

HEALTH & *Nutrition* SUMMARY

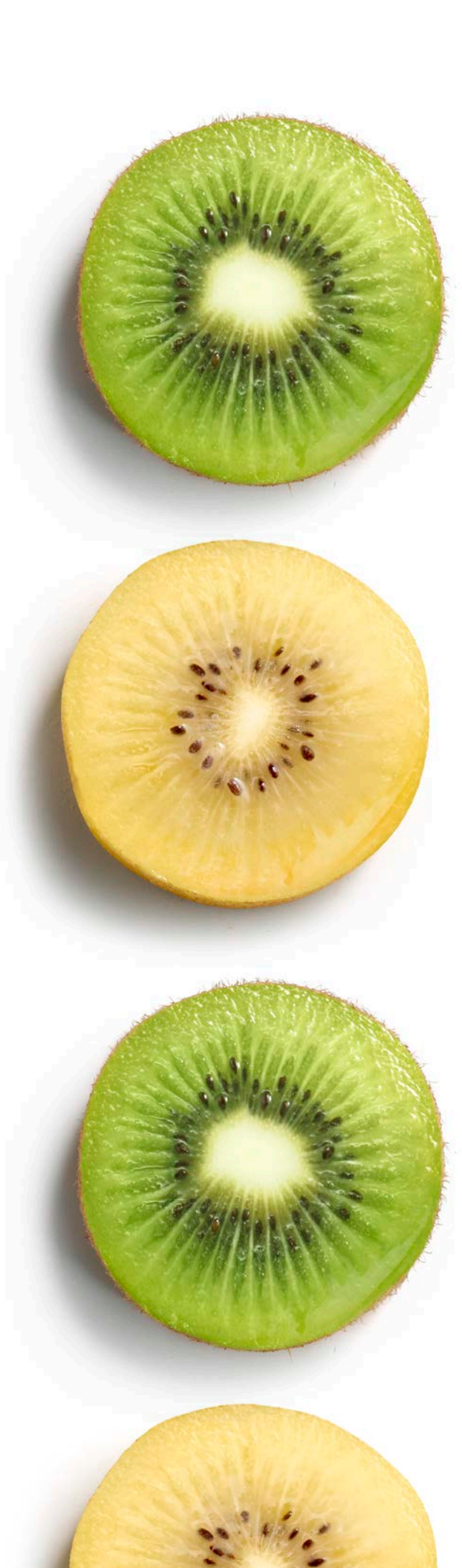


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INTRODUCTION

At Zespri, we believe in taking a holistic and feel-good approach to healthy living. Every day we help consumers around the world make healthier lifestyle choices by delivering refreshingly delicious kiwifruit that are packed with unrivalled nutrition. We take pride in our land and what comes out of it, so we're always thinking of kiwifruit and the ways in which this delicious fruit is good for everyone.

We continue to invest in health and nutrition research to help build new knowledge and increase the awareness and understanding of kiwifruit's benefits to overall human health. Zespri developed a world-class health and nutrition research programme by joining forces with the Riddet Institute to form the Scientific Advisory Board (SAB) back in 2008. The Riddet Institute is a New Zealand Government-funded Centre of Research Excellence with a widely acknowledged international standing. The main aims of the SAB are to ensure that Zespri research projects are independently reviewed by experienced and respected scientists in the nutrition and health field. The projects are considered for their fit with the overarching Zespri Health Strategy and the SAB also reviews the scientific protocols and ensures that the research provider is the best science team for the required work. SAB members have been carefully selected to cover the range of activities that we are working on, with diverse expertise from dietetics to gastroenterology to psychology.

We know the importance of demonstrating the scientific efficacy of our kiwifruit, and as such, this health booklet summarises the existing and latest research on the nutritional goodness of kiwifruit.

Health starts from within, and Zespri aims to support people feeling good from the inside out.

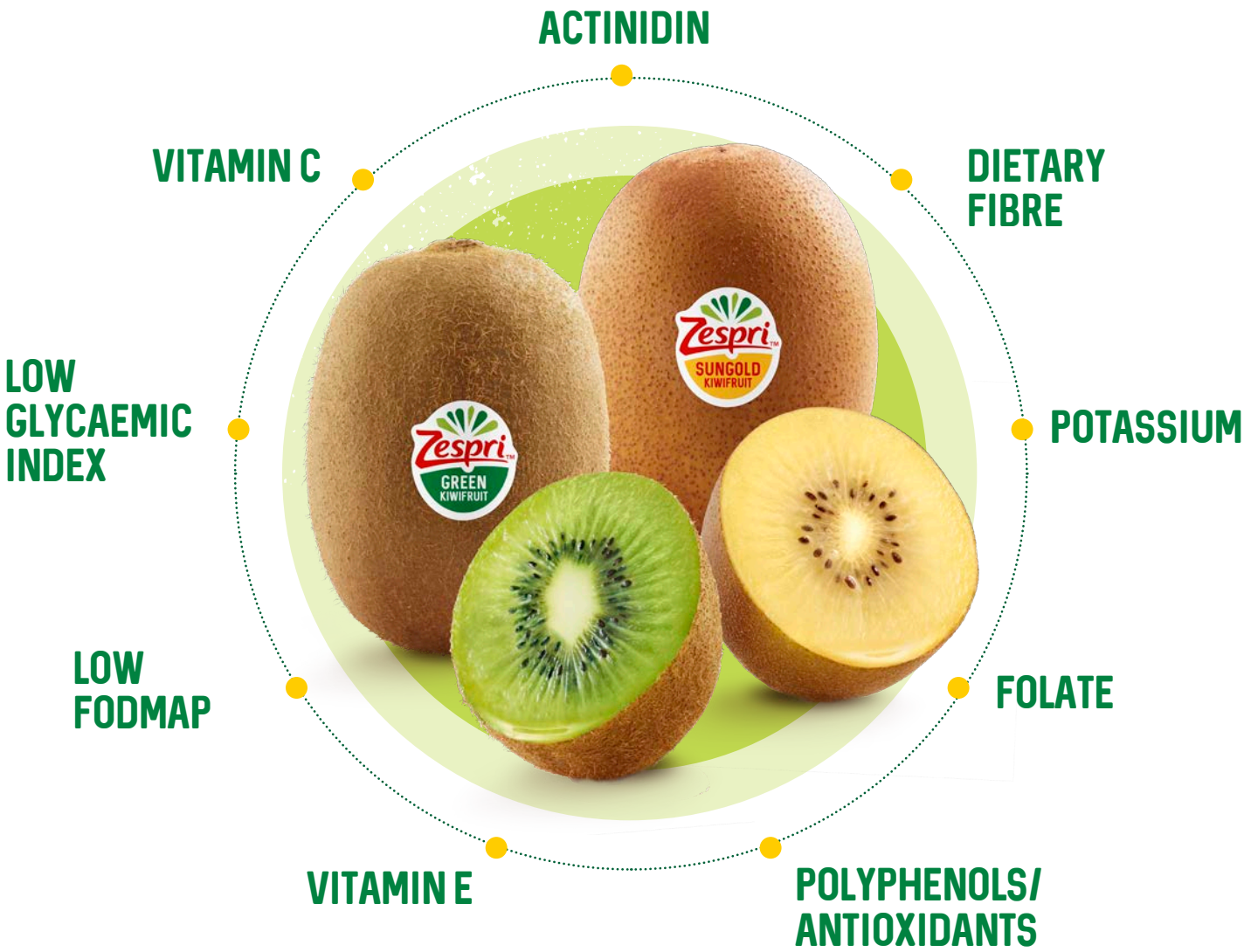
THE GOODNESS OF KIWIFRUIT

THE GOODNESS OF KIWIFRUIT

Key Health Attributes

Zespri SunGold and Green Kiwifruit contain plenty of healthful nutrients and attributes to help our bodies thrive and support our overall health, particularly with regard to:

- THE POWER OF VITAMIN C
- DIGESTIVE HEALTH
- METABOLIC HEALTH



THE GOODNESS OF KIWIFRUIT

Nutritional Composition

NUTRIENT CONTENT OF ZESPRI KIWIFRUIT

Sources:
USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.
The Concise New Zealand Food Composition Tables 13th Edition, 2018.
Zespri International Limited.
Nutrient adequacy and Nutrient Density Calculations based on US Daily Values and Calculations in Darmon N. A Nutrient Density Standard for Vegetables and Fruits. *J Am Diet Assoc.* 2005;105:1861-87.
Lesperance L, *et al.* Nutritional assessment of ZESPRI® GREEN Kiwifruit ('Hayward') and ZESPRI® GOLD Kiwifruit ('Hort16A'). Palmerston North: Plant & Food Research; 2010. 42/SPTS No. 3199.
Sivakumaran S, *et al.* The nutritional composition of Zespri® SunGold Kiwifruit (Gold3) and Zespri® Sweet Green Kiwifruit (Green14). Palmerston North: Plant & Food Research; 2013. 107/SPTS No. 8606.

Since 2008, Zespri has worked to populate global data sources to include nutrition content for important kiwifruit varieties. Publicly available databases, such as The Concise New Zealand Food Composition Tables and the USDA National Nutrient Database for Standard Reference, ensure that robust nutrition information is available and that approved analytical methodology has been used to determine the nutrient content of foods.

Data populated in this booklet is sourced primarily from the Concise New Zealand Food Composition Tables 13th Edition, 2018; the USDA National Nutrient Database for Standard Reference Legacy Release, April 2018, where additional information was available; and data on file with Zespri.

| NUTRIENT | UNIT/100 G EDIBLE FLESH | KIWIFRUIT, ZESPRI GREEN | KIWIFRUIT, ZESPRI SUNGOLD |
|------------------------|-------------------------|-------------------------|---------------------------|
| PROXIMATES | | | |
| WATER | g | 83.5 | 82.4 |
| ENERGY | kcal | 61.0 | 63.0 |
| ENERGY (NIP) | kJ | 250.0 | 280.0 |
| PROTEIN | g | 1.2 | 1.0 |
| FAT | g | 0.7 | 0.3 |
| CARBOHYDRATE | g | 9.1 | 12.4 |
| DIETARY FIBRE | g | 3.0 | 1.4 |
| SUGARS | g | 8.8 | 12.3 |
| MINERALS | | | |
| CALCIUM (CA) | mg | 27.0 | 17.3 |
| COPPER (CU) | mg | 0.12 | 0.15 |
| IRON (FE) | mg | 0.2 | 0.2 |
| MAGNESIUM (MG) | mg | 14.4 | 12.3 |
| MANGANESE (MN) | mg | 0.08 | 0.05 |
| SELENIUM (SE) | µg | 0.6 | 0.4 |
| SODIUM (NA) | mg | 2.3 | 2.7 |
| PHOSPHORUS (P) | mg | 34.0 | 25.2 |
| POTASSIUM (K) | mg | 301.0 | 315.0 |
| ZINC (ZN) | mg | 0.1 | 0.1 |
| VITAMINS | | | |
| B1 - THIAMIN | mg | 0.0 | 0.0 |
| B2 - RIBOFLAVIN | mg | 0.05 | 0.07 |
| B3 - NIACIN | mg | 0.0 | 0.23 |
| B5 - PANTOTHENIC ACID | mg | <1.0 | 0.12 |
| B6 - PYRIDOXINE | mg | 0.07 | 0.08 |
| B9 - FOLATE | µg | 38.2 | 31.0 |
| CHOLINE | mg | <10.0 | 1.9 |
| VITAMIN B12 | µg | <0.2 | 0.08 |
| VITAMIN A (RAE) | µg | 9.0 | 2.3 |
| VITAMIN A | IU | 90.0 | 23.0 |
| VITAMIN C | mg | 85.1 | 161.3 |
| VITAMIN E | mg | 0.86 | 1.4 |
| VITAMIN K | µg | 11.0 | 6.1 |
| OTHER | | | |
| BETA-CAROTENE | µg | 54.0 | 14.0 |
| LUTEIN + ZEAXANTHIN | µg | 138.0 | 23.0 |
| NUTRIENT ADEQUACY (NA) | Sum %DV | 8.7 | 14.2 |
| NUTRIENT DENSITY | NA per 100 kcal | 14.3 | 22.5 |
| GLYCAEMIC INDEX | GI | 39 | 38 |

Nutrient Adequacy/ Nutrient Density

A COMPARISON OF THE NUTRIENT ADEQUACY AND NUTRIENT DENSITY PROPERTIES OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

Notes:

Based on National Institutes of Health. Labeling Daily Values on the reference caloric intake of 2,000 calories for adults and children aged 4 years and older. <https://www.dslid.nlm.nih.gov/dslid/dailyvalue.jsp>.

Calculations based on US Daily Values and Calculations. in Darmon N. A Nutrient Density Standard for Vegetables and Fruits. *J Am Diet Assoc.* 2005;105:1881-87.

Sources:

USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.

The Concise New Zealand Food composition Tables 13th Edition, 2018.

Zespri International Limited.

Lesperance L, *et al*. Nutritional assessment of ZESPRI® GREEN Kiwifruit ('Hayward') and ZESPRI® GOLD Kiwifruit ('Hort16A'). Palmerston North: Plant & Food Research; 2010. 42/SPTS No. 3199.

