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MONK FRUIT

There's no mistaking it: Americans love to eat. Enjoying good food with good company is one of life's great pleasures. And yet, frequent over-indulgences can have a detrimental impact on conditions like obesity and type 2 diabetes, which take a substantial toll on individuals, communities and our healthcare system. Replacing foods and beverages high in calories and added sugars with ones that are lower in sugar is one option to help reduce intake of excess calories. In turn, this may help reduce the risk of obesity and related chronic diseases. One group of low-calorie sweeteners, monk fruit sweeteners, are used in foods and beverages as a way to lower intake of added sugars while still providing satisfaction from enjoying something sweet. This fact sheet will examine many topics of interest around monk fruit sweeteners and health so that you can make informed decisions about their place in your diet.

WHAT ARE MONK FRUIT SWEETENERS?

Monk fruit, also known as *lo han guo* or Swingle fruit (*Siraitia grosvenorii*), is a small round fruit native to southern China. It has been used for centuries in Eastern medicine as a cold and digestive aid, and now it is also being used to sweeten foods and beverages. Monk fruit sweeteners are created by removing the seeds and skin of the fruit, crushing the fruit, and collecting the juice. The fruit extract, or juice, contains zero calories per serving. Monk fruit sweeteners are permitted for use in foods and beverages by the U.S. Food and Drug Administration (FDA).

The compounds that give ripe monk fruit its sweetness are called *mogrosides*, which consist of a backbone structure called a mogrol with glucose units or glycosides attached to it. Most of what is known about mogroside metabolism comes from studies done in animals, which is thought to be the same or similar to mogroside metabolism in humans. Mogrosides are not absorbed in the upper gastrointestinal tract and do not contribute to any calories to our diet. When they reach the colon, gut microbes cleave off the glucose molecules and use them as an energy source. The mogrol and some metabolites are then primarily excreted from the gastrointestinal tract, while minor amounts are absorbed into the bloodstream and excreted in the urine (Zhou 2018, Xu 2015, Murata 2010).

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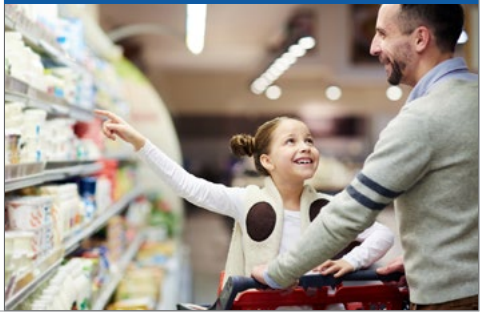


MONK FRUIT

Monk fruit sweeteners are 150-200 times sweeter than sugar and contribute sweetness to foods and beverages without adding calories. They are found in Nectresse®, PureLo®, Purefruit®, Fruit-Sweetness® and Monk Fruit in the Raw®, as well as other retail products sold under store brand names. Monk fruit sweeteners are used in beverages and foods like soft drinks, juices, dairy products, desserts, candies and condiments. Because they are stable at high temperatures, monk fruit sweeteners can be used in baked goods. However, a food containing monk fruit sweeteners may be slightly different in appearance, texture and taste than the same food made with sugar, as sugar contributes to the structure and texture of foods.

Like all no- and low-calorie sweeteners, only very small amounts of monk fruit sweeteners are needed to achieve the sweetness of sugar. To make measuring and pouring easier, they are typically blended with common approved food ingredients. This is why a packet of monk fruit sweeteners seems equal in quantity to a packet of table sugar, for example.

ARE MONK FRUIT SWEETENERS SAFE TO CONSUME?

YES. Monk fruit sweeteners have been permitted as generally recognized as safe (GRAS) by the FDA since 2010, a category which requires expert consensus that a food ingredient is safe for its intended use. Governments in Australia and New Zealand, China, Japan and Canada (tabletop packets only; not approved for use in foods and beverages) have also concluded that monk fruit sweeteners are safe for the general population, including children, people with diabetes, and women who are pregnant or nursing.

An acceptable daily intake (ADI) has not been established for monk fruit sweeteners because adverse effects have not been demonstrated, even after high amounts of monk fruit sweeteners were given in animal studies. The ADI typically represents an amount 100 times less than the quantity of a substance found to be safe in research studies.

ARE MONK FRUIT SWEETENERS SAFE FOR CHILDREN?

