Tucson Audubon recommends feeding hummingbirds sugar solution

There has been some discussion of the merits of feeding nectar formulas to wild, free-living hummingbirds. One recent article in the *Arizona Daily Star*(*Angela Pittenger Arizona Daily Star Wednesday, July 24, 2013*) even suggests that feeding sugar water is harmful to hummingbirds.

Jon Friedman, who owns The Wild Bird Store on East Fort Lowell Road and is co-owner of The Hummingbird Market that manufactures Clear Hummingbird Nectar said in the *Arizona Daily Star* that "Birds have a hard time metabolizing the wrong type of sugars, and it wears out their livers and kidneys". His implication is that regular white refined sugar is harmful.As a result of that Tucson Audubon and other organizations have received calls about the safety of feeding hummingbirds sugar solution.

To our knowledge, there is no published scientific work that indicates that feeding a solution of white sugar (sucrose) in water is harmful to wild, free-living hummingbirds.

To our knowledge, there is no published scientific work that indicates that feeding a solution of nectar formula is more beneficial to wild, free-living hummingbirds than feeding them sugar water.

If you plan to feed hummingbirds, Tucson Audubon recommends thatthat you mix one part white sugar with four parts water and bring the solution to a boil, then cool before use. Tucson Audubon also recommends that you grow a range of native plants that produce nectar-producing flowers that have evolved to attract hummingbirds. We can supply a list of these plants upon request.

It is important to remember thatthe nectar in the flowers we plant and the sugar water we provide in feeders attracts hummingbirds for our viewing pleasure. They achieve a balanced diet by selecting many other foods in their environment, and especially insects.

More background information

Cane and beet-derived white sugar that you buy in a store is sucrose, which is a compound sugar made up of two simple sugars, glucose and fructose, in equal proportions. Dextrose is another name for glucose that is derived from corn. Sucrose is the preferred sugar food of hummingbirds, and flowers that depend upon hummingbirds for pollination have sucrose-dominated nectar. Sucrose is digested with an efficiency of almost 100% by hummingbirds.

Hummingbird Market's product reproduces the mix of sugars (sucrose, fructose, and dextrose=glucose) commonly contained in flowers that have evolved to be pollinated by hummingbirds. There is no evidence that this sugar combination brings any additional benefits to hummingbirds. Hummingbirds naturally digest the sucrose into fructose and glucose before further metabolizing these sugars.

There are other nectar formulas on the market that contain a variety of other additives, including red food coloring, calcium, and other minerals. While we understand that captive hummingbirds, or those that are being rehabilitated, need an enhanced nectar since they are unable to balance their diet with naturally occurring foods, we are unaware of any scientific research that shows a beneficial effect of these nectar formulations on wild, free-flying hummingbirds.

The scientific literature documents that hummingbirds will feed on flower nectar, tree sap, other sugary exudations from plants (as may occur as a result of injury), insects, and spiders.

All species probably actively balance their diet, and there are published reports that hummingbirds do on occasion eat the juices from fruit, the honey dew produced by aphids, as well as such items as ashes, sand, and even seawater, presumably to acquire trace minerals and elements lacking in their regular food. The naturally occurring nectar, and the sugar water we provide, provides the energy that enables hummingbirds to locate the other foods they need to balance their diet. Insects form an especially large part of the diet of hummingbirds.

Further to the comments on the effects of sucrose on livers and kidneys, Jon Friedman is doing some inappropriate generalizing. In the case of liver issues, while fatty liver disease is common in captive birds, hummingbirds included, it is virtually unknown in the wild. The liver damage rumor seems to have originated with Augusto Ruschi, who kept hummingbirds in captivity in addition to feeding free-living ones.

In the case of kidneys, high blood sugar can "wear out" human kidneys, but hummingbirds are not humans. Their bodies are adapted to cope with serum glucose levels that would have devastating consequences for our pancreas, kidneys, livers, retinas, blood vessels, and nerves.

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Similarity and Apparent Convergence in the Nectar-Sugar Composition of Some Hummingbird-Pollinated FlowersC. Edward Freeman, William H. Reid, James E. Becvar and Ron Scogin*Botanical Gazette*Vol. 145, No. 1 (Mar., 1984), pp. 132-135

The nectar-sugar composition of 40 species of purportedly hummingbird- pollinated plants in 12 families was determined by high-performance liquid chromatography. The distribution of relative percentages by mass for the major sugars--fructose, glucose, and sucrose--was normal about their means. **The means and 95% confidence limits were: fructose, 15% (3%-33%); glucose, 11% (0%-23%); and sucrose, 74% (55%-94%).** One sample also contained a trace of maltose. Salvia spathacea contained only fructose and sucrose. The data, primarily from southwestern North America, define a range of nectar composition, possibly representing the preferences of hummingbirds. These data support assertions of adaptive convergence in the sugar composition of nectar in hummingbird-pollinated species.