Sivakumaran S, *et al*. The nutritional composition of Zespri® SunGold Kiwifruit (Gold3) and Zespri® Sweet Green Kiwifruit (Green14). Palmerston North: Plant & Food Research; 2013. 107/SPTS No. 8606.

Zespri uses a published formula¹ to calculate the nutrient adequacy and the nutrient density of its kiwifruit varieties and other commonly eaten fruits.

The **nutrient adequacy** tells us how many nutrients it provides relative to its weight. The calculation we use factors the nutrient composition of each fruit as a percentage of the of the Recommended Daily Allowance (RDA) for 16 specific vitamins and minerals, including protein, fibre, calcium, iron, vitamin A, thiamin B1, riboflavin B2, niacin B3, vitamin B6, vitamin B12, folate, vitamin C, vitamin D, vitamin E, pantothenic acid B5, and magnesium.

The **nutrient density** tells us how many nutrients the food provides relative to the number of calories it contains. We divide the nutrient adequacy score by the number of calories it has.

As you can see in the table below, the high amount of vitamin C in kiwifruit is the primary driver of its **high nutrient adequacy** score. Other nutrients boosting this score include fibre, folate, and vitamin E. Kiwifruit’s uniquely high nutrient density is one of the key advantages it has over other commonly eaten fruit.

| | NUTRIENT ADEQUACY |
|---------------------------|-------------------|
| KIWIFRUIT, ZESPRI SUNGOLD | 14.2 |
| LONGAN | 12.8 |
| AVOCADO | 10.8 |
| KIWIFRUIT, ZESPRI GREEN | 8.7 |
| DURIAN | 8.5 |
| MELON (CANTALOUPE) | 7.0 |
| ORANGES | 6.8 |
| MANDARINS | 6.7 |
| POMEGRANATES | 6.2 |
| PEARS | 4.1 |
| MANGO | 4.0 |
| BANANAS | 3.7 |
| PINEAPPLE | 3.7 |
| CHERRIES | 3.4 |
| CRANBERRIES | 3.1 |
| STRAWBERRIES | 3.1 |
| TOMATO | 2.7 |
| WATERMELON | 2.7 |
| BLUEBERRIES | 2.6 |
| GRAPES | 2.5 |
| APPLES | 1.9 |
| PAPAYA | 1.9 |

| | NUTRIENT DENSITY |
|---------------------------|------------------|
| KIWIFRUIT, ZESPRI SUNGOLD | 22.5 |
| LONGAN | 21.3 |
| MELON (CANTALOUPE) | 20.6 |
| TOMATO | 14.9 |
| ORANGES | 14.4 |
| KIWIFRUIT, ZESPRI GREEN | 14.3 |
| MANDARINS | 12.7 |
| STRAWBERRIES | 9.7 |
| WATERMELON | 8.9 |
| POMEGRANATES | 7.4 |
| PINEAPPLE | 7.3 |
| PEARS | 7.2 |
| CRANBERRIES | 6.8 |
| MANGO | 6.7 |
| DURIAN | 5.8 |
| AVOCADO | 5.4 |
| CHERRIES | 5.4 |
| BLUEBERRIES | 4.5 |
| PAPAYA | 4.4 |
| BANANAS | 4.2 |
| APPLES | 3.6 |
| GRAPES | 3.6 |



BOOST YOUR HEALTH WITH FRUIT

Eating healthily throughout your life helps to prevent malnutrition as well as noncommunicable diseases and conditions. Unfortunately, the increased production of processed foods and changing lifestyles means dietary patterns have shifted, and people are commonly consuming more foods high in energy, fats, free sugars, as opposed to nutrient-rich fresh fruit, vegetables and wholegrains.

The World Health Organisation recommends eating at least 400 grams, or five portions, of fruit and vegetables per day to reduce the risk of noncommunicable disease, and ensure a daily intake of dietary fibre^{2,3}.

- Fruit and vegetable intake can be improved by:**
- Always include vegetables in meals
 - Snack on fresh fruit and vegetables
 - Eat seasonally
 - Eat a variety of fruit and vegetables

NUTRITIONAL
COMPOSITION

Vitamin C

Vitamin C can be found naturally in some foods, and is also available as a dietary supplement. Humans can only obtain vitamin C through diet, and because the body can only store a certain amount, it must be ingested daily⁴. Fruit and vegetables are some of the best available sources of vitamin C, and both Zespri SunGold and Green contain high sources of vitamin C compared to other commonly eaten fruit.

VITAMIN C COMPARISON OF ZESPRI KIWIFRUIT
AND OTHER COMMONLY EATEN FRUIT

| | Measure | Vitamin C | US RDA* | US RDA | EU PRI** | EU PRI | NZ RDI** | NZ RDI |
|---------------------------|---------|-----------|---------|--------|----------|--------|----------|--------|
| | g | mg | mg | % | mg | % | mg | % |
| Kiwifruit, Zespri SunGold | 100 | 161.3 | 90 | 178.89 | 95 | 169.47 | 45 | 357.78 |
| Kiwifruit, Zespri Green | 100 | 85.1 | 90 | 94.56 | 95 | 89.58 | 45 | 189.11 |
| Longan | 100 | 84.0 | 90 | 93.33 | 95 | 88.42 | 45 | 186.67 |
| Papaya | 100 | 60.9 | 90 | 67.67 | 95 | 64.11 | 45 | 135.33 |
| Oranges | 100 | 48.4 | 90 | 53.78 | 95 | 50.95 | 45 | 107.56 |
| Strawberries | 100 | 45.6 | 90 | 50.67 | 95 | 48.00 | 45 | 101.33 |
| Mango | 100 | 30.0 | 90 | 33.33 | 95 | 31.58 | 45 | 66.67 |
| Melon (cantaloupe) | 100 | 27.1 | 90 | 30.11 | 95 | 28.53 | 45 | 60.22 |
| Pineapple | 100 | 25.0 | 90 | 27.78 | 95 | 26.32 | 45 | 55.56 |
| Mandarins | 100 | 21.0 | 90 | 23.33 | 95 | 22.11 | 45 | 46.67 |
| Cherries | 100 | 20.0 | 90 | 22.22 | 95 | 21.05 | 45 | 44.44 |
| Durian | 100 | 19.7 | 90 | 21.89 | 95 | 20.74 | 45 | 43.78 |
| Cranberries | 100 | 14.0 | 90 | 15.56 | 95 | 14.74 | 45 | 31.11 |
| Tomato | 100 | 11.8 | 90 | 13.11 | 95 | 12.42 | 45 | 26.22 |
| Grapes | 100 | 10.8 | 90 | 12.00 | 95 | 11.37 | 45 | 24.00 |
| Pomegranates | 100 | 10.2 | 90 | 11.33 | 95 | 10.74 | 45 | 22.67 |
| Bananas | 100 | 5.5 | 90 | 6.11 | 95 | 5.79 | 45 | 12.22 |
| Watermelon | 100 | 5.0 | 90 | 5.56 | 95 | 5.26 | 45 | 11.11 |
| Apples | 100 | 4.8 | 90 | 5.33 | 95 | 5.05 | 45 | 10.67 |
| Blueberries | 100 | 3.8 | 90 | 4.22 | 95 | 4.00 | 45 | 8.44 |
| Pears | 100 | 3.0 | 90 | 3.33 | 95 | 3.16 | 45 | 6.67 |
| Avocado | 100 | 2.7 | 90 | 3.00 | 95 | 2.84 | 45 | 6.00 |

*Based on National Institutes of Health. Labeling Daily Values on the reference caloric intake of 2,000 calories for adults and children aged 4 years and older. <https://www.dslid.nlm.nih.gov/dslid/daily-value.jsp>.
**Based on healthy adult female
Sources:
USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.
The Concise New Zealand Food composition Tables 13th Edition, 2018.
Zespri International Limited.
Vitamin C. Office of Dietary Supplements. Accessed September 8, 2019 at <http://ods.od.nih.gov/factsheets/VitaminC-HealthProfessional>.
EFSA. Scientific Opinion on Dietary Reference Values for Vitamin C. Accessed September 8, 2019 at <https://www.efsa.europa.eu/en/efsajournal/pub/3418>.
Australian Government: Ministry of Health. Nutrient Reference Values for Australia and New Zealand. Accessed September 9, 2019 at <https://www.nrv.gov.au/nutrients>.

Fruits and vegetables are generally regarded as the best available source of vitamin C, and Zespri Kiwifruit is one of the best sources of vitamin C in this category, as just one SunGold surpasses the NZ Recommended Daily Intake (RDI).

EXPERTS INCLUDE
KIWIFRUIT
AMONG THE MOST
NUTRITIOUS FOODS

In a study published in 2015, researchers analysed food and nutritional data on a global scale and calculated each food’s nutritional fitness, which measures the food quality based on its overall nutritional balance and composition. Calculations from this study found SunGold and Green Kiwifruit among the healthiest food and fruit choices, ranked as number 68 and 69, respectively, among the top 100 foods and number 35 (combined), among the top 40 fruits and vegetables⁵.

IRON
ENRICHMENT

Poor iron levels remain one of the most common micronutrient concerns worldwide, but research has shown that high levels of vitamin C can improve iron uptake from your diet. New Zealand researchers found eating two Zespri Gold Kiwifruit alongside an iron-fortified breakfast cereal significantly increased the iron levels of young women with low iron stores⁶.



NUTRITIONAL COMPOSITION

Dietary Fibre

ACROSS NZ, USA AND EU, DIETARY RECOMMENDATIONS FOR TOTAL FIBRE ARE 25 GRAMS PER DAY.

DIETARY FIBRE COMPARISON OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

| | Measure | Dietary Fibre | US RDA* | US RDA | EU RDA** | EU RDA | NZ AI** | NZ AI |
|---------------------------|---------|---------------|---------|--------|----------|--------|---------|-------|
| | g | g | g | % | g | % | g | % |
| Avocado | 100 | 5.1 | 25 | 20.40 | 25 | 20.40 | 25 | 20.40 |
| Pomegranates | 100 | 4.0 | 25 | 16.00 | 25 | 16.00 | 25 | 16.00 |
| Blueberries | 100 | 3.9 | 25 | 15.60 | 25 | 15.60 | 25 | 15.60 |
| Durian | 100 | 3.8 | 25 | 15.20 | 25 | 15.20 | 25 | 15.20 |
| Cranberries | 100 | 3.6 | 25 | 14.40 | 25 | 14.40 | 25 | 14.00 |
| Pears | 100 | 3.2 | 25 | 12.80 | 25 | 12.80 | 25 | 12.80 |
| Kiwifruit, Zespri Green | 100 | 3.0 | 25 | 12.00 | 25 | 12.00 | 25 | 12.00 |
| Pineapple | 100 | 2.1 | 25 | 8.40 | 25 | 8.40 | 25 | 8.40 |
| Apples | 100 | 2.0 | 25 | 8.00 | 25 | 8.00 | 25 | 8.00 |
| Bananas | 100 | 1.8 | 25 | 7.20 | 25 | 7.20 | 25 | 7.20 |
| Oranges | 100 | 1.8 | 25 | 7.20 | 25 | 7.20 | 25 | 7.20 |
| Strawberries | 100 | 1.8 | 25 | 7.20 | 25 | 7.20 | 25 | 7.20 |
| Papaya | 100 | 1.7 | 25 | 6.80 | 25 | 6.80 | 25 | 6.80 |
| Mango | 100 | 1.5 | 25 | 6.00 | 25 | 6.00 | 25 | 6.00 |
| Kiwifruit, Zespri SunGold | 100 | 1.4 | 25 | 5.60 | 25 | 5.60 | 25 | 5.60 |
| Mandarins | 100 | 1.4 | 25 | 5.60 | 25 | 5.60 | 25 | 5.60 |
| Tomato | 100 | 1.4 | 25 | 5.60 | 25 | 5.60 | 25 | 5.60 |
| Cherries | 100 | 1.3 | 25 | 5.20 | 25 | 5.20 | 25 | 5.20 |
| Longan | 100 | 1.1 | 25 | 4.40 | 25 | 4.40 | 25 | 4.40 |
| Melon (cantaloupe) | 100 | 0.5 | 25 | 2.00 | 25 | 2.00 | 25 | 2.00 |
| Watermelon | 100 | 0.5 | 25 | 2.00 | 25 | 2.00 | 25 | 2.00 |
| Grapes | 100 | 0.0 | 25 | 0.00 | 25 | 0.00 | 25 | 0.00 |

Dietary fibre has been linked with a multitude of health benefits, including digestive health, diabetes, improved blood cholesterol levels and weight management. There are two types of fibre that we need in our daily diets: soluble and insoluble.