YES. Foods that include monk fruit sweeteners can add sweetness to a child's diet without contributing to increased calorie intake, sugar intake or risk of cavities. While no research has been published on monk fruit sweetener intake in children, no negative effects on health have been demonstrated in animal models or adults. As with adults, current intake of low-calorie sweeteners in children is considered to be well within acceptable levels. Due to limited studies in children, however, the American Academy of Pediatrics does not have official recommendations on low-calorie sweetener intake.

CAN PREGNANT AND BREASTFEEDING WOMEN CONSUME MONK FRUIT SWEETENERS?

YES. While no published research has examined possible effects of monk fruit sweeteners on pregnant and lactating women, several studies in animals have demonstrated no adverse reproductive or developmental effects on mother or offspring, even when animals were exposed to very high levels of mogrosides every day over long periods of time (Yang 2015, FSANZ 2018). All women should try to consume the necessary nutrients and calories for their baby's growth during pregnancy and breastfeeding, while taking care not to exceed their needs. This may include being mindful of all sources of sweeteners, whether they be from sugar or low-calorie sweeteners.

CAN PEOPLE WITH DIABETES CONSUME MONK FRUIT SWEETENERS?

YES. Products containing monk fruit sweeteners provide a sweet taste and are often low or lower in carbohydrates, which is important for people who must monitor their carbohydrate intake. Monk fruit sweeteners do not raise blood sugar levels. The 2018 American Diabetes Association Standards of Medical Care in Diabetes state that, "The use of nonnutritive sweeteners may have the potential to reduce overall calorie and carbohydrate intake if substituted for caloric (sugar) sweeteners and without compensation by intake of additional calories from other food sources. Nonnutritive sweeteners are generally safe to use within the defined acceptable daily intake levels." Nonetheless, people with diabetes should talk with a registered dietitian, healthcare professional or a certified diabetes educator for advice on healthy eating to improve blood sugar control.

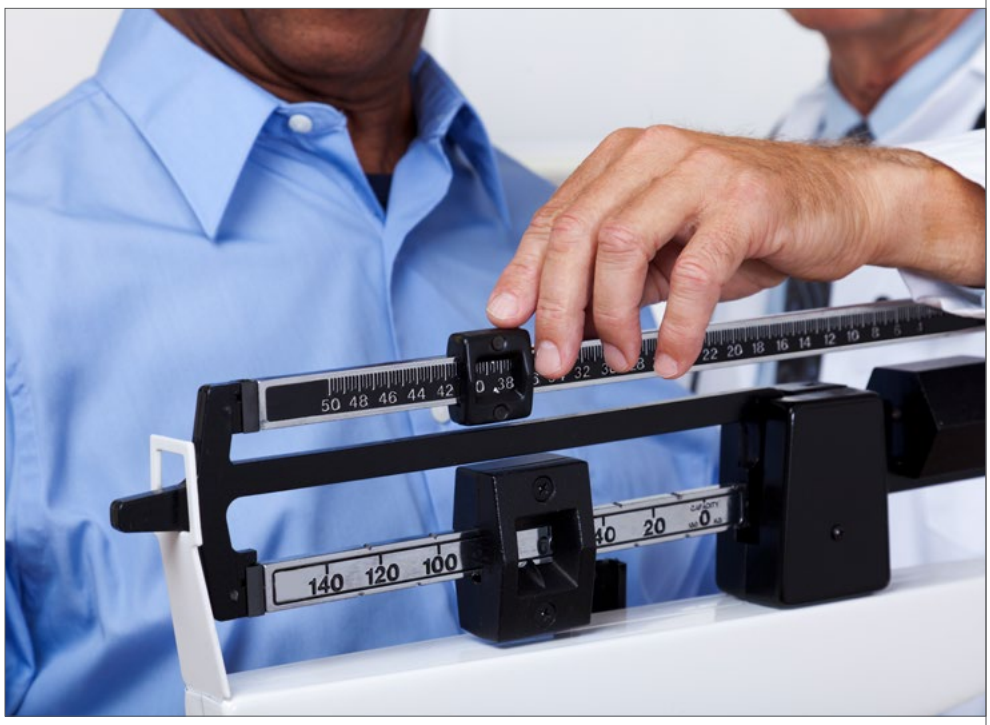
WHAT IS AN ADI?

The acceptable daily intake, or ADI, is the average daily intake over a lifetime that is expected to be safe based on significant research (WHO 2009). It is usually derived by determining the highest intake level found to have no adverse effects in lifetime studies in animal models. These studies are required by FDA and other regulatory agencies around the world before permitting any new food ingredient. That amount is then divided by a safety factor (usually 100) to determine the ADI (Renwick 1991). The ADI is a conservative number that the vast majority of people will not reach.

WHAT IS GRAS?

