ICE CREAM SCIENCE

STEVIA IN ICE CREAM

September 30, 2016 / By Ruben / 19 Comments

[Total: 23 Average: 3.7/5]

14 MINUTE READ

In this post, I'll be covering the use of *stevia rebaudiana* (Bertoni) as a natural sweetener in ice cream. I'll cover the sweetness potency, flavour profile, and the sweetness temporal profile of stevioside and rebaudioside A, the two main compounds providing sweetness in *stevia*. I'll also cover the Acceptable Daily Intake (ADI), metabolism, *stevia* and diabetes, health concerns, and sucrose and *stevia* blends in ice cream.

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- Sugar in ice cream
- How to make homemade vanilla bean ice cream – Recip
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1. WHAT IS STEVIA?

Stevia rebaudiana (Bertoni) is a sweet herb native to Paraguay and Brazil (Carakostas et al., 2011). Studies have shown that *stevia* has been used since ancient times for various purposes throughout the world: the Guarani tribes of Paraguay and Brazil used *stevia* as a sweetener in yerba mate and medicinal teas for treating heartburn and other ailments (Brandle & Telmer, 2007).

The leaves of *stevia* are known to contain at least 35 different zero-calorie sweetening compounds (Ceunen & Geuns, 2013) called *steviol glycosides* (SGs), namely stevioside, rebaudioside A, B, C, D, and E, dulcoside and steviol biosides. Stevioside and rebaudioside A are believed to be the main compounds providing the sweetening properties in *stevia* (Lemus-Mondaca et al., 2012).

2. STEVIOSIDE AND REBAUDIOSIDE A

2.1. SWEETNESS POTENCY

Stevioside is said to be 250-300 times sweeter than sucrose (Duke & deCellier, 1993; Lester, 1999), whilst rebaudioside A has a sweetening potency even higher than stevioside, about 250-450 times sweeter than sucrose (Barriocanal et al., 2008). Rebaudioside A is said to be superior in terms of both sweetness and quality of taste (DuBois, 2000; Fry, 2012).

In contrast to sucrose, all high-intensity sweeteners become less effective at sweetening the higher their concentration. Stevioside and Rebaudioside A reach a maximum sweetness intensity (a plateau where the sweetness intensity remains constant) at 9.9% and 10% sucrose equivalence respectively (DuBois et al., 1991). Sucrose equivalency (SE) is the standardised sweetness intensity scale established in sweetener research with sucrose as the reference. An x% SE is equivalent in sweetness to an x% sucrose water solution (Stargel et al., 2001).

2.2. FLAVOUR PROFILE

The sweet tastes of stevioside and rebaudioside A are accompanied by bitter and liquorice-like ‘off’ tastes that are more notable for stevioside than rebaudioside A. In rebaudioside A, these ‘off’ tastes are generally only apparent at relatively high concentrations and are not significant at lower levels (Prakash et al., 2008). A trained descriptive panel evaluated a high-purity rebaudioside A (Young & Wilkens, 2007a). At low to medium SE levels (SE less than 6%), bitter and black liquorice attributes were low/negligible, whilst at higher SE levels (SE higher than 6%), they became notable.

Because stevioside is only half as sweet as the same concentration of rebaudioside A, it is at a disadvantage in that twice as much is required to reach the same sweetness intensity as a given concentration of rebaudioside A. Higher concentrations of stevioside are, however, more likely to be accompanied by bitter ‘off’ tastes.

2.3. SWEETNESS TEMPORAL PROFILE

Sweetness temporal profiles demonstrate changes in the perception of sweetness over time. Most high-potency sweeteners, in contrast to sucrose, display a prolonged Extinction Time (ET) (Prakash et al., 2008), which means that the sweet sensation in the mouth is perceived for longer. Young & Wilkens (2007b) found that the ET of a high-purity rebaudioside A was significantly longer than that of sucrose.

3. ACCEPTABLE DAILY INTAKE

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) have established an Acceptable Daily Intake (ADI) for steviol glycosides (expressed as steviol equivalents) of 4 mg/kg body weight per day (FAO, 2010). This ADI takes into account a no-observed-adverse-effect-level (NOAEL) and applies a 100-fold safety uncertainty factor extrapolated from a 2 year carcinogenicity study on rats consuming 2.5% stevioside in the diet, equating to 967 mg stevioside/kg body weight per day or 388 mg steviol equivalents per kg body weight per day (Xili et al., 1992).

