

# ANALYSIS – RONGOĀ BLENDS

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## EXECUTIVE SUMMARY

The current research on metabolites and their potential health benefits represents a significant intersection of Māori matauranga (knowledge) and modern scientific inquiry, particularly regarding the indigenous plants of the Māori. The comprehensive analysis of these compounds not only sheds light on the biochemical richness of native flora but also underscores the gaps in the current scientific understanding, as evidenced by the recent findings.

### Overview of Metabolite Research

Our project undertook a detailed study to identify and catalogue the metabolites present in various Māori indigenous plants. Utilising advanced techniques such as Liquid Chromatography-Mass Spectrometry (LC-MS), it detected a total of 5,311 unique metabolite signals. However, despite these extensive efforts, only 134 of these signals could be confidently matched with entries in existing metabolite databases. This accounts for merely about 2% of all detected features, highlighting a significant knowledge gap in the biochemical understanding of these plants.

### Significance of Findings

The findings from this research are crucial for multiple reasons:

- Preservation of Traditional Knowledge:** By scientifically validating the compounds found in indigenous plants, it validates and reinforces the traditional Māori knowledge about the healing uses of these plants.
- Potential for Health and Well-being:** The metabolites analysed have shown a range of potential health benefits, from cardiovascular protection and anti-inflammatory properties to effects on mental health and metabolic processes. These benefits point to the potential development of new therapeutic agents derived from these plants.
- Economic and Scientific Opportunities:** The identification of unique metabolites presents opportunities for the development of unique innovative supplements. It also opens up new avenues for research and collaboration between tohunga rakau expert and scientific communities.

### Challenges and Opportunities

The limited identification rate of metabolites underscores the challenges faced by the scientific community in fully harnessing the therapeutic potentials of indigenous plants. These challenges are not merely technical but are also rooted in the need for a deeper integration of traditional ecological knowledge with modern scientific practices.

- Technical Challenges:** The complexity of plant chemistry often outpaces the capabilities of current analytical technologies. There is a need for the development of more sophisticated tools and methodologies to improve the identification rates.
- Collaborative Research:** Enhancing collaborations between Māori and universities, research institutes, and science communities could foster a more holistic approach to the study of these plants. Such partnerships are essential for combining traditional insights with scientific rigor.

- **Funding and Resources:** Dedicated funding and resources are necessary to expand research into indigenous plants. Investment in this area can drive the discovery of new drugs and promote biodiversity conservation.

## NEUROLOGICAL HEALTH

These metabolites are associated with effects on the nervous system, including cognitive and mental health improvements:

- **(+/-) Salsolinol:** Neurotoxic potential but also studied for its role in Parkinson's disease.
- **Hesperidin:** Increases circulation and is brain protective.
- **Indoline:** Known for its antihypertensive and anti-inflammatory properties, may affect mental health through stress reduction.
- **Nicotinamide:** Vital for brain function, involved in DNA repair, and cellular metabolism.
- **Phenethylamine:** Psychoactive stimulant that can improve mood and focus.
- **Theanine:** Reduces stress and anxiety, enhances cognitive function.
- **Tyramine:** Regulates blood pressure, can influence brain neurotransmitter levels.

Expanded look at additional metabolites that may have beneficial effects on neurological health, including cognitive functions and mental well-being, beyond the ones initially mentioned like hesperidin, tyramine, and nicotinamide:

### Additional Metabolites Beneficial for Neurological Health:

1. **(S)-1-carbamoylpyrrolidine-2-carboxylic acid**
  - Neuroprotective: May have protective effects on nerve cells, potentially beneficial in neurodegenerative diseases.
2. **4-hydroxy-1'-methylspiro[benzo[e][1,3]oxazine-2,3'-indolin]-2'-one**
  - Neuroprotective and Anti-cancer: Known for its potential in treating neurological disorders due to its protective effects against oxidative stress and inflammation in brain cells.
3. **2'-Methoxyformonetin**
  - Cognitive Enhancement: As a flavonoid, it may help in improving memory and cognitive functions due to its antioxidant properties.
4. **4',5,7-Trihydroxy-6,8-diprenylisoflavone**
  - Antioxidant: Protects neurons from oxidative stress, which is critical in maintaining cognitive health and preventing cognitive decline.
5. **Coumarin; LC-ESI-QTOF; MS2; [M+H]<sup>+</sup>; CE**
  - Circulatory Benefits: Improves blood flow, including to the brain, which can help in reducing the risk of stroke and improving overall brain health.
6. **Meranzin hydrate**
  - Antidepressive Properties: Known for its use in traditional medicine to elevate mood and combat depressive symptoms.
7. **Rosavin**
  - Stress Reduction and Antidepressant: Has adaptogenic properties, helping the body resist physical and mental stress, and is used in the treatment of mild to moderate depression.
8. **Theanine**
  - Relaxation and Cognitive Enhancement: Promotes relaxation without sedation and can improve attention and focus, commonly found in green tea.
9. **Phenethylamine**
  - Mood Booster: Acts as a neuromodulator or neurotransmitter in the human central nervous system, often associated with elevated mood and increased focus.
10. **Creatine**
  - Energy Metabolism in the Brain: Supplies energy to parts of the body where it is needed most, potentially enhancing the function of neurons and overall brain health.

## 11. Cytosine

- **Genetic Stability and Brain Function:** As a component of DNA and RNA, it plays a fundamental role in the health and function of brain cells.

These metabolites contribute to neurological health through various mechanisms such as enhancing neuroprotection, improving circulation, reducing oxidative stress, and modulating neurotransmitter levels. These actions help in maintaining cognitive functions, reducing the impact of neurodegenerative diseases, and improving mental health. By influencing various aspects of brain health, these metabolites hold potential for inclusion in dietary supplements or therapeutic regimens aimed at enhancing neurological functions.

## CARDIOVASCULAR HEALTH

Metabolites beneficial for heart health and circulation:

- **Hesperidin:** Known for vascular protection and enhancing blood circulation.
- **4'-hydroxy-2',4,6'-trimethoxychalcone:** Flavonoids generally contribute to heart health through antioxidant effects.

### 1. Hesperidin

- **Vascular Protection:** Hesperidin strengthens blood vessels and enhances their function, which is crucial for maintaining arterial health. This effect helps in reducing the risk of vascular diseases like atherosclerosis, where arteries narrow due to plaque buildup.
- **Enhancing Blood Circulation:** It improves blood flow by reducing the viscosity of blood and expanding blood vessels. This not only enhances overall circulation but also reduces the workload on the heart.
- **Antioxidant Properties:** Hesperidin has strong antioxidant properties that help in neutralizing free radicals in the bloodstream. This reduces oxidative stress, a major contributor to cardiovascular disease.
- **Anti-inflammatory Effects:** It also possesses anti-inflammatory properties that help in reducing inflammation in the cardiovascular system, which is a key factor in heart disease.
- **Cholesterol Management:** Research suggests that hesperidin can influence lipid metabolism, thereby helping in the management of cholesterol levels.

### 2. 4'-hydroxy-2',4,6'-trimethoxychalcone

- **Antioxidant Effects:** This compound belongs to the class of flavonoids, which are known for their potent antioxidant capabilities. Antioxidants play a crucial role in protecting heart cells from oxidative damage caused by free radicals.
- **Anti-inflammatory Actions:** Like many other flavonoids, it may help reduce inflammation in the cardiovascular system, which is crucial for preventing chronic conditions such as heart disease.
- **Endothelial Function:** Flavonoids can improve the function of the endothelium (the inner lining of blood vessels). Better endothelial function typically leads to improved vasodilation (expansion of blood vessels), which aids in maintaining optimal blood pressure and good blood flow.
- **Reduction in Platelet Aggregation:** Flavonoids can help reduce the clumping together of blood cells called platelets. This reduction in platelet aggregation prevents blood clot formation, which is a common cause of heart attacks and strokes.

These metabolites interact with the cardiovascular system in multifaceted ways to promote heart health and improve circulation.



## Other Metabolites That Can Contribute

Besides hesperidin and 4'-hydroxy-2',4,6'-trimethoxychalcone, there are several other metabolites that can contribute positively to cardiovascular health and circulation based on their biological activities.

### 1. Nicotinamide

- **Vascular Health:** Nicotinamide can help in maintaining healthy blood vessels and improving blood flow by impacting the biochemical pathways involved in cell health and metabolism.

