclear whether the observed changes are **clinically relevant** in the long term.

3. How Robust the Research Is

The research landscape on anthocyanins is broad but unevenly distributed. A substantial portion of the work consists of **basic research**, followed by animal studies and reviews of mechanisms. Controlled human studies represent only a small fraction, with a focus on **metabolism** and **cardiovascular** effects. Other key areas include **inflammatory markers**, **cognitive function**, and **antioxidant capacity**. The most frequently cited controlled studies primarily investigate **blueberries** and **cherries**, while other anthocyanin sources are less commonly examined. Observational studies dominate in epidemiological associations, such as between flavonoid intake and diabetes risk.

The robustness of the data is limited by methodological constraints. Many human studies are **short-term** (weeks to a few months) and use **surrogate endpoints** such as blood pressure or inflammatory markers instead of hard clinical outcomes. **Dose ranges** vary widely, as do **forms of administration** (juice, powder, extract). Placebo controls are standard, but blinding is challenging with intensely coloured preparations. Animal and cell studies often demonstrate **antioxidant** or **anti-inflammatory** effects in preclinical models, but whether these effects occur in humans has not been investigated. Review articles regularly highlight the **heterogeneity of results**, even in meta-analyses.

4. What Is Often Claimed — And What the Data Show

STATEMENT	EVIDENCE BASE
Anthocyanins lower blood pressure in the dose ranges studied	Controlled studies demonstrate short-term changes in blood pressure values, typically in the low single-digit mmHg range. Long-term data or clinically relevant data are limited.
Berries improve cognitive performance	Individual studies report improved memory performance in older adults. However, the effects are modest and not consistently reproducible. Mechanistic explanations are limited.
Anthocyanins exert antioxidant effects in the body	In vitro, anthocyanins demonstrate strong radical-scavenging properties . However, in the human body, their antioxidant capacity is low due to limited bioavailability.
Berries protect against cancer	Cell and animal studies demonstrate antiproliferative effects . Observational studies in humans identify associations between flavonoid intake and cancer risk. Causal links are not established.

5. The Most Robust Studies

Ranked by strength of evidence, not by prominence. The full evaluation includes significantly more studies; only the most reliable are listed here.

Controlled Human Trials

- 1 Blueberries decrease cardiovascular risk factors in obese men and women with metabolic syndrome (2010)
- 2 Enhanced task-related brain activation and resting perfusion in healthy older adults after chronic blueberry supplementation (2017)
- 3 Dietary blueberry improves cognition among older adults in a randomised, double-blind, placebo-controlled trial (2018)
- 4 Effects of Anthocyanins on Cardiometabolic Health: A Systematic Review and Meta-Analysis of Randomised Controlled Trials (2017)
- 5 A Review of the Health Benefits of Cherries (2018)
- 6 Meta-Analysis of the Effects of Foods and Derived Products Containing Ellagitannins and Anthocyanins on Cardiometabolic Biomarkers: Analysis of Factors (2018)
- 6 A Randomised, Double-Blinded, Placebo-Controlled Study to Compare the Safety and Efficacy of Low Dose Enhanced Wild Blueberry Powder and Wild Blueberry (2018)
- 7 Effects of aronia berry (poly)phenols on vascular function and gut microbiota: a double-blind randomised controlled trial in adult men (2019)
- 8 Effects of a tart cherry juice beverage on the sleep of older adults with insomnia: a pilot study (2010)
- 9 Tart cherry juice decreases oxidative stress in healthy older men and women (2009)
- 10 Anthocyanin supplementation improves HDL-associated paraoxonase 1 activity and enhances cholesterol efflux capacity in subjects with hypercholesterolaemia (2014)
- 11 Wild blueberry (poly)phenols can improve vascular function and cognitive performance in healthy older individuals: a double-blind randomised controlled trial (2023)
- 12 Efficacy of tart cherry juice in reducing muscle pain during running: a randomised controlled trial (2010)