4. METABOLISM

Consumption studies demonstrate that intact steviol glycosides are poorly absorbed by humans after consumption (Pawar et al., 2013). *In vitro* (Gardana et al., 2003; Hutapea et al., 1997; Koyama et al., 2003; Purkayastha et al., 2014) and *in vivo* (Geuns et al., 2007; Geuns et al., 2006; Simonetti et al., 2004; Temme et al., 2004; Wheeler et al., 2008) metabolism studies with stevioside and rebaudiosides A, B, D, and M, suggest that all steviol glycosides are degraded to steviol by intestinal microflora in the colon, where the majority is absorbed across the gut wall and the rest is excreted in the faeces. To aid excretion from the body, absorbed steviol is rapidly transformed to steviol glucuronide in the liver, which is then excreted in urine (Geuns et al., 2006; Brusick, 2008).

5. STEVIA AND DIABETES

Steviol glycosides have been found to have beneficial effects on blood glucose and insulin levels in human studies, suggesting that they may serve a potential role in the treatment of type 2 diabetes. Gregersen et al. (2004) reported that there was a significant reduction (an average of 18%) in postprandial glucose levels in Type II diabetic patients given test meals supplemented with stevioside. Anton et al. (2010) found that *stevia* reduced postprandial blood glucose and insulin levels in humans and, more recently, Ritu & Nandini (2016) found that subjects suffering from type 2 diabetes mellitus who were given *stevia* leaf powder had significantly lowered fasting and post-prandial blood glucose levels on completion of 60 days.

6. HEALTH CONCERNS

6.1. POTENTIAL GENOTOXICITY

Steviol glycosides have been subjected to extensive genetic testing. Although negative genotoxicity results have been reported in the majority of studies, steviol has induced positive genotoxicity results in some studies (Pezzuto et al., 1985, 1986; Matsui et al., 1989, 1996a,b; Suttajit et al., 1993 Terai et al., 2002; Nunes et al., 2007). Readers are referred to Brusick (2008) and to Urban et al. (2012, 2015) for a comprehensive evaluation of these studies.

6.2. EFFECTS ON REPRODUCTION

Several animal studies have suggested that steviol glycosides may have adverse effects on the male and female reproductive system. Studies have reported anti-fertilitiy effects in female rats, as well as decreases in the weights of the testes, seminal vesicle, and cauda epididymides, and a reduction in spermatozoa concentration, in male rats, administered *stevia* extracts (Planas & Kucacute, 1968; Oliveira-Filho et al., 1989; Melis, 1999).

Planas & Kucacute (1968) investigated the potential of aqueous *stevia* extract to act as a contraceptive in female rats. They reported that female rats of proven fertility fed a 5% aqueous extract of *stevia* displayed reduced fertility and that fertility continued to decrease for at least 50-60 days after intake was stopped. Similar results were reported by Bakal & O'brien (1986) for female rats and by Portella Nunes & Pereira (1988) for female mice. In the latter study, fertility was reduced by 20% and 40% respectively, by treatment with 1% and 5% tea infusions prepared from *stevia* leaves, during the 12-day period before mating. The 1% infusion when given during the mating period reduced the number of uterine implants but had no effect if given before mating began.

In contrast, two reports have appeared in which no anti-fertility effects were seen in male rats fed *stevia* leaf extracts (Sincholle & Marcorelles, 1989; Oliverira-Filho et al., 1989). Similarly, Kinghorn et al. (1991) found that stevioside administered to male and female rats at concentrations of up to 3% of the diet produced no abnormal responses in mating performance or fertility, and Curry et al. (2008) found no treatment-related effects of rebausioside A on mating performance, fertility, gestation, and estrous cycle in rats.

In a recent study, Shannon et al. (2016) argued that steviol glycosides and steviol may have the potential to act as a hormone disrupting chemical. The researchers found that steviol can antagonise the progesterone nuclear receptor transcriptional activity and increase progesterone production. Progesterone is a steroid hormone that plays a major role in female reproductive health such maintaining pregnancy, regulating the monthly menstrual cycle and preparing the body for conception (Healy, 1990). The researchers also found that steviol induced an agonistic response on Catsper, the progesterone receptor of sperm cells.