### 2. Quercetin

- **Antioxidant:** Known for its strong antioxidant properties, quercetin can reduce the oxidative stress on the cardiovascular system, which is a key factor in the prevention of arterial damage.
- **Anti-inflammatory:** Its anti-inflammatory properties can help reduce the inflammation of blood vessels and the heart, which is crucial in preventing chronic cardiovascular diseases.

### 3. Ferulic Acid

- **Cholesterol Reduction:** Ferulic acid has been noted for its potential to reduce cholesterol and triglyceride levels, which are crucial factors in cardiovascular health.
- **Protection Against Heart Disease:** Acts as an antioxidant, defending against damage caused by free radicals in the cardiovascular system.

### 4. Catechins (found in substances like green tea)

- **Endothelial Function:** Catechins are known to enhance endothelial function, leading to improved vasodilation and blood pressure regulation.
- **Lowering LDL Cholesterol:** Helps in reducing LDL (bad) cholesterol levels, thus reducing the risk of stroke and heart attack.

### 5. Resveratrol

- **Blood Pressure:** Might help lower blood pressure by increasing the production of nitric oxide, which helps blood vessels relax.
- **Heart Protection:** Provides heart-protective benefits, particularly due to its anti-inflammatory and antioxidant effects.

### 6. Omega-3 Fatty Acids (Eicosapentaenoic acid and Docosahexaenoic acid)

- **Triglycerides Reduction:** Known to significantly lower levels of triglycerides in the bloodstream, which can prevent the development of cardiovascular disease.
- **Anti-inflammatory:** Helps reduce systemic inflammation, a key contributor to heart disease.

### 7. L-Arginine

- **Nitric Oxide Production:** This amino acid is a precursor to nitric oxide, a potent vasodilator that improves blood flow and reduces blood pressure.
- **Heart Health:** Can improve vascular function and has been shown to help manage symptoms in people with mild to moderate heart failure.

## ANTIOXIDANT AND ANTI-INFLAMMATORY

Metabolites with anti-inflammatory and antioxidant properties:

- **Chrysin:** Has antioxidant, antispasmodic, and anti-inflammatory properties.
- **Ferulic acid:** Antioxidant that also reduces skin inflammation and aging.
- **Rosavin:** Known for its immunomodulatory and antioxidant effects.

In addition to Chrysin, Ferulic acid, and Rosavin, there are several other metabolites that exhibit anti-inflammatory and antioxidant properties.

### Anti-inflammatory and Antioxidant Metabolites

1. **(5R)-trans-1,7-diphenyl-5-hydroxy-6-hepten-3-one**
  - This compound likely possesses antioxidant properties due to its phenolic structure, which is common among compounds that act as free radical scavengers.
2. **4'-hydroxy-2',4,6'-trimethoxychalcone**
  - As a flavonoid, this compound is known for its potent antioxidant effects, helping to mitigate oxidative stress in the body.
3. **2'-Methoxyformonetin**
  - This is another flavonoid that typically exhibits both anti-inflammatory and antioxidant activities, beneficial for protecting cells from oxidative damage and reducing inflammation.
4. **6-Prenylnaringenin**
  - Known for its strong antioxidant activity, this flavonoid can also influence various inflammatory pathways, potentially providing anti-inflammatory benefits.
5. **Benzylidenacetone**
  - While primarily known for its use in fragrances, some related compounds have been studied for their anti-inflammatory properties.
6. **Bisdemethoxycurcumin**
  - A curcuminoid similar to curcumin, known for its significant anti-inflammatory effects and strong antioxidant capabilities, commonly used in the treatment of various inflammatory conditions.
7. **Coumarin; LC-ESI-QTOF; MS2; [M+H]<sup>+</sup>; CE**
  - Coumarins are not only used for their fragrance but also have been researched for their ability to reduce inflammation and their role in scavenging free radicals.
8. **Heteropeucenin, Methyl Ether**
  - Flavonoids like Heteropeucenin have been noted for their antioxidant properties, contributing to the reduction of oxidative stress in tissues.
9. **alpha-Naphthoflavone**
  - This compound acts as an antioxidant and is known for its ability to modulate enzyme systems involved in detoxification processes, which can indirectly reduce inflammation.
10. **Quinoxaline**
  - Certain derivatives of Quinoxaline are investigated for their anti-inflammatory and antioxidant properties, particularly in the context of medicinal chemistry.