Food ingredients permitted for use in the U.S. fall into one of two categories: food additives (which require review prior to approval from the FDA) or Generally Recognized as Safe (GRAS) ingredients. Whether GRAS or a food additive, food ingredients must be safe and must meet the same high food safety standards. To be considered GRAS, an ingredient must meet one of the following two conditions: 1) A history of safe use has been established and a significant number of people consumed the ingredient prior to the enactment of the Food Drug and Cosmetic Act of 1958; or 2) Scientific data and information about the safety and use of the ingredient are widely known and publicly available in scientific articles, position papers, etc., with consensus among scientific experts that the ingredient is safe for its intended use.

WILL MONK FRUIT SWEETENERS HELP ME LOSE OR MAINTAIN MY WEIGHT?



Currently, no research has examined how monk fruit sweeteners affect weight. However, there is substantial evidence that substituting foods and beverages sweetened with low-calorie sweeteners for their full-sugar counterparts can play a role in weight loss or weight management. In a survey of members of the National Weight Control Registry, the largest study of successful weight loss maintainers, over 50 percent of all respondents stated that they regularly consume low-calorie beverages, 78 percent of whom felt that doing so helped control their calorie intake (Catenacci 2014).

Data from randomized clinical trials, considered to be the gold standard for assessing causal effects, support that substituting low-calorie sweetener options for regular-calorie versions leads to modest weight loss (Miller 2014, Rogers 2016). For example, in one study, over 300 participants were assigned to consume either water or low-calorie sweetened beverages for one year as part of a weight loss program. Those who were assigned to the low-calorie sweetener group lost 6.21 kg on average, compared to those in the water group, who lost 2.45 kg (Peters 2016). However, clinical trials on the effect of monk fruit sweeteners on body weight have not yet been published.

Some observational studies have demonstrated an association between low-calorie sweeteners and increased weight and waist circumference (Fowler 2016). Observational studies, which examine the relationship between an exposure (such as intake of monk fruit sweeteners) and an outcome (such as body weight or a health condition), are not able to establish cause and effect. This is because they are not randomized, so they cannot control for all of the other exposures or factors that may be causing or influencing the results. For example, one hypothesis is that people may compensate for "calorie-free" choices by eating or drinking more calories in other food choices or future meals (Mattes 2009). Think of a person who may justify ordering dessert at a restaurant because they had a diet soda with their meal: the extra calories from the dessert will be greater than the calories saved by ordering the diet beverage. These additional calories may contribute to weight gain or prevent further weight loss. It has also been suggested that people who are already overweight or obese may begin to choose low-calorie sweetened foods and beverages as one method for losing weight (Drewnowski 2016). This makes it difficult to assume that the use of a low-calorie sweetener can be the cause of weight gain but it may reflect how low-calories sweeteners are typically used in the diet. RCTs may, therefore, represent the efficacy of low-calories sweeteners while observational studies may be reflecting their real-world effectiveness. Recent systematic reviews and meta-analyses (a scientific approach that combines findings from many studies into one powerful analysis) have concluded that, overall, findings from observational studies showed no association between low-calorie sweetener intake and body weight, and a small positive association with body mass index (BMI) (Miller 2014, Rogers 2016).

It is important to note that losing and maintaining one's weight often require multiple simultaneous approaches. Making a single change, such as substituting foods and beverages made with low-calorie sweeteners for full-calorie, sugar-containing products is just one approach. Lifestyle and behavior practices like reducing total calorie intake, eating a healthful diet, exercising regularly, getting enough sleep and maintaining social support networks are all important factors in achieving weight-loss and weight-maintenance goals.

EMERGING RESEARCH:

CAN MONK FRUIT SWEETENERS MAKE ME HUNGRIER?

Highly palatable foods activate brain regions of reward and pleasure. This positive association has been hypothesized to enhance appetite, and if left unchecked, the resulting increase in food intake may contribute to overweight and obesity (Singh 2014). Substituting full-calorie and sugar-containing foods with their counterparts made with low-calorie sweeteners has exhibited a similar effect on reward pathways, but without contributing additional calories. No research has been published on the specific effects of monk fruit sweeteners on appetite and satiety, though one small study demonstrated that total daily energy intake did not differ between people consuming monk fruit sweeteners and those consuming sugar (Tey 2017a).