6.3. HEALTH SUMMARY

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) reviewed steviol glycoside safety on several occasions and concluded that stevioside and rebaudioside A were not genotoxic (JECFA, 2005). Similar conclusions that steviol glycosides are safe at the proposed levels of consumption have been announced by the European Food Safety Agency (EFSA, 2010), Australia-New Food Safety Authority (ANZFSA, 2008) and others (Carakostas et al., 2012).

7. SUCROSE AND STEVIA BLENDS IN ICE CREAM

Because of the low maximum sweetness intensity, the 'off' tastes at high concentrations, and prolonged extinction times, stevioside and rebaudiside A are principally used in blends with caloric (e.g. sucrose, high fructose starch syrup, fructose, glucose, etc.) and non-caloric sweeteners (e.g. erythritol, mogrol, glycosides, etc.) (DuBois, 2000).

Alizadeh et al. (2014) investigated whether a low calorie and low glycemic index (GI) ice cream could be developed using a mixture of sucrose (su) and *stevia* (St). Varying proportions of *stevia* (steviol glycoside, white powder, 240 times sweeter than cane sugar) and sucrose were added to make the following five different ice cream formulations: formulation A. 18.6g (su); formulation B. 13.95g (su) and 20 mg (St); formulation C. 9.3g (su) and 40mg (St); formulation D. 4.64g (su) and 70mg (St) and formulation E. 110 mg (St) without any sugar.

The researchers found that the suitability of taste, texture, and mean liking was relatively higher in formulation C, as compared to the other ice creams, and formulation E had the lowest texture, taste, and total mean liking scores. These results suggest that substituting half of the sucrose in an ice cream mix with 0.04g *stevia* produces ice cream with similar texture and taste to a sucrose only formulation. Using *stevia* as the sole sweetener is, however, unlikely to produce ice cream with a favourable taste and texture.

8. SUMMARY

Stevioside and rebaudioside A are believed to be the main compounds providing the sweetening properties in *stevia*. Rebaudioside A has a sweetening potency higher than stevioside and is said to be superior in terms of both sweetness and quality of taste.

Because of the low maximum sweetness intensity, the ‘off’ tastes at high concentrations, and the prolonged extinction times, stevioside and rebaudiside A are unlikely to be used as the sole sweetener in ice cream. Instead, their principal use is in blends with caloric (e.g. sucrose, high fructose starch syrup, fructose, glucose, etc.) and non-caloric sweeteners (e.g. erythritol, mogrol, glycosides, etc.). Substituting half of the sucrose in ice cream with 0.04g *stevia* has been shown to produce ice cream with similar texture and taste to a sucrose only formulation.

Steviol glycosides have been found to have beneficial effects on blood glucose and insulin levels, suggesting they may serve a potential role in the treatment of type 2 diabetes. Health concerns associated with *stevia* consumption include genotoxicity, as well as adverse effects on the male and female reproductive system.

In the United States, whole-leaf *stevia* or crude extracts are currently not permitted for use as food additives. Steviol glycosides (including Rebaudioside A, Stevioside, Rebaudioside D, and steviol glycoside mixture preparations with Rbaudioside A and/or Stevioside being the predominant components) of high purity (95% minimum purity) have, however, been given GRAS (Generally Recognised as Safe) Notices (USFDA, 2012).

I hope this post helps. I will be testing *stevia* in ice cream and will update this post with my results. I'd love your feedback on how this post can be improved so please do get in touch and say hi! All the best, Ruben 🙂

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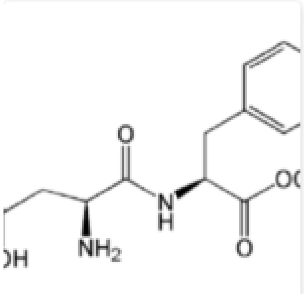

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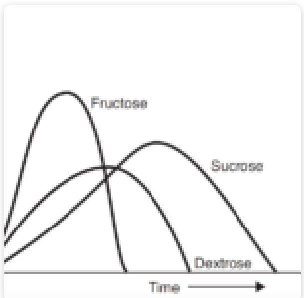

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« Artificial Sweeteners in Sugar-Free Ice Cream

Ice crystals in ice cream »