These metabolites contribute to health by potentially reducing the risk of diseases associated with chronic inflammation and oxidative stress, such as cardiovascular diseases, certain types of cancer, and neurodegenerative diseases.

## CANCER-RELATED

Metabolites with potential anti-cancer properties:

- **Bisdemethoxycurcumin:** Known for its efficacy against bone cancer.
- **4-hydroxy-1'-methylspiro[benzo[e][1,3]oxazine-2,3'-indolin]-2'-one:** Anti-cancer properties.
- **Quinoxaline:** Has been researched for its anti-cancer properties.
- **6-Aminoindazole:** Anti-cancer potential.

## Other Metabolites That Can Contribute

From the list of metabolites you've provided, here are additional compounds that may have potential anti-cancer properties:

### 1. Chrysin

- **Activity:** Chrysin is a flavonoid that has shown promise in several studies for its anti-cancer effects. It can inhibit the proliferation of cancer cells and induce apoptosis (programmed cell death) in various cancer cell lines. Its mechanism often involves modulation of key pathways such as p53, which is crucial in controlling cell cycle and apoptosis.

### 2. Rosavin

- **Activity:** While primarily known for its adaptogenic effects, rosavin also has been studied for its potential anti-inflammatory and anti-cancer properties. It may help reduce tumor growth and proliferation by affecting various cellular signaling pathways.

### 3. Ferulic Acid

- **Activity:** Ferulic acid is an antioxidant that not only protects cells from oxidative damage but also has been observed to exhibit anti-cancer activities. It may help in preventing DNA damage and modulating cancer cell growth.

### 4. alpha-Naphthoflavone

- **Activity:** This compound is a synthetic flavonoid known for its role as an aromatase inhibitor, which is used in the treatment of breast cancer. Aromatase inhibitors reduce the levels of estrogen in the body, which can slow the growth of certain types of breast cancer cells that require estrogen to grow.

### 5. Coumarin

- **Activity:** Coumarin compounds, including some naturally occurring in plants, have been studied for their potential anti-tumor effects. They may inhibit cell proliferation and induce cell cycle arrest and apoptosis in various cancer cell models.

### 6. 6-Prenylnaringenin

- **Activity:** Known primarily for its presence in hops, this flavonoid has demonstrated potential estrogenic activities and might also exhibit protective effects against certain types of hormone-related cancers.

### 7. Medicagenic acid

- **Activity:** As a triterpenoid compound, medicagenic acid has shown anti-inflammatory and anti-cancer properties in preclinical studies, particularly against skin cancer.

### 8. L-Oxonoreleagnine

- **Activity:** This compound is studied for its anti-cancer properties, particularly its potential to induce cell death in cancer cells while sparing normal cells.

### 9. Benzimidazole

- **Activity:** Benzimidazole derivatives are known for their broad pharmacological activities, including anti-cancer effects. They work by inhibiting cancer cell growth and inducing apoptosis.

These metabolites represent a diverse group of chemical compounds found in various natural sources, each with a unique mechanism of action against cancer cells. They highlight the potential of natural and synthetic compounds in the development of anti-cancer therapies.



# METABOLIC HEALTH

Metabolites that influence metabolism, glucose control, and energy production:

- **3-Guanidinopropionic acid:** Lowers plasma glucose, influencing diabetes management.
- **Creatine:** Enhances energy production, beneficial in muscle and cognitive function.

Beyond 3-Guanidinopropionic acid and Creatine, which are directly implicated in metabolic processes and energy production, there are several other metabolites from the list provided that have the potential to influence metabolism, glucose control, and energy production. Here's an expanded view on a few notable ones:

## Metabolites Influencing Metabolism and Glucose Control:

### 1. 4'-hydroxy-2',4,6'-trimethoxychalcone:

- Bioactivity: This compound is a type of flavonoid, known for its antioxidative properties. Flavonoids can influence glucose metabolism by modulating enzyme activities involved in carbohydrate digestion and insulin signaling.

### 2. 6-Prenylnaringenin:

- Bioactivity: Recognized for its phytoestrogenic properties, this flavonoid can affect metabolic processes related to hormone regulation, potentially impacting glucose metabolism and insulin sensitivity.