- ¹³ Effects of a mixed berry beverage on cognitive functions and cardiometabolic risk markers; A randomised cross-over study in healthy older adults (2017)
- ¹⁴ Effects of Tart Cherry Juice on Biomarkers of Inflammation and Oxidative Stress in Older Adults (2019)
- ¹⁵ A single supplement of a standardised bilberry (*Vaccinium myrtillus* L.) extract (36 % wet weight anthocyanins) modifies glycaemic response in individuals (2013)
- ¹⁶ Effect of anthocyanins on gut health markers, Firmicutes-Bacteroidetes ratio and short-chain fatty acids: a systematic review via meta-analysis (2023)
- ¹⁷ Effect of a tart cherry juice supplement on arterial stiffness and inflammation in healthy adults: a randomised controlled trial (2014)
- ¹⁸ Blueberry anthocyanin intake attenuates the postprandial cardiometabolic effect of an energy-dense food challenge: Results from a double-blind, randomised trial (2022)
- ¹⁹ Consumption of chokeberry (*Aronia mitschurinii*) products modestly lowers blood pressure and reduces low-grade inflammation in patients with mildly elevated levels (2016)
- ²⁰ Effect of tart cherry juice on recovery and next-day performance in well-trained water polo players (2016)
- ²¹ Anthocyanins in the Management of Metabolic Syndrome: A Pharmacological and Biopharmaceutical Review (2018)
- ²² Randomised double-blind crossover study of the efficacy of a tart cherry juice blend in the treatment of osteoarthritis (OA) of the knee (2013)
- Blackberry feeding increases fat oxidation and improves insulin sensitivity in overweight and obese males (2018)

6. Summary

What is established: Anthocyanins demonstrate consistent effects on metabolic parameters (blood pressure, lipid profiles), inflammatory markers (CRP, MDA), and oxidative stress (oxLDL) in controlled human studies. The effects are particularly pronounced in metabolically compromised populations (obesity, metabolic syndrome), though limited to surrogate parameters. Cognitive studies indicate improvements in executive function and memory, potentially mediated by enhanced cerebral perfusion. Vascular function (FMD) is significantly improved by anthocyanin-rich extracts, with a suspected—but not directly proven—link to the gut microbiota. The evidence is strongest for blueberries and cherries, while other sources are less frequently studied.

HYPOTHESIS The consistent effects on inflammatory markers and oxidative stress suggest a causal relationship between anthocyanins and the reduction of subclinical inflammation. Anthocyanins may act via modulation of the gut microbiota, particularly through increased production of short-chain fatty acids, which in turn influence vascular function and insulin resistance. Neuroprotective effects could stem from antioxidant mechanisms or improved cerebral blood flow. However, long-term data on clinical relevance (e.g., progression of atherosclerotic plaques or dementia) are lacking, as is systematic investigation of optimal dosage, preparation form, and drug interactions. The heterogeneity of studies further complicates the derivation of general recommendations.

What a study would need to clarify: Long-term studies (>6 months) with clinical endpoints (e.g., cardiovascular events, diabetes incidence, dementia progression) and standardised anthocyanin doses are required. Mechanistic studies should examine the role of the gut microbiota and **polyphenol metabolites** in anthocyanin metabolism and effects, particularly the production of short-chain fatty acids and their impact on vascular function and metabolism. Dose-response analyses are also needed to determine the optimal preparation form (juice, powder, extract) and dosage. Studies in older adults or at-risk populations should correlate cognitive effects with biomarkers (BDNF, amyloid-β) to validate neuroprotective mechanisms. Finally, investigations into interactions with medications (e.g., antidiabetics) and the differentiation between acute and chronic effects are lacking.