COMMENTS

Susan Wrightson

October 9, 2019 at 6:22 am

Hello Ruben… I am a foodie, not diabetic, but do have a sensitivity to artificial sweeteners by way of migraines. This past summer I have tried my hand at making sorbets and ice cream. My first attempt at making ice cream (lemon) with only stevia for me was a taste flop. The stevia packaging said it was 1:1 for sugar but having made the product it tasted very bitter. My sister, a diabetic, loved it, another friend thought it was too sour. I wanted a product that was good for a small group of people who loved ice cream but all have diabetes. Since reading your research I now have a better understanding of the ratio, and the science behind my results. With this information I will try making sorbet again but might forego ice cream as there is too much that needs to be replaced for volume and be cost effective. Thank you for sharing your research. I look forward to your next blog on this subject. Best regards…Susan

REPLY

David Hosking

September 18, 2019 at 8:46 am

Hi Ruben, in the various formulas mentioned (A, B, C, D, E) there's no mention of what this is against? Is it per 100mls? Thanks for your help, Dave 🙂

REPLY

JV

August 8, 2018 at 5:45 pm

Hello Ruben! Thank you for sharing your research with all of us foodies. I have enjoyed reading your articles and have found them very compelling and thought provoking. I appreciate it ;). I thought it might interest you to to read about my ice cream adventures.

I have been making sugar-free ketogenic ice cream for about a year and a half, and came across your site a few months ago but haven't decided to try your methods until now, because I wasn't sure how I could follow the formula without the use of sugar, milk, or skim milk powder. I have been using a mix heavy cream (35% milk fat I believe), almond milk (which is less than 2% almonds I believe) and cottage cheese (blended of course) in attempt to lend a creamy texture without using so much cream (pure calories!). To this I've been adding a stevia-erythritol mix, egg yolks, a touch of stabilizer (glucomannan), heating it and tempering the yolks, cooling on an ice bath, aging, and finally churning and freezing.

This is what I have been doing, which has turned out pretty darn good. But since I am selling it, I would like to raise the bar with typical keto ice cream and use your methods as much as possible to try and mimic the wonderful smooth, dense, creamy properties that you tell us about :). I love how you can

achieve results like that with so few ingredients.
I have also experimented with the use of vegetable glycerin in terms of keeping the ice cream soft and scoopable. It's magical, really but I would prefer to go for a more natural route.
I have a few ideas of how I could implement your methods, but if you have any ideas or suggestions it would be greatly appreciated. I understand that you're a busy man so please don't worry about it if you don't have time to reply. Thanks a bunch,
JV
P.S. Here is a great article about natural sugar free sweeteners. Paola, the author, is another source of inspiration for me and you might find the article as useful as I did .
https://www.gnom-gnom.com/best-low-carb-keto-sweeteners/

REPLY

StefanGourmet

January 22, 2018 at 8:22 pm

Hi Ruben, thanks for a very interesting post! By using skim milk powder I managed to make home made ice cream with stevia only that was great in terms of texture, however it kind of defeats the purpose of the stevia because skim milk powder is 50% lactose (i.e. sugar).

REPLY

Ruben

February 12, 2018 at 7:37 pm

Hi there Stefan,

Did you manage to make ice cream with a combination of sucrose and stevia, or just with stevia? You could look into using whey powder instead of skim milk powder if you want to reduce lactose. I've never tried using whey powder myself so not too sure how much you would need to use.

All the best,

Ruben

REPLY

Steve

December 9, 2017 at 3:50 pm

Hi Ruben,

Since Stevia does not lower the freeze point, how can you remove 50% of the sucrose in the formulation and still have an acceptable texture? Since you have not replaced it with any other solids i assume it gets replaced with water in the five examples. Have you researched using erythritol or erythritol Stevia blend to substitute for the other half of the sugar? With the 2017 Halo Top craze here in America, many manufacturers want to do a Stevia based product to lower the overall calories of a pint…but scoopability/texture is an issue.

REPLY

Ruben

December 12, 2017 at 10:58 am

Hi there Steve,

That's a good question. You could use either maltodextrins or a low DE corn syrup (20 DE corn syrup) to replace the solids lost from removing the sucrose. This will likely produce a hard ice cream though so you could also add a little fructose or dextrose to depress the freezing point (both depress the freezing point nearly twice as much as sucrose). Replacing the solids is key because mixes with high total solids are more likely to have smaller ice crystals and smoother texture. I've just published a new post on corn syrups in ice cream. I'd recommend having a quick read through the sections on freezing point depression and viscosity.

I haven't tried using erythritol before but it is something I will be researching soon and will post my findings on the blog.

I hope that answers your questions. Let me know if you need a hand with anything else.