- SOLUBLE FIBRE** – includes pectins, gums and mucilage, which are found mainly in plant cells. Soluble fibre, when eaten regularly as part of a diet low in saturated fat and trans fat, is associated with better diet quality, a reduced risk of cardiovascular disease, and moderately lower cholesterol levels.
 - Good sources include fruit, vegetables, oat bran, barley, seed husks, flaxseed, psyllium, dried beans, lentils, peas, soy milk and soy products.
- INSOLUBLE FIBRE** – includes cellulose, hemicelluloses and lignin, which make up the structural parts of plant cell walls. A major role of insoluble fibre is to add bulk to faeces and to alleviate constipation and associated problems such as haemorrhoids. Insoluble fibre is also linked to reduced cardiovascular risk, as well as slower progression of cardiovascular disease in people at higher-risk.
 - Good sources include wheat bran, corn bran, rice bran, fruit and vegetables, nuts, seeds, dried beans and wholegrain foods.

Kiwifruit contains both soluble and insoluble fibre at a ratio of approximately 1:4 in Green Kiwifruit and 1:3 in SunGold⁷. The soluble fibre fraction contains almost exclusively pectic polysaccharides that have the ability to retain water and form gels, which supports digestive comfort. The insoluble fraction is mostly cellulose and hemicelluloses, which make up the structural parts of plant cell walls, with small amounts of pectin, which adds bulk to the stool and facilitates efficient digestion.

CAN YOU EAT THE SKIN?

Yes! Zespri SunGold Kiwifruit has a smooth skin, but all varieties, even those with “hair,” can be eaten once washed. In fact, consuming the skin of kiwifruit offers many benefits⁸.

EASY SNACKING: Eat unpeeled slices or bite into your kiwifruit like an apple. You can also put the fruit in a blender.

ADDED FIBRE: When eaten with its smooth skin, Zespri SunGold provides nearly double the fibre with four grams per two kiwifruit serving.

ADDED VITAMINS AND MINERALS: Eating SunGold skin provides 34 percent folate and 32 percent more vitamin E to the diet than eating the flesh alone. The vitamin E found in the skin, when paired with the high vitamin C content in the flesh, helps support both the immune system and skin health.

MORE ANTIOXIDANT POWER: 30 percent of the total phenolics in SunGold are in the skin. Phenolics provide antioxidant support for the immune system and protect the body from stressors, such as environmental pollutants and the sun’s harmful rays.

*Based on National Institutes of Health. Labeling Daily Values on the reference caloric intake of 2,000 calories for adults and children aged 4 years and older. <https://www.dslid.nlm.nih.gov/dslid/dailyvalue.jsp>.
**Based on healthy adult female.

Sources:
USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.
The Concise New Zealand Food composition Tables 13th Edition, 2018.
Zespri International Limited.
National Academies Press. Dietary Reference Intakes for Energy, Carbohydrate, Fibre, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Accessed 9.8.19 at <https://www.nap.edu/read/6015/chapter/3>.
EFSA. Scientific Opinion on Dietary Reference Values for carbohydrates and dietary fibre. Accessed 9.8.19 at <https://www.efsa.europa.eu/en/efsajournal/pub/1462>.
Australian Government: Ministry of Health. Nutrient Reference Values for Australia and New Zealand. Accessed 9/9/19 at <https://www.nrv.gov.au/nutrients>.

NUTRITIONAL
COMPOSITION

Actinidin

Actinidin is a cysteine protease enzyme known for its ability to break down proteins, which prompted research on the role of kiwifruit in promoting digestive comfort through improved protein digestion and action on digestive motility. Actinidin may also play a role in maintaining muscle health as it has been shown to enhance protein digestion in the small intestine^{9,10}, which may improve protein absorption and could translate to improved muscle health.

How much actinidin is in kiwifruit?

RELATIVE LEVELS OF ACTINIDIN IN ZESPRI
KIWIFRUIT VARIETIES

| VARIETY | RELATIVE ACTINIDIN ACTIVITY |
|------------------------|--------------------------------|
| Zespri Green (Hayward) | 100% |
| Zespri SunGold | 26% |

The level of actinidin in Zespri Kiwifruit differs between varieties¹¹ and it is often difficult to compare values as methods of measurement and reporting differ. Actinidin levels may also be a function of maturity¹¹. In addition, Zespri analysis investigating the levels in newly released varieties shows a range of actinidin levels. Research is exploring the effects of actinidin on potential digestive health benefits.

KIWIFRUIT, ACTINIDIN AND FOOD ALLERGIES

Actinidin may be responsible for a small number of people who report allergic reactions to kiwifruit. Those that have mild allergies to Green Kiwifruit do not typically have the same reaction to SunGold, but should consult a healthcare professional before trialling it.

Actinidin may help improve digestive health by breaking down proteins and improving functions at both the gastric and intestinal levels. This natural digestive enzyme occurs only in kiwifruit, especially in the Green variety.

Due to actinidin’s ability to break down proteins, it is common for many marinade recipes to include kiwifruit for its softening and tenderising ability.

NUTRITIONAL
COMPOSITION

FODMAPS

Gastrointestinal issues, including Irritable Bowel Syndrome (IBS), are common conditions worldwide and can negatively affect an individual’s quality of life¹². It is estimated 7-21 percent of the global population has IBS¹³. Gastrointestinal symptoms associated with IBS can be triggered by poorly absorbed, fermentable, short-chain carbohydrates in certain food and beverages called FODMAPs (Fermentable Oligo-, Di-, Mono-saccharides and Polyols) can be fermented by bacteria in the colon-releasing gases¹⁴⁻¹⁶ that stretch the bowel, causing bloating, wind and pain. They can also cause water to enter the colon, resulting in loose movements and diarrhoea.

FODMAP COMPARISON OF ZESPRI KIWIFRUIT AND OTHER
COMMONLY EATEN FRUIT

| | Goal Comparison Measure | Approximate Measure | FODMAP Rank |
|---------------------------|----------------------------|------------------------|-------------|
| | | Measure | |
| Durian | 100 | 150 | L |
| Grapes | 100 | 150 | L |
| Kiwifruit, Zespri Green | 100 | 150 | L |
| Kiwifruit, Zespri SunGold | 100 | 150 | L |
| Mandarin | 100 | 125 | L |
| Melon (cantaloupe) | 100 | 120 | L |
| Oranges | 100 | 130 | L |
| Papaya | 100 | 140 | L |
| Pineapple | 100 | 140 | L |
| Strawberries | 100 | 150 | L |
| Tomato | 100 | 119 | L |
| Apples | 100 | 165 | H |
| Avocado | 100 | 80 | H |
| Bananas | 100 | 100 | H |
| Blueberries | 100 | 125 | H |
| Cherries | 100 | 150 | H |
| Cranberries | 100 | 30 | H |
| Longan | 100 | 140 | H |
| Mango | 100 | 140 | H |
| Pears | 100 | 170 | H |
| Pomegranates | 100 | 87 | H |
| Watermelon | 100 | 150 | H |

Sources:
Zespri International Limited.
Monash University (2015). The Monash University Low FODMAP Diet for Apple iOS (Version 1.5.1.) [Mobile application software]. Retrieved from <https://itunes.apple.com/au/app/monash-university-low-fodmap/id586149216?mt=8>.

NUTRITIONAL
COMPOSITION

Potassium

POTASSIUM MAINTAINS FLUID AND ELECTROLYTE BALANCE, WHICH IS WHY BANANAS ARE OFTEN ASSOCIATED WITH EXERCISE. A 100-GRAM PORTION OF ZESPRI SUNGOLD CONTAINS NEARLY AS MUCH POTASSIUM AS A COMPARABLE 100-GRAM PORTION OF BANANA.

POTASSIUM COMPARISON OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

| | Measure | Potassium | US RDA* | US RDA | EU RDA** | EU RDA | NZ AI** | NZ AI |
|---------------------------|---------|-----------|---------|--------|----------|--------|---------|-------|
| | g | mg | mg | % | mg | % | mg | % |
| Avocado | 100 | 520.0 | 4700 | 11.06 | 3500 | 14.86 | 2800 | 18.57 |
| Durian | 100 | 436.0 | 4700 | 9.28 | 3500 | 12.46 | 2800 | 15.57 |
| Melon (cantaloupe) | 100 | 370.0 | 4700 | 7.87 | 3500 | 10.57 | 2800 | 13.21 |
| Bananas | 100 | 360.0 | 4700 | 7.66 | 3500 | 10.29 | 2800 | 12.86 |
| Kiwifruit, Zespri SunGold | 100 | 315.0 | 4700 | 6.81 | 3500 | 9.14 | 2800 | 11.25 |
| Kiwifruit, Zespri Green | 100 | 301.0 | 4700 | 6.38 | 3500 | 8.57 | 2800 | 10.75 |
| Longan | 100 | 266.0 | 4700 | 5.66 | 3500 | 7.60 | 2800 | 9.50 |
| Tomato | 100 | 260.0 | 4700 | 5.53 | 3500 | 7.43 | 2800 | 9.29 |
| Pineapple | 100 | 250.0 | 4700 | 5.32 | 3500 | 7.14 | 2800 | 8.93 |
| Pomegranates | 100 | 236.0 | 4700 | 5.02 | 3500 | 6.74 | 2800 | 8.43 |
| Cherries | 100 | 210.0 | 4700 | 4.47 | 3500 | 6.00 | 2800 | 7.50 |
| Grapes | 100 | 190.0 | 4700 | 4.04 | 3500 | 5.43 | 2800 | 6.79 |
| Mango | 100 | 190.0 | 4700 | 4.04 | 3500 | 5.43 | 2800 | 6.79 |
| Oranges | 100 | 190.0 | 4700 | 4.04 | 3500 | 5.43 | 2800 | 6.79 |
| Papaya | 100 | 182.0 | 4700 | 3.87 | 3500 | 5.20 | 2800 | 6.50 |
| Mandarins | 100 | 170.0 | 4700 | 3.62 | 3500 | 4.86 | 2800 | 6.07 |
| Strawberries | 100 | 170.0 | 4700 | 3.62 | 3500 | 4.86 | 2800 | 6.07 |
| Watermelon | 100 | 150.0 | 4700 | 3.19 | 3500 | 4.29 | 2800 | 5.36 |
| Pears | 100 | 120.0 | 4700 | 2.55 | 3500 | 3.43 | 2800 | 4.29 |
| Apples | 100 | 100.0 | 4700 | 2.13 | 3500 | 2.86 | 2800 | 3.57 |
| Cranberries | 100 | 80.0 | 4700 | 1.70 | 3500 | 2.29 | 2800 | 2.86 |
| Blueberries | 100 | 67.0 | 4700 | 1.43 | 3500 | 1.91 | 2800 | 2.39 |

*Based on National Institutes of Health. Labeling Daily Values on the reference caloric intake of 2,000 calories for adults and children aged 4 years and older. <https://www.dslid.nlm.nih.gov/dslid/dailyvalue.jsp>.
**Based on healthy adult female.
Sources:
USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.
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NUTRITIONAL COMPOSITION

Folate

FOLATE COMPARISON OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

| | Measure | Dietary Folate | US RDA* | US RDA | EU PRI* | EU RDA | NZ RDI* | NZ RDI |
|---------------------------|---------|----------------|---------|--------|---------|--------|---------|--------|
| | g | µg | µg | % | µg | % | µg | % |
| Avocado | 100 | 110.0 | 400 | 27.50 | 330 | 33.33 | 400.00 | 27.50 |
| Mango | 100 | 43.0 | 400 | 10.75 | 330 | 13.03 | 400.00 | 10.75 |
| Kiwifruit, Zespri Green | 100 | 38.0 | 400 | 9.50 | 330 | 11.52 | 400.00 | 9.50 |
| Pomegranates | 100 | 38.0 | 400 | 9.50 | 330 | 11.52 | 400.00 | 9.50 |
| Papaya | 100 | 37.0 | 400 | 9.25 | 330 | 11.21 | 400.00 | 9.25 |
| Durian | 100 | 36.0 | 400 | 9.00 | 330 | 10.91 | 400.00 | 9.00 |
| Mandarins | 100 | 34.0 | 400 | 8.50 | 330 | 10.30 | 400.00 | 8.50 |
| Kiwifruit, Zespri SunGold | 100 | 31.0 | 400 | 7.75 | 330 | 9.39 | 400.00 | 7.75 |
| Oranges | 100 | 27.0 | 400 | 6.75 | 330 | 8.18 | 400.00 | 6.75 |
| Strawberries | 100 | 20.0 | 400 | 5.00 | 330 | 6.06 | 400.00 | 5.00 |
| Melon (cantaloupe) | 100 | 19.0 | 400 | 4.75 | 330 | 5.76 | 400.00 | 4.75 |
| Blueberries | 100 | 12.0 | 400 | 3.00 | 330 | 3.64 | 400.00 | 3.00 |
| Pears | 100 | 7.0 | 400 | 1.75 | 330 | 2.12 | 400.00 | 1.75 |
| Cherries | 100 | 6.0 | 400 | 1.50 | 330 | 1.82 | 400.00 | 1.50 |
| Pineapple | 100 | 5.0 | 400 | 1.25 | 330 | 1.52 | 400.00 | 1.25 |
| Tomato | 100 | 2.6 | 400 | 0.65 | 330 | 0.79 | 400.00 | 0.65 |
| Grapes | 100 | 2.0 | 400 | 0.50 | 330 | 0.61 | 400.00 | 0.50 |
| Cranberries | 100 | 1.0 | 400 | 0.25 | 330 | 0.30 | 400.00 | 0.25 |
| Apples | 100 | 0.0 | 400 | 0.00 | 330 | 0.00 | 400.00 | 0.00 |
| Bananas | 100 | 0.0 | 400 | 0.00 | 330 | 0.00 | 400.00 | 0.00 |
| Watermelon | 100 | 0.0 | 400 | 0.00 | 330 | 0.00 | 400.00 | 0.00 |
| Longan | 100 | n/a | 400 | n/a | 330 | n/a | 400.00 | n/a |

*Based on healthy adult female.