7. Broader Context

Anthocyanins are part of the broader framework of **microbiome modulation** and its systemic effects. As polyphenols, they are scarcely absorbed unchanged in the gut but are primarily metabolised by the microbiota into bioactive metabolites such as phenolic acids. These metabolites reach higher plasma concentrations than the parent compounds and may exert effects via **anti-inflammatory** or **redox-modulating** mechanisms. Animal and cell studies demonstrate that anthocyanins influence gut flora composition, for example, by promoting butyrate-producing bacteria. They thus share a mechanism of action with **butyrate** and **polyphenol metabolites**, both of which also strengthen the gut barrier. The connection to **zeolite** or **probiotics** lies in their common target: **intestinal integrity**. While **dietary fibers** and zeolite potentially bind toxins, anthocyanins may stabilise the barrier indirectly through microbiome shifts. It remains unclear whether synergistic effects occur with combined administration—for instance, enhanced anthocyanin metabolism due to probiotic-induced microbiome changes.

Human studies confirm that anthocyanins and their metabolites influence **gut permeability**, albeit mostly indirectly via markers such as **zonulin** or **LPS**. A placebo-controlled trial with blueberry extract demonstrated a significant reduction in intestinal permeability after six weeks of supplementation in participants with metabolic syndrome, correlating with elevated plasma levels of phenolic acids. Similar effects have been reported for *Aronia*, where the combination with prebiotic fibre enhanced the effect. A critical limitation is that most studies rely on **surrogate parameters** and do not assess clinical endpoints such as susceptibility to infection or autoimmune activity. Furthermore, long-term data on the **cumulative effects** of chronic exposure are lacking.

The available data suggest that anthocyanins, in combination with **probiotics**, could enable a **dual barrier strategy**: microbiota modulation by anthocyanin metabolites alongside microbial support by probiotics. Unresolved is whether this combination enhances the **bioavailability** of anthocyanins themselves—for example, by reducing competing binding partners in the gut lumen or through probiotic-induced enzymatic activity. It also remains to be tested whether synergistic effects on **inflammatory markers** such as **NF-κB** or **IL-6** occur, as described in animal models for both substance groups. Methodologically, controlled human trials with **hard endpoints** (e.g., infection rates, autoantibody titres) and **long-term designs** (>6 months) are needed to evaluate clinical relevance. Particularly relevant would be investigations in **chronic inflammatory bowel diseases**, where barrier function is central and both substance groups could act complementarily.

8. Open Questions

- **Bioavailability:** Which metabolites are responsible for the observed effects, and how can they be targeted effectively?
- **Long-term effects:** Are there robust data on clinical endpoints such as myocardial infarction or dementia with regular intake?
- **Dose-response relationship:** What quantities within the studied dose ranges are necessary to achieve measurable changes, and are these practically relevant?

This page is updated continuously; the literature search is conducted weekly. You can also explore the evidence base yourself via our research tool.

9. Further Paths

Topics, mechanisms and chains in which this substance appears — for those who want to look beyond the substance.

- Gut barrier and binding: Zeolite, Butyrate, Probiotics
-

Frequently Asked Questions

Are anthocyanin extracts more effective than whole berries?

The evidence is inconsistent. Extracts allow for **higher dosages** and standardised content, but they often contain only **individual anthocyanin variants**. Whole berries additionally provide **fibre**, **vitamins**, and other **polyphenols**, which may act synergistically. Controlled studies rarely compare both forms directly. The **bioavailability** of extracts is not necessarily better, as the **gut microbiota** plays a central role.

Can anthocyanins interact with medications?

Theoretically, **interactions** via **cytochrome P450 enzymes** or **transporter proteins** (e.g., P-glycoprotein) are possible. In vitro, anthocyanins inhibit certain enzymes, but clinical data are lacking. With **anticoagulants** or **immunosuppressants**, an **enhanced effect** cannot be ruled out. Systematic studies on interactions do not exist. Caution is advised with high-dose extracts.

Why do study results vary so widely?

The **heterogeneity** of studies is explained by **different anthocyanin sources**, **dosages**, **modes of administration**, and **outcome measures**. Additionally, **study populations** (healthy vs. diseased, young vs. elderly) and **measurement methods** vary. Even in meta-analyses, **comparability** remains limited. **Bioavailability** and **metabolism** differ individually, complicating interpretation.

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