All the best,

Ruben

REPLY

Pia

October 14, 2017 at 9:38 am

HI Ruben! thanks for this blog, it's very helpful and informative. I was wondering if you were able to formulate a recipe using stevia? I make homemade ice cream for selling, and there is a current demand for low glycemic ice cream. Stevia for cooking is readily available here in Manila, I'm just not sure how to substitute it for the sugar in my recipes considering it cannot be on a per gram basis because stevia is supposed to be 300 times sweeter. I hope you can help me out. Thanks!

REPLY

adrianmakes

October 3, 2016 at 12:49 pm

My own observation is that Reb A by itself is far inferior to a mixture of multiple of steviosides. I tried some pure Reb A and threw it away because it was so much worse tasting than other products. This shouldn't be a big surprise, because we generally find when using alternative sweeteners that mixtures are better. In other words, erythritol+stevia is better than either one alone. So why should it be any different with the steviosides? I wonder if this maximum sweetness issue is addressed using mixtures? I am generally able to make my ice creams and other sweet preparations sweet enough (for me) with stevia alone.

I have also observed that how people taste stevia seems to vary. One person I knew found that things I made containing stevia always tasted terrible, even when most people thought they were good.

REPLY

Ruben

October 10, 2016 at 3:30 pm

Hi Adrian!

Interesting that you find a blend better than pure Reb A. Yes I think one way of solving the maximum sweetness issue is by blending with caloric and non-caloric sweeteners. I haven't had time to try steviol glycosides in ice cream yet but am looking forward to testing a sucrose-stevia blend. I'll try and post the results when I get the time.

Very interesting re how people perceive stevia flavour differently. I know this is the case with some artificial sweeteners (I've forgotten which ones) but didn't realise this was also the case with steviol glycosides. This might make them difficult to use in ice cream.

All the best,

Ruben

REPLY

adrianmakes

October 19, 2016 at 3:57 pm

Seems to me that people exhibit variable responses to a wide range of foods. If they don't like it, they don't have to eat it. That doesn't mean it shouldn't be made for the people who *do* like it. If I hate olives it doesn't mean olives shouldn't be used—it means I shouldn't buy foods containing olives. And of course labeling is important so people know it's in there.

Most of the people who ate preparations I made sweetened with stevia thought they were good. They seemed less picky than me about it. Presumably the goal for a commercially produced stevia sweetened ice cream is a formulation that appeals to a large population, and my experience suggests that this is possible.

REPLY

Janene

October 2, 2016 at 11:02 pm

Thanks for compiling such an interesting article. I tried Stevia sweeteners in the past and was not at all happy with the result – eeeew! Now I know why!!

REPLY

Ruben

October 10, 2016 at 3:21 pm

🙂

REPLY

marc

October 2, 2016 at 7:27 am

fantastic article Rubin. Thanks for sharing.

REPLY

marc

October 2, 2016 at 7:28 am

Ooops sorry mis spelt Ruben

REPLY

Ruben

October 10, 2016 at 3:21 pm

Close enough 🙂

REPLY

Ruben

October 10, 2016 at 3:20 pm

🙂

REPLY

Christian Barisch

September 30, 2016 at 9:41 pm

Hella Ruben !
Heres interesting information about the taste-qality/purity of different Stevia brands and what has changed, because of new FDA regulations:
http://healthyindulgences.net/ingredients-guide/stevia/

To my knowledge is JaJa Stevioside one of the beste tasting brands. (NuNaturals Stevia is it no more because the changed their formular)

I thing the Sugar “Palatinose” (Isomaltulose) (avaiable at Myproteine.co.uk) is quite Interesting – per weight it is half as sweet as sugar (but has the same caloric content), has a very natural sweet profil/taste (better than Xylit or Erithrit) and has an glycemic Index of 32 ! (I use it sometimes for Sorbets – 4 to 5% Palatinose in combination with other sugars – that it don´t gets to sweet).

Thank you for you great Blog about ice cream !

Christian

REPLY

Ruben

October 10, 2016 at 3:20 pm

Hi there Christian!

Thanks for getting in touch and for sharing your sweetener knowledge! Jaja Stevioside and palatinose are now on my to-try list 🙂

All the best,

Ruben

REPLY

LEAVE A REPLY

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ABOUT ME

I make ice cream in Manchester, U.K. **Read**

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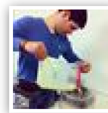

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