Sources:

USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.

The Concise New Zealand Food composition Tables 13th Edition, 2018.

Zespri International Limited.

National Academies Press. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline (1998). Accessed September 8, 2019 at <https://www.nap.edu/read/6015/chapter/3>.

EFSA. Scientific Opinion on Dietary Reference Values for folate. Accessed September 8, 2019 at <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2014.3893>.

Australian Government: Ministry of Health. Nutrient Reference Values for Australia and New Zealand. Accessed September 9, 2019 at <https://www.nrv.gov.au/nutrients>.

Folate is an essential nutrient for cell growth and development and is vital for the formation of red blood cells, which allow us to make efficient use of oxygen, iron and other minerals. Folate fulfils important functions in normal healthy

bodies and is required at significantly higher levels both before and during pregnancy and in growing children. Folate is important for normal fetal development.

BETWEEN 50 TO 80 PERCENT OF FOLATE IS DESTROYED IF COOKED, SO KIWIFRUIT, GENERALLY EATEN RAW, ARE A GOOD SOURCE OF FOLATE.

Folate is so important to healthy body functioning that many countries are considering fortifying bread and flour with folic acid to ensure adequate dietary intake. It has become common practice in many countries for folic acid to be taken as a pre-pregnancy and pregnancy dietary supplement

and for many cereals to be enriched with folic acid. Naturally, folate is found in a narrow selection of leafy green vegetables and some fruit, and in food such as liver. Green Kiwifruit provide 38.2 µg per 100 g of folate (28 µg per fruit), which is approximately 10 percent of the NZ RDI for this nutrient. SunGold meets nearly eight percent of the RDI.



As folate is vital for proper foetus growth, sufficiently high levels of the nutrient are needed before and during pregnancy and throughout lactation. Recommended values in the U.S. go up from 400 µg to 800 µg for women in this category. It is notably difficult to match this level with food alone, though, with 31.0-38.2 µg per 100 g (approximately one kiwifruit), this can provide a useful complement to folic acid supplements.

NUTRITIONAL COMPOSITION

Vitamin E

VITAMIN E COMPARISON OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

| | Measure | Vitamin E | US RDA* | US RDA | EU RDA* | EU RDA | NZ AI* | NZ AI |
|---------------------------|---------|-----------|---------|--------|---------|--------|--------|-------|
| | g | mg | mg | % | mg | % | mg | % |
| Avocado | 100 | 1.7 | 15 | 11.33 | 11 | 15.45 | 7 | 24.3 |
| Kiwifruit, Zespri SunGold | 100 | 1.4 | 15 | 9.33 | 11 | 12.73 | 7 | 20.0 |
| Cranberries | 100 | 1.32 | 15 | 8.80 | 11 | 12.00 | 7 | 18.9 |
| Mango | 100 | 1.1 | 15 | 7.33 | 11 | 10.00 | 7 | 15.7 |
| Blueberries | 100 | 0.91 | 15 | 6.07 | 11 | 8.27 | 7 | 13.0 |
| Kiwifruit, Zespri Green | 100 | 0.86 | 15 | 5.73 | 11 | 7.82 | 7 | 12.3 |
| Apples | 100 | 0.74 | 15 | 4.93 | 11 | 6.73 | 7 | 10.6 |
| Pomegranates | 100 | 0.6 | 15 | 4.00 | 11 | 5.45 | 7 | 8.6 |
| Mandarins | 100 | 0.45 | 15 | 3.00 | 11 | 4.09 | 7 | 6.4 |
| Cherries | 100 | 0.42 | 15 | 2.80 | 11 | 3.82 | 7 | 6.0 |
| Strawberries | 100 | 0.41 | 15 | 2.73 | 11 | 3.73 | 7 | 5.9 |
| Tomato | 100 | 0.38 | 15 | 2.53 | 11 | 3.45 | 7 | 5.4 |
| Papaya | 100 | 0.3 | 15 | 2.00 | 11 | 2.73 | 7 | 4.3 |
| Pears | 100 | 0.23 | 15 | 1.53 | 11 | 2.09 | 7 | 3.3 |
| Bananas | 100 | 0.2 | 15 | 1.33 | 11 | 1.82 | 7 | 2.9 |
| Grapes | 100 | 0.2 | 15 | 1.33 | 11 | 1.82 | 7 | 2.9 |
| Oranges | 100 | 0.18 | 15 | 1.20 | 11 | 1.64 | 7 | 2.6 |
| Pineapple | 100 | 0.1 | 15 | 0.67 | 11 | 0.91 | 7 | 1.4 |
| Watermelon | 100 | 0.1 | 15 | 0.67 | 11 | 0.91 | 7 | 1.4 |
| Melon (cantaloupe) | 100 | 0.06 | 15 | 0.40 | 11 | 0.55 | 7 | 0.9 |
| Durian | 100 | n/a | 15 | n/a | 11 | n/a | 7 | n/a |
| Longan | 100 | n/a | 15 | n/a | 11 | n/a | 7 | n/a |

*Based on healthy adult female
Sources:
USDA National Nutrient Database for Standard Reference Legacy Release, April 2018.
The Concise New Zealand Food composition Tables 13th Edition, 2018.
Zespri International Limited.
EFSA. Dietary Reference Values: Vitamin E and Cobalamin. Accessed September 8, 2019 at https://www.efsa.europa.eu/en/press/news/150709.
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NUTRITIONAL COMPOSITION

Polyphenols/Antioxidants

Naturally occurring plant-based chemicals, like polyphenols and carotenoids (e.g., lutein/zeaxanthin), help protect against cell damage. Zespri Kiwifruit contains various phytonutrients naturally found in kiwifruit, like polyphenols and flavonoids (compounds derived from polyphenols), that are important for skin health.

POLYPHENOLS

Kiwifruit contain a range of flavonoids (plant-derived polyphenolic compounds), which contribute to the overall antioxidant capacity of kiwifruit and are associated with a wide range of health benefits. Gold Kiwifruit contain mainly the polyphenolic known as epicatechin (0.64 mg per 100 g edible flesh), and Green Kiwifruit contain a range of compounds (epicatechin 0.27 mg per 100 g, luteolin 0.74 mg per 100 g and kaempferol 1.03 mg per 100 g)⁹. While it is not possible to link the polyphenolic compounds in kiwifruit to any specific health benefit, strong evidence exists demonstrating that eating foods with polyphenolic compounds contributes to good overall health²⁰.

Polyphenols are involved in the prebiotic-like and antioxidant effects found in SunGold, but plan to eat them with the skins on, as 30 percent of the total polyphenols in SunGold come from the skin⁸.

ANTIOXIDANTS

Antioxidants, found in certain foods, scavenge and neutralise free radicals from the body’s cells and prevent or reduce the damage caused by oxidation. These include the nutrient antioxidants vitamins A, C and E and a range of biologically active phytochemicals, many of which are found in kiwifruit. Vitamin E and the polyphenols and flavonoids found in both Zespri Green and Zespri SunGold are the major contributors to the antioxidant capacity of kiwifruit^{17,21}. Quercetin is another recognised antioxidant compound in kiwifruit. In addition, kiwifruit is a source of the dietary carotenoids known as lutein and zeaxanthin (which give yellow and orange fruits and vegetables their bright colours), support antioxidant function in the body, and are shown to support the health of the eyes^{22,23}. Zespri Kiwifruit not only has one of the highest concentrations of lutein in fruit, but the lutein in Zespri Kiwifruit has been shown to be well absorbed (the absorption is better than that from vegetables)²⁴.

In addition to vitamins C and E, kiwifruit contain a wide range of natural plant-derived antioxidants such as polyphenols, flavonoids (compounds derived from polyphenols) and phenolic acids, which are though to help protect human cells from oxidative damage^{17,19,25}.



THE GOODNESS OF KIWIFRUIT

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HEALTH & NUTRITION RESEARCH

VITAMIN C SUMMARY

In the previous sections of this booklet, the top nutritional attributes of kiwifruit were brought to light. In this section, we will translate each nutritional feature with details shown through the research. We've categorized the research into these primary health pillars aligned with kiwifruit benefits.

- VITAMIN C
- DIGESTIVE HEALTH
- METABOLIC HEALTH
- EMERGING RESEARCH

You can read more background information and research summaries within each section.

Many nutritional attributes found in kiwifruit may play a role in keeping the body functioning well; however, the rich content of vitamin C is one attribute that helps it stand out amongst many other fruits. Nutrients involved in supporting physical activity, like vitamin C and potassium, contribute to vitality, protect and support muscle tissue, maintain fluid and electrolyte balance and help release energy during exercise. With regard to energy metabolism, vitamin C is required for the synthesis of carnitine, a compound that plays a critical role in energy production by transporting long-chain fatty acids into the cell so they can be oxidized ('burned') for fuel¹. Vitamin C contributes to the normal function of the immune system and has been shown to have immunostimulant, anti-inflammatory, antiviral, and antibacterial properties^{2,3} that could potentially limit the risk of developing chronic diseases such as heart disease and cancer⁴⁻⁶. Vitamin C is important for promoting a healthy immune system and kiwifruit is noted as an excellent source of vitamin C.

The antioxidant properties of vitamin C and its role in collagen synthesis make it a vital molecule for skin health⁴. The skin is a living organ and responds to healthful vitamins and plant-based nutrients just like the rest of the body does. Along with vitamin C, vitamin E is an antioxidant, and Zespri Kiwifruit contains both. Antioxidants may protect cells from oxidative damage, and oxidative stress can happen with normal sun exposure. Vitamin E levels in Zespri are relatively high compared to other fruits at 0.86-1.4 mg per 100 g edible flesh. Phytonutrients, or naturally occurring plant-based chemicals, like polyphenols and carotenoids (e.g., lutein/zeaxanthin), also help protect against cell damage.

RESEARCH

Vitamin C and Immunity

AIM: Test the capacity to improve plasma vitamin C in a group of 15 male students with low vitamin C status consuming half a kiwifruit per day for four weeks, followed by one kiwifruit per day for six weeks, two kiwifruit per day for six weeks and finally three kiwifruit per day for four weeks.

CONCLUSION: Results indicate that plasma vitamin C levels in humans saturate at an intake of about 200 mg per day, which is equivalent to eating approximately two kiwifruit per day⁷.

AIM: Scientists aimed to assess the effect of dietary supplementation with vitamin C-rich SunGold Kiwifruit on four important functions of neutrophils: chemotaxis, oxidant generation, extracellular trap formation and apoptosis. They studied 14 young men (aged 18–30 years).

CONCLUSION: This study showed that supplementation with two vitamin C-rich SunGold Kiwifruit for four weeks among young males improved the function of neutrophils, which likely translates to enhanced immunity⁸.

AIM: In a randomised, cross-over study of 32 people over the age of 65, test participants consumed the equivalent of four Gold Kiwifruit or two bananas daily for four weeks.

CONCLUSION: Results showed that consuming four Zespri Gold Kiwifruit per day for four weeks reduced the severity and duration of colds and flu (upper-respiratory tract infections) in “at risk” older adults when compared with two bananas per day⁹.



RESEARCH

Vitamin C, Vitality and Energy

AIM: In observational research, the effects of deprivation of ascorbic acid were analysed.

CONCLUSION: Vitamin C can help to activate normal psychological function, which helps to reduce tiredness and fatigue. It has been shown that vitamin C triggers a series of enzymes that improve metabolic energy levels and different neurochemicals in the brain. Therefore, consuming vitamin C could reduce the sensation of fatigue and increase physical and mental energy^{10,11,12}.

AIM: In this human clinical study, researchers aimed to examine the effects of consuming SunGold Kiwifruit on the energy, vigour and well-being aspects of vitality.

CONCLUSION: SunGold significantly improved mood outcomes self-reported through validated questionnaires¹³.

RESEARCH

Vitamin C and Skin Health

AIM: To measure antioxidant presence in human epidermis and dermis from six healthy volunteers.

CONCLUSION: Vitamin C in the skin is normally transported from the bloodstream and is found at high levels in both the dermis and epidermis of human skin¹⁴.

AIM: To demonstrate whether oral supplementation can increase the presence of the vitamin in the skin.

CONCLUSION: Numerous studies have demonstrated that oral supplementation with vitamin C can effectively increase vitamin C levels in the skin^{15,16}.

AIM: To assess the value of vitamin supplementation on UV-induced sun damage.

CONCLUSION: Evidence shows that combining vitamin C and vitamin E supplementation is more effective in preventing UV damage than either vitamin alone^{17,18}.

AIM: To understand skin changes with the ageing process.