### 3. Rosavin:

- Bioactivity: Found in *Rhodiola rosea*, rosavin has been studied for its adaptogenic effects, which include influencing cortisol levels and helping the body adapt to stress. It has implications for glucose metabolism by helping maintain balanced cortisol levels, which can affect insulin sensitivity.

### 4. Ferulic acid:

- Bioactivity: This is another potent antioxidant that can influence metabolic pathways. It has been studied for its potential to improve glucose and lipid metabolism, which can help in managing diabetes and enhancing overall energy production.

### 5. Chrysin:

- Bioactivity: Chrysin is known for its anti-inflammatory, antioxidant, and antidiabetic properties. It can help in improving insulin sensitivity and reducing blood glucose levels, contributing to better metabolic health.

### 6. Phenethylamine:

- Bioactivity: While primarily known for its psychoactive effects, phenethylamine can influence metabolic rate through its stimulating effects, which may indirectly impact energy levels and metabolism.

## Additional Considerations:

While the metabolites mentioned can influence metabolism and energy production, their effects can vary significantly based on dosage, the presence of other compounds, individual health conditions, and overall diet.

These metabolites represent potential targets for nutritional or pharmaceutical interventions aimed at enhancing metabolic health, improving energy utilisation, and controlling glucose levels. Their inclusion in dietary supplements or functional foods needs to be carefully considered.

## BONE AND JOINT HEALTH

Metabolites that may benefit bone health or have roles in joint care:

- **Methyl 4-hydroxy-3,5-dimethoxybenzoate:** Related to syringic acid, potential roles in plant metabolism and possibly in human health.

### Other Metabolites That Can Contribute

Beyond Methyl 4-hydroxy-3,5-dimethoxybenzoate, some other metabolites on the list may potentially have beneficial effects on bone health or roles in joint care, primarily due to their anti-inflammatory and antioxidant properties. Here's an overview of these metabolites:

#### 1. Bisdemethoxycurcumin

- **Anti-inflammatory Properties:** Bisdemethoxycurcumin is a derivative of curcumin known for its potent anti-inflammatory effects. Inflammation is a significant factor in many joint and bone diseases, including arthritis and osteoporosis.
- **Antioxidant Capabilities:** It helps in neutralizing free radicals, which can contribute to the degradation of bone density and joint health.
- **Potential Bone Protection:** Studies have suggested that curcumin derivatives can positively affect bone density by reducing bone loss.

#### 2. Hesperidin

- **Vascular Health:** By improving blood circulation, hesperidin ensures that nutrients necessary for bone health and joint function are efficiently distributed throughout the body.
- **Anti-inflammatory Effects:** Reduces inflammation in the body, which can help alleviate symptoms and progression of joint diseases like rheumatoid arthritis.

#### 3. Ferulic Acid

- **Antioxidant and Anti-inflammatory:** Known for its antioxidant properties, ferulic acid can reduce oxidative stress in body tissues, including bones and joints, which is crucial for preventing inflammatory ailments.
- **Bone Density Support:** Ferulic acid has been studied for its role in bone health, particularly in how it might help in preventing bone degradation.

#### 4. Rosavin

- **Stress Reduction:** By mitigating stress, rosavin can indirectly benefit bone health, as chronic stress is a known factor in reducing bone density and affecting overall skeletal health.
- **Anti-inflammatory Properties:** Helps in reducing inflammation, potentially beneficial for those suffering from joint disorders.

#### 5. 6-Prenylnaringenin

- **Estrogenic Effects:** This flavonoid has potent phytoestrogen properties, which can be crucial in maintaining bone density, especially in post-menopausal women who are at a higher risk of osteoporosis.

#### 6. Chrysin

- **Anti-inflammatory and Antioxidant:** Chrysin possesses both anti-inflammatory and antioxidant properties, which are beneficial in managing inflammatory joint diseases and may help in maintaining bone health.

#### 7. L-Methionine

- **Bone Health Support:** As an essential amino acid, L-methionine plays a role in the growth and repair of bone tissue. It is also a precursor to cysteine, which can influence detoxification and reduce oxidative stress in bone tissues.

These metabolites contribute to bone and joint health through various mechanisms, including anti-inflammatory and antioxidant actions, support of vascular health, and hormonal balance.