Some have expressed concern that activating reward pathways without delivering sugar to the body may have unintended consequences, and the role that low-calorie sweeteners have on appetite and food cravings is a developing area of research. As noted in recent reviews (Fowler 2016, Sylvetsky & Rother 2018), some research in animal models has demonstrated changes in food intake and appetite-related hormones after consuming low-calorie sweeteners. And yet, similar effects have not been seen in humans. To date there is no strong evidence that low-calorie sweeteners enhance appetite or cravings in humans (Rogers 2017), and some randomized trials have demonstrated the opposite effect – including a decrease in hunger (Peters 2016) and reduced dessert intake compared to those who drank water (Piernas 2013). There is no research on monk fruit's relationship to appetite or cravings.

These discrepancies underscore an area in which animals and humans are inherently different as research subjects. In humans, the link between physiology, psychology, personal experiences and food is unmistakably complex, and the translation of animal research to this area of study should be viewed with caution.

DO MONK FRUIT SWEETENERS AFFECT BLOOD SUGAR CONTROL?

Foods and beverages made with low-calorie sweeteners are frequently recommended to people with diabetes as an alternative to sugar-sweetened foods and beverages. Research has shown that monk fruit sweeteners do not raise blood sugar levels in humans (Tey 2017a, Tey 2017b) and a recent consensus statement by experts in nutrition, medicine, physical activity and public health concluded that the use of low-calorie sweeteners in diabetes management may contribute to better glycemic control (Serra-Majem 2018).

Many medical, nutrition and public health organizations around the world, backed by a large body of evidence, support the consumption of low-calorie sweeteners in people with diabetes. These individuals, or those who are at risk for developing diabetes, should be mindful of food and beverage intake from all sources, including those containing low-calorie sweeteners and sugars. It is important to discuss nutrition with a doctor or registered dietitian and to eat a healthful, balanced diet to keep blood sugar levels under control.

A few observational studies have demonstrated an association between low-calorie sweetener consumption and risk for type 2 diabetes (Sakurai 2014, Imamura 2015) but these studies are not able to directly link cause and effect and as with the studies on body weight and obesity, they are at risk of confounding. Given that overweight and obese individuals tend to consume more low-calorie sweetened beverages as compared to lean individuals (Bleich 2014), this is a critical omission. It is also important to note that none of these observational studies included monk fruit and therefore, no evidence of an association between monk fruit consumption and type 2 diabetes has been described.

EMERGING RESEARCH:

WHAT ABOUT THE MICROBIOME?

The microbes living in our intestinal tract have become recognized as potentially significant contributors to our health, though research on the gut microbiome is still in its infancy. Despite the involvement of the gut microbiota in the metabolism of monk fruit's mogrosides, to date there is no evidence that monk fruit sweeteners meaningfully impact the composition or function of the gut microbiome. However, randomized clinical trials have not yet been conducted in humans. There are significant differences between the microbiome profiles from one person to another and research has shown that the gut microbiome changes in response to normal changes in the diet (David 2014). A great deal of research is still needed to identify a microbiome profile and degree of diversity considered to be "optimal" in populations and in individuals.

MONK FRUIT AT A GLANCE

SCIENTIFIC NAME: Siraitia grosvenorii

BRAND NAME: Nectresse®, PureLo®, Purefruit®, Fruit-Sweetness® and Monk Fruit in the Raw®

COMMON NAMES SEEN ON FOOD LABELS: monk fruit extract, luo han guo, Swingle fruit

DATE OF GRAS STATUS BY FDA: Generally Recognized as Safe status in 2010 for use in foods and beverages

NUMBER OF TIMES SWEETER THAN SUGAR: 150-200

SAFE FOR CHILDREN? Yes

SAFE FOR PREGNANT AND BREASTFEEDING WOMEN? Yes

WHAT IS THE BOTTOM LINE?

All types of foods and beverages can have a place in our diets, including those made with monk fruit sweeteners. Monk fruit sweeteners have been considered GRAS in the United States since 2010 and their safety has been acknowledged by many international health agencies.

Since monk fruit sweeteners are relatively new to the food supply, their impact on, and association with, chronic conditions like obesity and diabetes has not been well studied. However, they have been safely used for centuries in Asian cultures and have not demonstrated any side effects, even after very high amounts have been consumed. Small randomized trials have shown that monk fruit sweeteners do not negatively impact blood sugar or insulin levels. Research continues on emerging issues like the effect of low-calorie sweeteners on the gut microbiome.

Adopting a healthful, active lifestyle that is tailored to personal goals and priorities is vital to supporting one's wellbeing. Choosing foods and beverages sweetened with low-calorie sweeteners such as monk fruit may be one tool to help control sugar intake and keep calories in check, which are important components of maintaining a healthy body weight. and reducing risk for diet-related disease.

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