CONCLUSION: Levels of vitamin C decline with age and excessive exposure to UV light or pollutants, such as cigarette smoke, and therefore supplementation to increase vitamin C levels in the skin is common^{19,20}.



DIGESTIVE HEALTH SUMMARY

Fibre

Kiwifruit has been found to provide various digestive functions at both the gastric and intestinal level. This is partly due to their relatively high fibre content²¹ (3.0 g per 100 g of edible flesh in raw Zespri Green Kiwifruit and 1.4 g per 100 g of edible flesh in raw Zespri SunGold Kiwifruit). The fibre in kiwifruit is made up of both soluble components (e.g., pectin) and insoluble components (e.g., hemicelluloses and celluloses), which make up cell walls²². Soluble fibre has the ability to retain water and form gels, which increase the size and softness of the stools, and aids stimulation of peristaltic movements²². Insoluble fibres also enhance digestion by adding bulk to the stools, aiding movement through the digestive tract²².

There is some evidence to suggest that as kiwifruit ripens, there is increasing solubilization of insoluble fibre within the cell walls of kiwifruit. This results in a unique and greatly increased ability to hold water, causing a lubricating effect²³⁻²⁵. It also increases the sense of fullness, since the fibre swells by taking up water and acts to increase viscosity, which has demonstrated a positive effect on the rate of gastric emptying²⁶.

Clinical studies of daily Zespri Kiwifruit intake have demonstrated positive results in the management of constipation and promotion of regular bowel habits in a range of adult populations, including healthy subjects, the elderly and patients with IBS²⁷⁻³⁰ because kiwifruit has laxative properties. New high-definition studies have revealed the mechanisms behind the laxative effect of kiwifruit. It is possible that kiwifruit could be used as an adjunct or alternative to laxatives in individuals with mild constipation³¹.

Collectively, these properties can help to improve digestive health and the symptoms of constipation as follows²²:

- Increasing the frequency of bowel movements
- Improving the type of stools
- Reducing the sensation of bloating
- Increasing satisfaction when moving the bowels
- Reducing the time of intestinal transit



DIGESTIVE HEALTH

Actinidin & Protein Digestion

Zespri Green contains the digestive enzyme actinidin, which is unique to kiwifruit, and can help with digestive health by facilitating gastric digestion and breakdown of dietary proteins^{27,32}. Actinidin has been shown to enhance protein digestion in the stomach and the small intestine^{33,34}, potentially allowing faster and more complete digestion of food proteins. This improved digestion results in:

- **A reduced sensation of heaviness associated with protein-rich foods**
- **Improved protein absorption**
- **Improved digestive comfort**

DIGESTIVE HEALTH

Prebiotics/ Microbiota

A healthy balance of bacteria colonising the gastrointestinal tract (microbiota) is essential for the breakdown and metabolism of foods as well as for the production of microbially synthesized vitamins. Many scientific studies have demonstrated that components of kiwifruit are able to modulate colonic microbiota with a prebiotic-like effect, which may promote a healthy gut microbiota and better digestive health^{35-41,43-45}. These are just some of the broad digestive health mechanisms that are shown to occur with prebiotics:

- **Are non-digestible and resistant to breakdown**
- **Are selectively fermented by intestinal microorganisms**
- **Increase mucus production, development and function of cells in intestinal lining**
- **Improve and sustain the barrier of the intestinal lining**
- **Lead to a stimulation in the growth of beneficial bacteria (e.g., *Lactobacillus*, Ruminococcaceae, Lachnospiraceae, *Faecalibacterium prausnitzii*, Coriobacteriaceae, *Bifidobacterium*)**
- **Lead to a suppression of pathogenic bacteria (e.g., Enterobacteriaceae, *Escherichia coli*, *Salmonella enterica* serovar Typhimurium, *Staphylococcus aureus*, Bacillaceae, Clostridiaceae)**
- **Lead to the production of short-chain fatty acids (SCFA) (e.g., acetate, butyrate, propionate), which provide energy for intestinal cells, peripheral muscle and tissue and induce peristaltic contractions**
- **Enhance ability for beneficial bacteria to adhere to intestinal cells**
- **Increase the activity of beneficial bacteria and enzymes responsible for breaking down fibres**
- **Increase production of anti-microbial substances important to host defense such as defensins**
- **Have an absence of undesirable side effects**

Human gut bacteria (microbiota) have co-evolved with us metabolically to live symbiotically and share the workload of extracting energy and nutrients from the diet. A healthy balance of microbiota is therefore essential for the breakdown of foods and for the production of vitamins. The dietary fibre and polyphenols found in kiwifruit can be degraded by various components of the gut microbiota and result in beneficial effects^{35,43,44}.

The gut microbiota can also affect the structure and function of the mucosal barrier in the colon, which prevents the influx of water-soluble bacterial products and toxins from the colon into the blood, which is just one portion of the body's immune function⁴⁶. The dietary fibre and polyphenols found in kiwifruit may contribute to the healthy balance of human gut bacteria (microbiota), supporting a vital aspect of the body's immune function^{35,43,44}.



RESEARCH ON ZESPRI GREEN KIWIFRUIT

found that actinidin hydrolyses a variety of food proteins more completely and more rapidly than digestive enzymes can do alone^{33,34,47}. Additionally, after protein digestion with actinidin, potentially bioactive peptides may be produced from the food proteins. However, it is unknown if these have any effect on gastric motility⁴⁸.

WHAT ARE PREBIOTICS?

According to the International Scientific Association for Probiotics and Prebiotics (ISAPP), the definition of prebiotics is 'a substrate that is selectively utilised by host microorganisms conferring a health benefit'⁴⁹. Put simply, prebiotics are food ingredients, generally of plant origin, that cannot be broken down by human digestive system fibre. Instead, they reach the colon and are available as food for our resident gut bacteria (microbiota). The breakdown of prebiotics selectively stimulates the growth and activity of 'good' bacteria in the colon. These bacteria include lactobacilli and bifidobacterial species, which are commonly included in probiotic foods and supplements.



DIGESTIVE HEALTH

FODMAPS & Irritable Bowel Syndrome

A diet low in FODMAPs has been shown to increase quality of life and be one of the most effective dietary therapies for individuals with IBS⁵⁰. Interestingly, many fruits and vegetables are high in FODMAPs that can trigger abdominal symptoms in people with IBS, but this is not the case with kiwifruit. Whereas fruits such as apples, ripe bananas, cherries, pears and watermelon are considered high FODMAP foods, kiwifruit delivers great nutritional value without the digestive discomfort. Clinical studies of daily Zespri Kiwifruit intake have demonstrated positive results in the management of constipation and promotion of regular bowel habits in a range of adult populations, including healthy subjects, the elderly and patients with IBS²⁷⁻³⁰. And, in fact, Zespri Green and SunGold Kiwifruit variants are the first branded fruit to be certified as low FODMAP by Monash University, a worldwide leader in research and practice on the low FODMAP diet⁵¹ and can be included as part of a low FODMAP diet for sufferers of IBS.



MONASH
UNIVERSITY
LOW FODMAP
CERTIFIED™

ZESPRI KIWIFRUIT IS CERTIFIED AS A LOW FODMAP FOOD, WITH OFFICIAL LOW FODMAP CERTIFICATION FROM MONASH UNIVERSITY.



RESEARCH

Digestive Health and Fibre for Laxation and Comfort

AIM: This study tested the hypothesis that regular consumption of kiwifruit provided a functional and acceptable laxation method for the elderly. 38 older persons were recruited, eating one kiwifruit per 30 kg body weight for three weeks.

CONCLUSION: Consumption leads to increased frequency of defecation, higher volume of stool production, and greater softness of bowel movements⁵².

AIM: To investigate whether increased dietary fibre intake through kiwifruit is effective in Chinese constipated patients.

CONCLUSION: Twice-daily kiwifruit consumption significantly increased complete spontaneous bowel motion, improved transit time and rectal sensation, and decreased days of laxative use compared with control subjects who were not given kiwifruit⁵³.

AIM: The effect of kiwifruit intake on physiological bowel functions in 41 patients diagnosed with irritable bowel syndrome (IBS) was evaluated.

CONCLUSION: Having eaten two kiwifruit per day for four weeks, participants significantly increased defecation frequency and decreased colon transit time²⁹.

AIM: The aim of this study was to evaluate the effect of kiwifruit intake on functional constipation in a Mediterranean patient population characterised by its distinctive nutritional habits.

CONCLUSION: The intake of three kiwifruit per day significantly improved the quality of evacuation (number of depositions, consistency, and ease)⁵⁴.

AIM: This review paper served to describe the nutritional and health attributes of kiwifruit and the benefits relating to improved nutritional status, digestive, immune and metabolic health.

CONCLUSION: With regard to digestive health, daily consumption of two kiwifruits was found to reduce symptoms associated with constipation but did not adversely affect bowel habits in healthy non-constipated individuals⁵⁵.

AIM: This review of the literature intended to capture an overview of the physiological and pathophysiological processes underlying constipation and IBS-C, the composition of kiwifruit, and highlight recent advances in the research of kiwifruit and abdominal comfort²⁷.

CONCLUSION: Mechanisms that may be activated by kiwifruit compounds include the induction of motility via protease-activated signaling, modulation of microflora, changes in colonic methane status, bile flux, or mediation of inflammatory processes.

AIM: Using non-invasive MRI techniques, researchers assessed the effects of ingestion of kiwifruit on fluid distribution in the intestines and bowel function.

CONCLUSION: The group consuming kiwifruit were found to have remarkably greater volume in their gastrointestinal tract, indicative of increased water retention in the small bowel and ascending colon. Observationally, the researchers noted an increase in stool frequency and looser stool consistencies, suggesting that kiwifruit could be used as a dietary alternative to laxatives in mild constipation³¹.

RESEARCH

Digestive Health and Protein Digestion

AIM: Researchers at the New Zealand Institute for Plant and Food Research Limited conducted a human randomised, controlled, clinical trial to assess if daily consumption of three Zespri SunGold Kiwifruit for four weeks could alleviate constipation and decrease gastrointestinal discomfort in mildly constipated individuals with and without pain.

CONCLUSION: Compared to the matched control psyllium supplement, the kiwifruit was clinically superior in increasing bowel movement frequency and resulted in clinically meaningful reductions in GI discomfort when compared with not consuming kiwifruit or when compared with the control and improved stool consistency²⁸.

AIM: This *in vitro* study examined the effect of actinidin on gastric protein digestion, a range of common protein sources derived from soy, meat, milk, and cereals using kiwifruit extract to simulate gastric digestion in humans.

CONCLUSION: Results showed that for milk, soy, and meat protein sources, the presence of kiwifruit extract enhanced gastric digestion to a greater extent than pepsin alone³³.

AIM: A range of food proteins was studied to assess the proposition that actinidin influences the digestion of proteins in the small intestine, including soy, meat, milk, and cereals.

CONCLUSION: For some proteins, actinidin had little impact on digestion. However, for whey, zein, collagen, and wheat proteins, the presence of actinidin resulted in a substantially greater increase in digestion³⁴.

AIM: The study aimed to investigate the effect of dietary actinidin on the kinetics of gastric digestion of beef muscle proteins and on the rate of stomach emptying in growing pigs.

CONCLUSION: There was a significant increase in gastric digestion of beef muscle proteins with added actinidin (25 percent with actinidin, 17 percent without actinidin) and faster gastric emptying rate (half-life for dry matter was 137 minutes with actinidin versus 172 minutes without actinidin). Actinidin is responsible for the enhanced gastric hydrolysis of food proteins. Stomach emptying rate was also faster when Green Kiwifruits were consumed with meat²⁶.

AIM: In this study, the effect of dietary actinidin on gastric emptying rate and gastric digestion of six dietary protein sources (beef muscle, gelatin, gluten, soy protein isolate, whey protein isolate, and zein) was determined in growing rats.

CONCLUSION: Researchers saw increased gastric protein digestion with dietary actinidin from kiwifruit and accelerated gastric emptying rate for several dietary protein sources and they concluded that gastric emptying is affected by gastric protein digestion⁵⁶.

AIM: Similar to above, in this study, actinidin from Green Kiwifruit was tested with rats to measure protein digestion.

CONCLUSION: In the subject rats, there was significantly increased gastric digestion of beef muscle protein, gelatin soy protein, and gluten by 27–60 percent. The researchers concluded that gastric digestion of specific protein sources increased⁴⁷.

AIM: In order to follow up on the promising results of the effects of actinidin on protein digestion *in vitro* and *in vivo*, a human clinical trial was conducted to examine its effect on gastric comfort following a protein meal. In this study, ten healthy adult males ate a meal of >400 g lean steak with 200 g kiwifruit containing either active or inactive actinidin.

CONCLUSION: For all measures of gastric comfort (pain in upper abdomen, rumbling in stomach, bloating, belching, and flatulence), men who ate the kiwifruit with active actinidin resulted in fewer symptoms. For the symptom of ‘bloating,’ this difference was statistically significant³².

AIM: Investigators intended to assess whether the protein digestion properties of actinidin in Zespri Green Kiwifruit could help maintain muscle mass in an elderly population.