C. Martínez del Rio, H. G. Baker, I. Baker Experientia15 June 1992, Volume 48, Issue 6, pp 544-551 Ecological and evolutionary implications of digestive processes: Bird preferences and the sugar constituents of floral nectar and fruit pulp

Plants pollinated and dispersed by different groups of birds offer different kinds of sugars in nectar and fruit pulp. The preferences and physiological traits of avian pollinators and seed dispersers are broadly correlated with the sugar composition of the nectar and fruit that they feed on and appear to have influenced the evolution of the sugar composition of the rewards that plants offer. Hummingbirds prefer sucrose whereas many nectar- and fruit-eating passerines prefer glucose and fructose. Preference for hexoses in passerines seems to be associated with poor sucrose assimilation resulting from two physiological mechanisms: lack of intestinal sucrase activity and fast passage rates. Sucrase activity absence appears to be restricted to a single phylogenetic group (the sturnid-muscicapid lineage). Fast passage rates seem to be characteristic of many small frugivores and to hinder the assimilation of complex nutrients that require hydrolysis before absorption. Hummingbirds have extremely specialized digestive traits that allow them to assimilate sucrose at high rates and with extremely high efficiency. These specialized digestive traits appear not to be present in many nectar-feeding passerines.

Abrol, D. P. 2011. Pollination Biology: Biodiversity Conservation and Agricultural Production. Springer. (Ch. 14, pp. 465-466)

Hainsworth, F.R. 1974. Food quality and foraging efficiency: the efficiency of sugar assimilation by hummingbirds. J. Comp. Physiol. 88:425431.

Throughout the breeding season of hummingbirds in southeastern Arizona flowers provide hummingbirds with nectar equivalent to sucrose concentrations of 0.24–2.10 M, and nectar from most flowers is composed only of sucrose, glucose, and/or fructose.

When fed sucrose solutions of 0.5–2.0 M hummingbirds are at least 97–99% efficient in assimilating sugars.The efficiency with which hummingbirds can extract nectar from flowers will depend on the size of the bird species, nectar concentration in flowers, and factors influencing rate of nectar intake.

Although species with low assimilation efficiencies (poor quality diets) may achieve sufficient foraging efficiencies by processing large quantities of food at low caloric cost, a high assimilation efficiency from a high quality food may be important for hummingbirds which employ an energetically costly foraging strategy.

McWhorter T.J., and C. Martinez del Rio. Food ingestion and water turnover in hummingbirds: how much dietary water is absorbed? J. Exp. Biol. 1999:2851-8.

Hummingbirds are specialized nectarivores that feed on dilute solutions of sugars with trace amounts of amino acids and electrolytes. Their diets contain excess water that, if absorbed, must be eliminated. It has been hypothesized that in hummingbirds only a small fraction of this dietary water may be absorbed in the intestine. Here, we report the results of experiments designed to examine the relationship between nectar intake and water turnover in hummingbirds. Our results also allow the estimation of water absorption across the intestine and therefore test the hypothesis that ingested water in hummingbirds passes largely unabsorbed through the gastrointestinal tract. We found that fractional and total water turnover increased linearly with water ingestion. At low sucrose concentrations, food intake rates between four and five times body mass per 12 h were not unusual. A simple mass-balance model suggested that 78 % of ingested water was absorbed in the gastrointestinal tract and hence must be processed by the kidneys. However, fractional water absorption was variable and did not appear to be correlated with food or water intake parameters. Our results do not lend support to the hypothesis that the bulk of dietary water passes through the intestine unabsorbed. Although hummingbird kidneys appear well suited to excrete large volumes of dilute urine, rates of energy assimilation in hummingbirds may be constrained by excess water elimination when these birds are feeding on nectars with a low sugar concentration

Fowler, Murray E., and Zalmir S. Cubas, eds. 2008. Biology, Medicine, and Surgery of South American Wild Animals. John Wiley & Sons. [p. 178]

Terres, John K. 1977. Songbirds in Your Garden. [p. 132: "Once the hummingbirds are coming to your feeders, you can dilute the solution to one part sugar to four parts water and eventually to the one part sugar to eight parts water recommended by Dr. Ruschi to protect hummingbirds against the possibility of getting enlarged livers from the richer solutions..."]

Diabetic nephropathyhttp://www.nlm.nih.gov/medlineplus/ency/article/000494.htm

Hargrove, James L. 2005. Adipose energy stores, physical work, and the metabolicsyndrome: lessons from hummingbirds. Nutr J. 2005; 4: 36.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1325055/

Hummingbirds and other nectar-feeding, migratory birds possess unusual adaptive traits that offer important lessons concerning obesity, diabetes and the metabolic syndrome. Hummingbirds consume a high sugar diet and have fasting glucose levels that would be severely hyperglycemic in humans, yet these nectar-fed birds recover most glucose that is filtered into the urine. Hummingbirds accumulate over 40% body fat shortly before migrations in the spring and autumn. Despite hyperglycemia and seasonally elevated body fat, the birds are not known to become diabetic in the sense of developing polyuria (glucosuria), polydipsia and polyphagia. The tiny (3–4 g) Ruby-throated hummingbird has among the highest mass-specific metabolic rates known, and loses most of its stored fat in 20 h by flying up to 600 miles across the Gulf of Mexico. During the breeding season, it becomes lean and maintains an extremely accurate energy balance. In addition, hummingbirds can quickly enter torpor and reduce resting metabolic rates by 10-fold. Thus, hummingbirds are wonderful examples of the adaptive nature of fat tissue, and may offer lessons concerning prevention of metabolic syndrome in humans.