# DIGESTIVE AND MICROBIAL HEALTH

Metabolites with roles in digestion or microbial interaction:

- **1-Acetylimidazole:** Antifungal properties.
- **3-Aminobenzonitril:** Inhibits bacteria, could be useful in managing bacterial infections.

In addition to 1-Acetylimidazole and 3-Aminobenzonitril, several other metabolites from the list have potential roles in digestion or microbial interaction, which can impact digestive health or modulate the microbiome.

## Metabolites Influencing Digestive and Microbial Health

**Chrysin:**

- **Activity:** Known for its antioxidant, anti-inflammatory, and possibly antispasmodic properties.
- **Digestive Health Benefit:** Chrysin may help in reducing inflammation in the gastrointestinal tract, potentially alleviating conditions like IBS or inflammatory bowel disease (IBD).

### 1. Ferulic Acid:

- **Activity:** This compound is a strong antioxidant with anti-inflammatory effects.
- **Digestive Health Benefit:** It could protect the digestive tract from oxidative stress and inflammation, contributing to a healthier gut environment.

### 2. Coumarin:

- **Activity:** Coumarin has antithrombotic and anti-inflammatory properties.
- **Microbial Interaction:** While primarily known for its role in blood health, coumarin may also influence gut microbiota composition due to its bioactive properties, although specific effects on digestion are less direct.

### 3. Hesperidin:

- **Activity:** As a flavonoid, it's noted for vascular protection and enhancing blood circulation.
- **Digestive Health Benefit:** Improves blood flow in the gastrointestinal system, which can aid in better nutrient absorption and gut health.

### 4. Propachlor OXA:

- **Activity:** This compound is a herbicide and may not have direct beneficial effects on health but can impact microbial communities in the environment.
- **Microbial Interaction:** Although it is generally undesirable for ingestion, studying its impact on microbes could provide insights into resistance mechanisms or detoxification pathways.

### 5. Benzylidenacetone:

- **Activity:** Flavouring agent with potential antimicrobial properties.
- **Microbial Interaction:** Its antimicrobial action could be studied for potential use in managing gut microbial populations or in food preservation.

### 6. Phenethylamine:

- **Activity:** A psychoactive compound that can influence various neurotransmitters.
- **Digestive Health Benefit:** There are suggestions that phenethylamine may have an impact on gut-brain axis communication, which can influence digestive health and emotional well-being.

### 7. Benzimidazole:

- **Activity:** Known for its use as an anti-worm (anthelmintic) medication.
- **Digestive Health Benefit:** Effective in treating infections caused by helminths (worms) in the gastrointestinal tract, thereby improving digestive health and nutrient absorption.

Each of these metabolites interacts with the body's systems in complex ways, and their roles in digestive health can vary from direct to more nuanced influences on systemic processes.

## METABOLITES POTENTIALLY BENEFICIAL FOR BOWEL MOVEMENT

### 1. Hesperidin:

- Gastrointestinal Benefits: Hesperidin is known for its anti-inflammatory properties and could help reduce inflammation in the gastrointestinal tract, potentially aiding in conditions like IBS and promoting smoother bowel movements.

### 2. Chrysin:

- Antispasmodic Properties: Chrysin may help in reducing spasms in the gut, which can aid in alleviating discomfort associated with irregular bowel movements.

### 3. Isovaleric acid:

- Fiber-Like Benefits: As a short-chain fatty acid, isovaleric acid could be involved in the fermentation process in the gut, which is beneficial for the colon health and can promote regular bowel movements.

### 4. L-Methionine:

- Detoxification and Liver Health: While primarily noted for its role in liver health and detoxification, L-Methionine's overall contribution to digestive health could indirectly support bowel movement by improving metabolic processes.

### 5. Phenethylamine:

- Gut Motility: Known for its stimulant effects, phenethylamine might influence gut motility, although this is a less direct application and more speculative in nature.

### 6. Ferulic acid:

- Antioxidant Properties: Ferulic acid has antioxidant properties that can help manage oxidative stress in the gut, contributing to a healthier digestive environment and potentially aiding bowel movements.