CONCLUSION: Green Kiwifruit consumed immediately prior to red meat leads to faster protein digestion and absorption of essential amino acids in an elderly population.

RESEARCH

Digestive Health and Prebiotics/Microbiota

Given the extensive research in this particular area, the table below provides a comprehensive overview of 15 studies on two cultivars of Green Kiwifruit and three cultivars of Gold Kiwifruit, including Zespri SunGold.



| STUDY TYPE | TEST | RESULT | CONCLUSION | SOURCE |
|---|---|---|---|---|
| IN VIVO | Determine the available energy contents and digestibility of fresh, ripe kiwifruit in human digestion | <ul style="list-style-type: none">Kiwifruit pulp fibre fractions were undigested in the small intestineKiwifruit had a relatively low available energy score and a high water content, which further reduces the energy density of kiwifruit | Kiwifruit has properties that make it an ideal source of nourishment for the microbiota | Henare SJ, Rutherford SM, Drummond LN, <i>et al.</i> Digestible nutrients and available (ATP) energy contents of two varieties of kiwifruit (<i>Actinidia deliciosa</i> and <i>Actinidia chinensis</i>). <i>Food Chemistry</i> . 2012;130(1):67-72. |
| GROWING PIG | TEST FRUIT: Green and Gold Kiwifruit | | | |
| IN VIVO | Determine the digestion of kiwifruit fibre in the gastro-intestinal tract | <ul style="list-style-type: none">Soluble fibre in kiwifruit was digested in the foregut (80 percent), and the insoluble fibre in the hindgut (95 percent)Greater concentrations of SCFA in group fed a higher amount of kiwifruit compared to a group fed a lower amount | Insoluble Green Kiwifruit fibres are resistant to breakdown until they reach the end part of the gastrointestinal tract, where they are fermented | Montoya CA, Saigeman S, Rutherford SM, Moughan PJ. The digestion of kiwifruit (<i>Actinidia deliciosa</i>) fibre and the effect of kiwifruit on the digestibility of other dietary nutrients. <i>Food Chemistry</i> . 2016; 197539-545. |
| GROWING PIG | TEST FRUIT: Crushed, Whole Green Kiwifruit | | | |
| CLINICAL HUMAN PILOT STUDY | Compare GI fermentation patterns following the ingestion of lactulose, fructose, and lactose to two Green Kiwifruit and one apple in 10 people with IBS and 10 healthy controls | <ul style="list-style-type: none">Eating two Green Kiwifruit was not associated with evidence of clinically significant colonic fermentation (hydrogen and methane on breath testing) in the three hours after consumption in a mixed population of subjects with and without IBS | Green Kiwifruit are not associated with clinically significant carbohydrate malabsorption or undesirable gas production | Chen A, Offereins M, Mulder CJ, Frampton CM, Geary RB. A pilot study of the effect of Green Kiwifruit on human intestinal fermentation measured by hydrogen and methane breath testing. <i>Journal of Medicinal Food</i> . 2018;21(12): 1295–1298. |
| IN VITRO | Describe the detailed microbial composition and metabolism changes from kiwifruit in a model human gut system | <ul style="list-style-type: none">Increased abundance of <i>Bacteroides</i> with both kiwifruitIncreased <i>Bifidobacterium</i> 24 hours after Green Kiwifruit exposureIncrease in organic acid short-chain fatty acid production (primarily acetate, butyrate, and propionate) | Despite different baseline microbiota profiles, kiwifruit improved the microbiota and metabolic composition | Blatchford P, Stoklosinski H, Walton G, <i>et al.</i> Kiwifruit fermentation drives positive gut microbial and metabolic changes irrespective of initial microbiota composition. <i>Bioactive Carbohydrates and Dietary Fibre</i> . 2015;6(1):37-45. |
| IN VITRO HUMAN | Assess whether Gold-fleshed Kiwifruit could positively change the composition of the human colonic microbiota | <ul style="list-style-type: none">Substantial shift in the bacteria populationIncreased abundance of <i>Bacteroides</i>, <i>Parabacteroides</i>, and <i>Bifidobacterium</i> after 48 hoursProduced short chain fatty acids within the first 10 hours of fermentationOrganic acid (propionate) concentration corresponded with rise in beneficial bacteria | SunGold Kiwifruit caused a direct, selective prebiotic-like effect in a model designed to mimic the human gut | Blatchford P, Bentley-Hewitt KL, Stoklosinski H, <i>et al.</i> <i>In vitro</i> characterisation of the fermentation profile and prebiotic capacity of gold-fleshed kiwifruit. <i>Beneficial Microbes</i> . 2015;6(6):829-839. |
| IN VITRO HUMAN DIGESTION AND FERMENTATION | Investigate potential gut health benefits of whole kiwifruit compared to inulin (a widely accepted prebiotic) and water through faecal samples from 10 healthy human subjects | Compared with inulin, kiwifruit created: <ul style="list-style-type: none">Greater abundance of <i>Bifidobacterium</i>, <i>Bacteroides-Prevotella-Porphyromonas</i> group at 48 hoursIncreased microbial glycosidase enzymes, specific to breakdown of kiwifruitGreater generation of SCFAGreater adhesion of <i>Bifidobacterium longum</i> to intestinal epithelial cells | Whole kiwifruit displayed prebiotic-like effects to a greater extent than inulin in an <i>in vitro</i> model | Parkar SG, Rosendale D, Paturi G, <i>et al.</i> <i>In vitro</i> utilization of gold and green kiwifruit oligosaccharides by human gut microbial populations. <i>Plant Foods for Human Nutrition</i> . 2012;67(3):200-207. |

| STUDY TYPE | TEST | RESULT | CONCLUSION | SOURCE |
|--|--|--|--|--|
| IN VITRO SIMULATED HUMAN DIGESTION | <p>Assess how different microbiota respond to and utilise the complex carbohydrate source from kiwifruit, testing faecal samples from three healthy human subjects</p> <p>TEST FRUIT: Whole Green Kiwifruit Puree</p> | <ul style="list-style-type: none"> Increased <i>Bacteroidetes</i> and <i>Actinobacteria</i>; major changes in numbers and/or proportion of <i>Firmicutes</i> Decreased <i>Enterobacteriaceae</i> after 24 hours of kiwifruit exposure Increase <i>Lachnospiraceae</i> at 24 hours of kiwifruit exposure Peak glycosidase and cellulosidase activity after 24 hours of exposure to kiwifruit Increased SCFA acetate, propionate, butyrate with peaks after 24-48 hours | <p>Simulated kiwifruit digestion produced shifts in microflora composition <i>in vitro</i> and may potentially contribute to a reduction or suppression of methanogenic bacteria, which can influence colonic motility</p> | <p>Rosendale DJ, Blatchford PA, Sims IM, Parkar SG, Carnachan SM, Hedderley, D, Ansell J. Characterizing kiwifruit carbohydrate utilization <i>in vitro</i> and its consequences for human faecal microbiota. <i>Journal of Proteome Research</i>. 2012;11(12):5863-5875.</p> |
| IN VITRO LABORATORY MODEL OF GI DIGESTION | <p>Characterise five varieties of kiwifruit (vary by fibre and polyphenol content) in terms of their ability to influence the gut microbiome by testing fermentations using faecal samples from 10 healthy volunteers</p> <p>TEST FRUIT: Freeze-Dried Kiwifruit (two Green-Fleshed Cultivars, three Gold Fleshed Cultivars)</p> | <ul style="list-style-type: none"> All kiwifruit increased acetate; butyrate/propionate ratio was the highest for ‘Hayward’ as compared to water ‘Hayward’ had highest lactate concentrations and correlated with the amount of the kiwifruit fibre and polyphenols All kiwifruit behaved similarly to inulin, with increased abundance of <i>Bifidobacterium</i> All kiwifruit increased abundance of <i>Ruminococcaceae</i> and decreased <i>Bacteroides</i> and <i>Clostridium</i> compared to inulin | <p>Even across different compositions of the gut microbiome between individuals, all kiwifruit types supported evidence of prebiotic-like effects <i>in vitro</i> and may support similar effects <i>in vivo</i></p> | <p>Parkar SG, Simmons L, Herath TD, <i>et al.</i> Evaluation of the prebiotic potential of five kiwifruit cultivars after simulated gastrointestinal digestion and fermentation with human faecal bacteria. <i>International Journal of Food Science & Technology</i>. 2018;53(5):1203-1210.</p> |
| IN VIVO RATS | <p>Assess the effects of consistent consumption of whole kiwifruit on large bowel health in rats</p> <p>TEST FRUIT: Whole, Fresh Green and Gold Kiwifruit; equal to intake of two fresh whole kiwifruit per day</p> | <ul style="list-style-type: none"> Increased growth of <i>Lachnospiraceae</i>, over control group Increase in <i>Bacteroides–Prevotella–Porphyromonas</i> group with gold kiwifruit No difference in <i>Lactobacillus</i> and <i>Bifidobacteria</i> species compared to control Upward trends in SCFA concentrations at week six of intake Increased butyric acid levels after green kiwifruit vs. control Altered components of defense in host innate immunity after six weeks | <p>Prebiotic-like effects of kiwifruit previously shown in cell models was supported in a whole animal system <i>in vivo</i></p> | <p>Paturi G, Butts CA, Bentley Hewitt KL, Ansell J. Influence of green and gold kiwifruit on indices of large bowel function in healthy rats. <i>Journal of Food Science</i>, 2014;79(8): H1611-H1620</p> |
| HUMAN TRIAL THREE-PHASE EXPERIMENTAL OPEN TRIAL | <p>Investigate how beneficial and pathogenic bacteria groups respond to the ingestion of kiwifruit in six healthy humans</p> <p>TEST FRUIT: Freeze-Dried Green Kiwifruit equivalent to two fresh kiwifruit per day</p> | <ul style="list-style-type: none"> Increased growth of intestinal lactic acid bacteria (<i>Lactobacillus</i> and <i>Bifidobacterium</i>) within 24 hours with kiwifruit, compared to baseline General trend of fewer pathogenic bacteria (<i>Clostridium</i> and <i>Bacteroides</i>) during kiwifruit consumption days | <p>Ongoing dietary inclusion of Green Kiwifruit may be necessary to maintain a high level of prebiotic-like effects in humans</p> | <p>Kun Lee Y, Yi Low K, Sia K, Drummond LM, Gwee KA. Kiwifruit (<i>Actinidia deliciosa</i>) changes intestinal microbial profile. <i>Microbial Ecology in Health and Disease</i>. 2012;23(1):18572.</p> |

| STUDY TYPE | TEST | RESULT | CONCLUSION | SOURCE |
|---|---|--|--|--|
| PILOT INTERVENTION TRIAL | <p>Determine whether SunGold Kiwifruit consumption by a prediabetic cohort altered gut microbiota composition, increased plasma vitamin C concentrations and improved glycaemic control in 26 humans with prediabetes</p> <p>TEST FRUIT: Whole SunGold Kiwifruit; two whole kiwifruits eaten per day over 12 weeks</p> | <ul style="list-style-type: none"> Increased <i>Coriobacteriaceae</i>, in faecal samples with kiwi, compared to baseline No confirmation of previously reported <i>in vitro</i> effect of kiwifruit fermentation | <p>This human intervention trial did not confirm the previously reported <i>in vitro</i> effect of SunGold fermentation but did find that <i>Coriobacteriaceae</i> increased</p> | <p>Wilson R, Willis J, Gearry R, Hughes A, Lawley B, Skidmore P, Tannock G.SunGold kiwifruit supplementation of individuals with prediabetes alters gut microbiota and improves vitamin C status, anthropometric and clinical markers. <i>Nutrients</i>. 2018;10(7):895.</p> |
| IN VITRO SIMULATED HUMAN DIGESTION | <p>Assess if kiwifruit and their prebiotic effects following a simulated digestion can change parts of the host immune response testing human faecal donors and human colon cells</p> <p>TEST FRUIT: Fresh Green Kiwifruit</p> | <ul style="list-style-type: none"> Increased SCFA (acetate, propionate and butyrate) concentrations with digested and fermented Green Kiwifruit, compared to control Fermentation of digested kiwifruit by the microbiota primed the gut with increased levels of anti-microbial compounds (human β-defenses) Effects appear to be predominantly caused by the presence of SCFA | <p>Green Kiwifruit may support defense mechanisms <i>in vitro</i> through fermentation by beneficial bacteria that increase SCFA production, which in turn causes the production of anti-microbial products from the lining of the colon</p> | <p>Bentley-Hewitt KL, Blatchford PA, Parkar SG, Ansell J, Pernthaner A. Digested and fermented green kiwifruit increases human β-defensin 1 and 2 production <i>in vitro</i>. <i>Plant Foods for Human Nutrition</i>. 2012;67(3):208-214.</p> |
| IN VITRO | <p>Assess the beneficial gut health effects of six different pectins extracted from Green Kiwifruit with human colon cells</p> <p>TEST FRUIT: Whole Green Kiwifruit</p> | <ul style="list-style-type: none"> Kiwifruit pectin (monoK) decreased adhesion of pathogenic <i>Salmonella typhimurium</i> bacteria to intestinal cells compared to inulin Kiwifruit pectin (monoK) increased enhanced adhesion of <i>Lactobacillus rhamnosus</i> to cells compared to inulin | <p>Green Kiwifruit pectin reinforced markers of gut health in a cell model with a prebiotic-like effect superior to that of inulin, a standard prebiotic</p> | <p>Parkar SG, Redgate EL., Wibisono R, Luo X, Koh ET, Schröder R. Gut health benefits of kiwifruit pectins: Comparison with commercial functional polysaccharides. <i>Journal of Functional Foods</i>. 2010;02(3):210-218.</p> |
| IN VITRO | <p>Explore the interactions between kiwifruit polyphenols and vitamin C against pathogenic bacteria</p> <p>TEST FRUIT: Polyphenol Extract and Vitamin C from Green Kiwifruit Pulp</p> | <ul style="list-style-type: none"> On cells chosen to be a model of the intestinal barrier, the combination of vitamin C and representative kiwifruit polyphenols decreased <i>Salmonella</i> adhesion | <p>The polyphenols and vitamin C from Green Kiwifruit may combine <i>in vitro</i> to generate synergistic inhibitory effects on the adhesion of pathogenic bacteria to the gut wall</p> | <p>Dawes HM, Keene JB. Phenolic composition of kiwifruit juice. <i>Journal of Agricultural and Food Chemistry</i>. 1999;47(6):2398-2403.</p> |
| IN VIVO MALE PIGS | <p>Investigate the effect of Green Kiwifruit on the colonic microbiota of growing pigs</p> <p>TEST FRUIT: Freeze-Dried or Fibre Extract of Green Kiwifruit</p> | <ul style="list-style-type: none"> Freeze-dried kiwifruit or kiwifruit fibre increased total bacteria and <i>Bacteroides</i> group compared to control and cellulose Decreased number of Enterobacteria and <i>E. coli</i> groups (pathogens) compared to control and cellulose Improved ratio of <i>Lactobacillus</i> to Enterobacteria compared to control and cellulose | <p>Green Kiwifruit supported beneficial bacteria while lowering the growth of pathogenic bacteria in an animal model similar to human digestion</p> | <p>Han KS, Balan P, Molist Gasa F, Boland M. Green kiwifruit modulates the colonic microbiota in growing pigs. <i>Letters in Applied Microbiology</i>. 2011;52(4):379-385.</p> |

*Disclaimer: These studies do not control for background fibre that would normally be present in the gut of humans consuming a mixed diet. Results from one kiwifruit variety should not be extrapolated to others. Research will continue to evaluate the prebiotic effects from kiwifruit ingestion, especially using human clinical trials.

RESEARCH

Digestive Health and Irritable Bowel Syndrome

AIM: This review provided an overview on the physiological and pathophysiological processes underlying constipation and IBS-C, the composition of kiwifruit, and recent advances in the research of kiwifruit and abdominal comfort.

CONCLUSION: While the effects of kiwifruit fibre are well documented, observed increases in gastrointestinal motility caused by kiwifruit are not fully characterised. There are a number of identified mechanisms that may be activated by kiwifruit compounds, such as the induction of motility via protease-activated signaling, modulation of microflora, changes in colonic methane status, bile flux, or mediation of inflammatory processes²⁷.

AIM: In a 16-week, randomised, single-blind, cross-over study of 32 participants, researchers investigated whether daily consumption of three SunGold Kiwifruit could alleviate constipation and improve gastrointestinal discomfort in mildly constipated individuals with and without pain.

CONCLUSION: Findings of this controlled trial demonstrated that daily consumption of three SunGold Kiwifruit is associated with a significant increase of two complete spontaneous bowel movements per week and reduction in gastrointestinal discomfort in mildly constipated adults²⁸.

AIM: The purpose of this study was to examine the impact of a four week kiwifruit intervention (with placebo control), on bowel function in patients diagnosed with irritable bowel syndrome with constipation. Fifty-four patients with IBS-C and 16 healthy adults participated in this study.

CONCLUSION: Findings suggest that kiwifruit consumption for four weeks shortens colon transit time, increases defecation frequency, and improves bowel function in adults diagnosed with IBS-C²⁹.

AIM: In this randomised, double-blind, placebo-controlled study, researchers examined the effects of Actazin and Gold (kiwifruit-derived nutritional ingredients) on stool frequency, stool form, and gastrointestinal comfort in healthy and functionally constipated (Rome III criteria for C3 functional constipation) individuals.

CONCLUSION: This study demonstrated that Actazin and Gold produced clinically meaningful increases in bowel movements in healthy individuals³⁰.

METABOLIC HEALTH SUMMARY

GLYCAEMIC INDEX COMPARISON OF ZESPRI KIWIFRUIT AND OTHER COMMONLY EATEN FRUIT

| | Serving Size | Glycaemic Index | Glycaemic Index Rank |
|---------------------------|--------------|-------------------------------|----------------------|
| | g | glucose comparison - 10 g CHO | L-M-H |
| Avocado | 100 | 15 | L |
| Tomato | 100 | 15 | L |
| Kiwifruit, Zespri SunGold | 100 | 38 | L |
| Apples | 120 | 39 | L |
| Kiwifruit, Zespri Green | 120 | 39 | L |
| Strawberries | 120 | 40 | L |
| Oranges | 120 | 43 | L |
| Bananas | 120 | 47 | L |
| Mandarins | 120 | 47 | L |
| Durian | 100 | 49 | L |
| Mango | 120 | 51 | L |
| Blueberries | 100 | 53 | L |
| Papaya | 120 | 56 | M |
| Grapes | 120 | 59 | M |
| Pineapple | 120 | 59 | M |
| Cherries | 120 | 63 | M |
| Melon (cantaloupe) | 120 | 70 | H |
| Watermelon | 120 | 76 | H |
| Cranberries | 100 | n/a | n/a |
| Longan | 100 | n/a | n/a |
| Pears | 100 | n/a | n/a |
| Pomegranates | 100 | n/a | n/a |

KEY: Low GI: 1 to 55; Medium GI: 56 to 69; High GI: 70 and higher

Sources:

1. Zespri International Limited.
2. Monro JA. Advances in Food and Nutrition Research. Chapter 14: Kiwifruit, carbohydrate availability, and the glycemic response. 2013;68:257-271.
3. Atkinson FS, Foster-Powell K, Brand-Miller JC. International tables of glycemic index and glycemic load values: 2008. *Diabetes Care*. 2008;31(12):2281-3.
4. Boland M, Moughan PJ. *Nutritional benefits of kiwifruit*. Vol. 68. Academic Press; 2013.
5. Chen YY, Wu PC, Weng SF, Liu JF. Glycemia and peak incremental indices of six popular fruits in Taiwan: healthy and Type 2 diabetes subjects compared. *J Clin Biochem Nutr*. 2011;49(3):195-9.
6. Rush E, Drummond LN. The Glycaemic index of kiwifruit. *New Zealand Kiwifruit Journal*. 2009;192:29-33.
7. Foster-Powell K, Holt SH, Brand-Miller JC. International table of glycaemic index and glycemic load values. *Am J Clin Nutr*. 2002;76:5-56.
8. Monro JA. Glycemic glucose equivalent: combining carbohydrate content, quantity and glycaemic index of foods for precision in glycaemia management. *Asia Pac Clin J*. 2002;11:217-25.

Metabolic health pertains to factors that can relate to a person’s risk for diabetes, heart disease, and stroke. This includes managing blood sugar levels, blood lipids, blood pressure and weight management.

Diabetes mellitus is an alteration of the body’s tolerance to glucose, and has various causes⁵⁷. About 422 million people in the world – between five percent and six percent of the population – suffer from diabetes. In addition, there is a rapidly increasing proportion of the population who, although not meeting all the criteria for diabetes, have challenges around managing their blood sugar levels or have prediabetes^{58,59}. This condition leads to poor absorption of glucose from the blood by the body’s tissues, so that levels may build up in the blood and high blood glucose concentrations can lead to multiple complications⁵⁷. Management of this disease requires adequately distributed intake of carbohydrates consumed in moderate quantity and carbohydrates with the lowest GI.

The Glycaemic Index (GI) indicates the amount of glucose that is released during digestion from carbohydrates into the blood system within about two hours of a meal. High GI foods are rapidly digested and absorbed, and result in a rapid, marked rise in plasma glucose levels, whereas the same amount of carbohydrate in low GI foods are more slowly digested and absorbed, resulting in a gradual rise in plasma glucose response and insulin levels⁶⁰.

FOODS ARE CLASSIFIED AS SUCH:

- HIGH GI (GI >70)
- MEDIUM GI (GI 55–70)
- LOW GI (GI <55)

Approximately 80 percent of the dry weight of kiwifruit consists of available carbohydrates, including glucose, fructose and sucrose at a ratio of about 2:2:1⁶¹. The remaining 20 percent of the dry weight of kiwifruit consists of protein (10 percent) and primary cell walls or fibre (10 percent).

The cell wall component of kiwifruit is undigested in the stomach and small intestine, and therefore increases in relative concentration in the gut lumen⁶¹. During digestion, the fibre in kiwifruit swells to four times its original volume, which reduces the rate of glucose diffusion by about 40 percent and profoundly reduces digesta mixing, the process which enables the transfer of sugars from the intestinal lumen to the gut wall⁶¹, which causes a delay in carbohydrate digestion and absorption.

RESEARCH

Metabolic Health and Glycaemia

With a low GI of 38-39, combined with a modest content of carbohydrate, and a fibre component that slows the rate of absorption, kiwifruit is an excellent fruit choice for people with diabetes trying to manage their blood sugar levels^{62,63}.

There is growing evidence highlighting that consuming of kiwifruit has a positive impact on the microbiota in the colon^{35-42,64}, which have also recently been identified as a new potential factor in obesity-related disorders⁶⁵. Growing evidence in clinical studies suggests that alterations in the colonic microbiota of people with obesity may lead to chronic low-level inflammation, insulin resistance and onset of Type 2 diabetes⁶⁶.

Consuming Zespri Kiwifruit has also been found to play a role in maintaining normal blood pressure and blood lipid values⁶⁷. Research directly linked to the potassium content of kiwifruit has not been completed. However, several studies have tested its connection.

AIM: In an effort to see how the effect of kiwifruit substitution is affected by its proximity in time to the ingestion of the partially substituted carbohydrate food, Weet-Bix was fed whole or partially substituted with SunGold Kiwifruit, with the substitution being made before, at the same time as, or after consuming the Weet-Bix.

CONCLUSION: This study indicates kiwifruit is highly effective in reducing the glycaemic impact (30 percent reduction) of a starchy meal and may be most effective when fed 30 minutes prior (50 percent reduction)⁶⁸.

AIM: Researchers at the New Zealand Institute for Plant & Food Research and Riddet Institute, in New Zealand sought to develop tables to guide partial exchange of kiwifruit for other carbohydrate foods while maintaining either constant carbohydrate intake or constant glycaemic impact.

CONCLUSION: Because of the modest sugar content and low glycaemic glucose equivalent content of kiwifruit, exchange tables may be used to guide incorporation of kiwifruit into healthy diets for glycaemic control⁶⁹.

AIM: To show that consuming two SunGold Kiwifruit per day at breakfast would be metabolically safe for healthy Chinese consumers, and that the increased intake of fructose from the kiwifruit would not cause the adverse metabolic effects that have been associated with high fructose intakes, healthy Chinese consumers were recruited and fed either two kiwifruit or water (control) as part of their breakfast for seven weeks. It was found that the kiwifruit group did not differ from the control group in any of the biomarkers measured.

CONCLUSION: Two kiwifruit per day may be safely consumed by Chinese consumers without risk of adverse metabolic effects as a result of increased fructose ingestion in the kiwifruit⁷⁰.

AIM: In effort to see whether the glycaemia-lowering effect of kiwifruit and its effectiveness as a preload would be apparent if the kiwifruit was consumed by Chinese consumers as part of a Chinese meal, healthy volunteers were fed two SunGold Kiwifruit before a congee meal (chicken-flavoured rice porridge) at breakfast time, or lunch time after a standard breakfast, using a kiwifruit exchange (equal carbohydrate) format.

CONCLUSION: Kiwifruit exchanges are effective in reducing the glycaemic impact of a starch-based Chinese meal in Chinese consumers⁷¹.

AIM: To see whether the glycaemia-lowering effects of kiwifruit substituted for food on an equal carbohydrate basis is simply a result of displacement of glucose by fructose, or whether other kiwifruit components were involved. Weet-Bix was partially substituted with either kiwifruit, or with the sugars alone that would be in the kiwifruit, and fed to healthy humans, so that if there were any difference in blood glucose response it must be due to non-sugar components in the kiwifruit.

CONCLUSION: The glycaemia suppressing effect of kiwifruit is due to factors in the kiwifruit in addition to the fructose substitution of glucose⁷².

AIM: To test the effect on glycaemic response when kiwifruit is included in a meal using the carbohydrate exchange principle, scientists offered Weet-Bix, and Weet-Bix partially substituted by enough kiwifruit to keep the sugar intake in both diets constant, to be consumed by human volunteers and their blood glucose responses measured.