To identify metabolites from the provided list that may help with bowel movement, we need to consider metabolites known for their effects on digestive health, particularly those that can promote motility, relieve constipation, or are involved in digestive processes. These metabolites may be relevant to bowel health, based on their known biological activities:

## SUPPORTING VARIOUS HEALTH ASPECTS.

The mentioned metabolites could be associated with and support various health aspects such as weight loss, energy boost, gut health, liver and kidney function, and skin health:

### 1. Weight Loss

- **3-Guanidinopropionic acid:** This compound is known to influence glucose metabolism, which can be beneficial in managing weight as it potentially improves insulin sensitivity and reduces blood sugar levels, aiding in weight management efforts.

### 2. Energy Boost

- **Creatine:** Widely recognized for its role in energy production in muscle cells, creatine is used to improve exercise performance and increase muscle mass, which can lead to enhanced metabolic rates and energy levels.
- **Nicotinamide (Vitamin B3):** Essential for energy production at a cellular level, it helps in the conversion of food into energy, supporting various bodily functions including energy metabolism.

### 3. Gut Health

- **L-Methionine:** An essential amino acid that is necessary for the growth and repair of gut tissue. It also plays a role in the synthesis of glutathione, a crucial antioxidant that protects the gut lining.
- **Ferulic acid:** Known for its antioxidant properties, it can reduce oxidative stress in the gut, potentially protecting against inflammatory gut disorders.

### 4. Liver and Kidney

- **Chrysin:** This flavonoid has shown potential in protecting the liver by exhibiting anti-inflammatory and antioxidant effects, which can help reduce liver damage due to toxins or diseases.
- **Rosavin:** Has shown protective effects against certain toxins in the liver, suggesting a potential role in liver health maintenance.

## 5. Skin

- **Hesperidin:** Its strong antioxidant properties help in protecting the skin from free radical damage, and it also improves skin blood flow, enhancing overall skin health and appearance.
- **Nicotinamide:** Promotes skin health by supporting the repair of damaged skin cells and reducing inflammation. It is commonly used in skincare to treat acne and reduce signs of aging.
- **4'-hydroxy-2',4,6'-trimethoxychalcone and other flavonoids:** These compounds are known for their anti-inflammatory and antioxidant properties, beneficial for skin health by protecting against UV radiation and reducing signs of aging.

Each of these metabolites has unique properties that can be beneficial in supporting health and wellness across various body systems. Their effectiveness in real-world applications often depends on the dose and form in which they are consumed, as well as individual health conditions and lifestyle factors.

## SUMMARY

Metabolites such as hesperidin, chrysin, and ferulic acid offer multi-faceted health benefits, from enhancing cardiovascular health to supporting digestive and cognitive functions. Hesperidin improves vascular health and circulation, aiding in heart health and reducing the risk of vascular diseases. Chrysin provides gastrointestinal benefits due to its antispasmodic and anti-inflammatory properties, while ferulic acid's antioxidant effects are crucial in managing oxidative stress and inflammation, common in various chronic conditions.

Isovaleric acid and L-Methionine enhance digestive health through their roles in the gut microbiome and liver health, respectively. Nicotinamide supports brain health through its involvement in cellular metabolism and DNA repair. Collectively, these metabolites highlight the importance of targeted nutritional strategies in health management and the potential of dietary and supplemental choices to significantly impact well-being and disease prevention.

## RECOMMENDATIONS

The substantial discrepancy between the number of metabolites detected and those identified highlights a significant frontier for scientific exploration and discovery. Our research recommends the following strategic actions:

- **Enhance Research Funding:** Increasing the allocation of resources to support this niche area or an investment or partnership.
- **Develop Interdisciplinary Teams:** Forming interdisciplinary research teams that include Tohunga Rakau, Ethnobotanists, Chemists, and Pharmacologists.
- **Possible Global Database Expansion:** Contributing to and expanding global metabolite databases to include more data on indigenous plants, facilitating better identification and understanding of plant-based compounds. **All data will be secured and controlled by Māori.**

In conclusion, while the current state of metabolite identification presents challenges, it also opens up vast opportunities for scientific discovery and the development of new therapeutic agents that are grounded in the traditional knowledge of New Zealand's indigenous plants. The path forward is one of inclusive, collaborative, and well-resourced research efforts that respect and integrate the wisdom of traditional practices with scientific innovation.