CONCLUSION: Kiwifruit exchange for starchy food would be an effective way of reducing the glycaemic impact of a diet without reducing carbohydrate intake⁶⁸.

AIM: In a study partially substituting high-glycaemic foods – such as those based on cereal starch – with kiwifruit, researchers saw improved uptake of nutrients, including vitamin C, and reduced glycaemic response. Interestingly, this glycaemic benefit was greatest when kiwifruit were consumed approximately 30 minutes before consumption of a cereal meal, substantially lowering both the amplitude of the response (the “spike”) compared with consuming the two foods together, while inducing a lower total response (area under the curve) compared with an equal carbohydrate amount of the non-substituted food.

CONCLUSION: Partial substitution of starch-based staples, such as cereals, potatoes and rice, with kiwifruit is an effective dietary strategy to simultaneously reduce exposure to glycaemia while increasing the amount of nutrients consumed⁶¹.



RESEARCH

Metabolic Health and Diabetes Health Markers

AIM: In one long-term study, the metabolic effects of kiwifruit consumption in prediabetic consumers were measured to assess whether or not there would be adverse effects of using kiwifruit as a source of vitamin C in prediabetic individuals, given its natural fructose content.

CONCLUSION: After eating two kiwifruit per day for 12 weeks, there was significantly increased plasma vitamin C, without adverse effects on lipids or glucose control. This implies that kiwifruit is a metabolically safe natural source of vitamin C for individuals at high risk of diabetes⁷³.

AIM: Another human study measured the effect of consuming two SunGold Kiwifruit per day over 12 weeks on vitamin C status, clinical and other measures of metabolic and cardiovascular health.

CONCLUSION: Findings did show that supplementation with kiwifruit significantly increased plasma vitamin C concentrations and provided small improvements in several markers of metabolic and cardiovascular health⁶⁷.

AIM: This human pilot study served to test the impact of consuming two kiwifruit per day on various clinical biomarkers of cardiovascular disease risk, immune function and oxidative stress, and on vitamin C intake. Researchers fed two groups of healthy participants either two kiwifruit per day incorporated into their habitual diet, or their habitual diet without kiwifruit, in a cross-over design in which each group received the kiwifruit intervention for six weeks.

CONCLUSION: Two kiwifruit per day may be included in a healthy mixed diet to improve vitamin C status without perturbing other biomarkers in healthy consumers⁷⁴.

AIM: To measure metabolic changes in prediabetic individuals after eating two SunGold Kiwifruit per day.

CONCLUSION: Two SunGold Kiwifruit per day increased vitamin C status without adverse metabolic changes due to the increased ingestion of fruit sugars⁷⁰.

RESEARCH

Metabolic Health and Blood Pressure

AIM: Investigate the effect of the consumption of kiwifruit compared with a mixed fruit diet in male smokers to assess change in blood pressure.

CONCLUSION: Small but significant change in blood pressure was detected in the kiwifruit group⁷⁵.

AIM: This was a follow-up measure of male smokers with mildly high blood pressure after the consumption of three kiwifruit per day over an eight-week period.

CONCLUSION: Results showed a significant reduction in systolic and diastolic blood pressure; reductions in platelet aggregation and an angiotensin-converting enzyme, both associated with cardiovascular disease, were also observed⁷⁶.

RESEARCH

Properties of Kiwifruit in the Gut

AIM: To study *in vitro* Green and Gold Kiwifruit flesh under gastric and gastroileal digestive conditions.

CONCLUSION: The undigested soluble and insoluble fibre in the kiwifruit cell walls was found to swell to four times the volume of the original fruit and interact with other foods. This reduced the rate of processes involved in the glycaemic response, and may explain why the GI of the sugars consumed in kiwifruit is so much less than the GI of the same sugars consumed alone⁷⁷.

AIM: In effort to determine the effect of SunGold and Green Kiwifruit on gastric pH and on gastric pH adjustment and its consequences for salivary amylase activity in the stomach, researchers created a gastric model *in vitro*. Kiwifruit reduced the initial pH of gastric medium to less than pH 4.0, but a strong buffering capacity meant that more gastric acid was required to reduce the pH further to 2.0 than in other fruit. The pH drop caused by kiwifruit was enough to inhibit salivary amylase activity, and activate pepsin activity, leading to destruction of actinidin. The reduction in amylase activity reduced gastric starch digestion, which may contribute to the glycaemic response.

CONCLUSION: Findings raise the possibility that the glycaemia-lowering effect of kiwifruit may be partly due to slowed gastric salivary amylase activity and delayed gastric emptying⁷⁴.

AIM: A cross-sectional pilot study investigated the relationships between gut microbiota composition and diet in people with metabolic disorders. After consuming two SunGold Kiwifruit per day over 12 weeks, measures of vitamin C status, clinical and anthropometric measures and faecal microbiota composition in people with prediabetes were taken.

CONCLUSION: In this study, kiwifruit did alter gut microbiota and result in significant improvement of metabolic health markers⁶⁷.

RESEARCH

Weight Management

In the upper gastrointestinal tract, the same properties of kiwifruit fibre that support digestive health act to reduce the rate of glucose absorption so that the glycaemic response is lower and blood sugar levels remain stable²². This is important for people who are wanting to maintain a healthy weight and prevent a progression into obesity and, eventually, metabolic diseases such as Type 2 diabetes. It also increases the sense of fullness or satiety, since the fibre swells by taking up water and acts to increase viscosity. Animal trials have also shown that eating kiwifruit can increase the rate of gastric emptying²⁶.

AIM: Measure progress of individuals with prediabetes who were overweight and told to maintain their normal dietary and lifestyle habits, while consuming two SunGold Kiwifruit per day for 12 weeks.

CONCLUSION: The results of this study showed an increase in plasma vitamin C, a reduced waist circumference, waist-to-hip ratio, and average weight change of 2.3 kg from baseline⁶⁷.

EMERGING RESEARCH SUMMARY

Through our research programme, we continue to investigate kiwifruit's nutritional attributes and understand the beneficial effects of kiwifruit consumption on human health. New areas of research include mood and well-being and the gut-brain axis.

THE GUT-BRAIN AXIS (GBA)

The gut-brain axis is a theory of how the gut and the gut bacteria communicate with the brain to impact mood and a sense of mental well-being. Nutritional components such as prebiotic fibres, may support a positive mood by feeding the good bacteria in the gut. Additionally, a good night's sleep and antioxidants may be a part of making that happen.

Ongoing research has revealed that the gut microbiota, the GI tract and the brain all appear to communicate bidirectionally, linking the emotional and cognitive centers of the brain with gastrointestinal functions. Some researchers have even called the gut microbiota a "newly discovered organ" given the complex role it plays in disease and health⁷⁸.

This pathway by which the brain and gut communicate has come to be known as the gut-brain axis (GBA). There is much to still learn about this bidirectional communication system, but some studies have identified that the health of, and changes to, the gut microbiota can result in influences on gut-brain disorders or conditions. For example, an unbalanced gut microbiota has been implicated in Inflammatory Bowel Disease (IBD), functional gastrointestinal disorders, or even changes to brain behaviours and responses (e.g., response to stress, immune system, emotional behaviour, mood, sleep, food response, pain, brain biochemistry⁷⁹). Understanding this pathway, what can influence it, and how changes to it affect health and disease, is emerging as an exciting development in research.

Due to the relationship between diet and changes to the gut microbiota, foods that have prebiotic effects could be one possible target to influence the bidirectional communications between the gut and brain that result in positive health outcomes, including changes to mood, psychological function, mental well-being or emotional behaviour^{78,80}. Knowing that kiwifruit has prebiotic-like effects that can change the microbiota and cause the production of beneficial metabolites that interact with the GBA, it may be possible that kiwifruit is one such dietary application that can influence it.

While much more research is still needed to confirm a direct relationship between eating kiwifruit and effects to the GBA – evidence does suggest that the properties in Green and SunGold Kiwifruit may possibly alter behaviours and outcomes associated with changes to the GBA indirectly or directly, as they have been found in preliminary studies to improve sleep and mood.

It is possible that these effects are due to the interaction between the high amounts of the antioxidant vitamin C (known to modify neurochemicals in the brain) and other compounds found in the kiwifruit that have

prebiotic-like effects and influence the gut-brain axis communications (e.g., polyphenols, fibre). Kiwifruit also contains tryptophan⁸¹ and serotonin – approximately twice as much as tomatoes⁸². Serotonin is a neurochemical and metabolite of the amino acid tryptophan, which is related to rapid eye movement sleep and low levels are associated with insomnia, poor memory and depressed mood⁸³. What's more, emerging evidence suggests that stimulation of neurochemical-producing bacteria in the gut can be achieved with prebiotic supplementation⁴⁹. Additionally, intestinal tryptophan metabolism can be directly or indirectly controlled by the gut microbiota and alterations in tryptophan metabolism may have an active role in the progression of conditions like Inflammatory Bowel Disease, Irritable Bowel Syndrome-subtype constipation and depression⁸⁴.

Zespri Kiwifruit contain many properties that could potentially impact mood and mental well-being through modulation of the intestinal gut microbiota and the gut-brain axis.



RESEARCH

The Gut-Brain Axis

Both clinical and experimental evidence in animals suggest that the gut microbiota has an important impact on the GBA.

IN VITRO

AIM: To test whether microbial metabolites produced when gut bacteria interact with fermentable substrates (e.g., kiwifruit), including short-chain fatty acids (SCFA), can influence brain function and behaviour.

CONCLUSION: While no direct evidence exists that SCFA travel in the blood stream to the brain in humans, there is increasing support for the indirect actions of SCFA on health including feeding behaviours, blood sugar regulation and inflammatory conditions like obesity⁸⁵.

ANIMAL STUDIES

AIM: To test whether taking the microbiota from human patients with depression and implanting it into animals without a microbiome would affect their mood.

CONCLUSION: This study did find that taking the microbiota from human patients caused behavioural and physiological features characteristic of depression in the recipient animals⁸⁶.

AIM: Assess whether a high-fat maternal diet during pregnancy is associated with increased risk of neurodevelopmental disorders, including autism spectrum disorder (ASD), in offspring.

CONCLUSION: This study provides a causal link between maternal diet, gut microbial imbalance, VTA plasticity and behaviour and suggests that probiotic treatment may relieve specific behavioural abnormalities associated with neurodevelopmental disorders⁸⁷.

AIM: This study looked at the effect of prebiotics on mood.

CONCLUSION: Researchers found evidence of anti-depressant and anti-anxiety behaviour after ingesting fructo-oligosaccharides (FOS) and galacto-oligosaccharides in both animal models and human studies⁸⁸.

AIM: This review assesses the latest evidence linking short-chain fatty acids with host metabolic health and cardiovascular disease (CVD) risk and presents the latest evidence on possible biological mechanisms.

CONCLUSION: Not only does dietary fibre fermentation regulate microbial activity in the gut, SCFA also directly modulate host health through a range of tissue-specific mechanisms related to gut barrier function, glucose homeostasis, immunomodulation, appetite regulation and obesity⁸⁹.

HUMAN TRIAL

AIM: In this human trial, young adult males were supplemented with either half or two kiwifruit per day for six weeks. Profile of Mood States questionnaires were completed at baseline and following the intervention.

CONCLUSION: Young adults who consumed two kiwifruit per day for six weeks experienced a 35 percent trend towards a decrease in total mood disturbance and a 32 percent trend towards a decrease in depression. Those with a higher mood disturbance from the start of the study also experienced a 38 percent reduction in total mood disturbance, as well as a 38 percent reduction in fatigue, 31 percent increase in vigour per energy and a 34 percent trend towards a reduction in depression after eating two kiwifruit per day⁹⁰.

AIM: Human clinical study that examined the effects of consuming SunGold Kiwifruit on energy, vigour and well-being aspects of vitality.

CONCLUSION: 135 participants consumed two SunGold Kiwifruit per day vs. vitamin C control. SunGold significantly improved mood outcomes self-reported through validated questionnaires¹³.

AIM: The aim of this study was to evaluate the effects of kiwifruit on sleep patterns, including sleep onset, duration, and quality.

CONCLUSION: Consuming two kiwifruit in the evening one hour before bed for four weeks has been shown to increase sleep onset, duration, and efficiency in adults with self-reported sleep disturbances⁹⁰.

AIM: The purpose of this study was to investigate whether kiwifruit had beneficial effects on sleep compared to a control fruit (pear).

CONCLUSION: Eating 130 g of kiwifruit before bed for four weeks resulted in a statistically significant favorable effect on sleep quality and daytime functioning in students suffering from chronic insomnia⁹¹.



INITIAL STUDIES

From the Institute of Human Nutrition and Department of Medicine, College of Physicians and Surgeons, Columbia University, New York, provide some evidence for a role of certain dietary patterns and foods, including kiwifruit, in the promotion of high-quality sleep, but more studies are necessary to confirm those preliminary findings. Vitamin C, vitamin E and folate may be potentially linked with reducing oxidative stress and increased production of serotonin, the neurotransmitter associated with well-being and happiness⁹².

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