Detox Desserts Blood Sugar and Insulin Response Trial

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Third party, independent data analysis conducted by Morgan Braxton, PhD, RN

INTRODUCTION

Detox Desserts is a physician created line of healthy baking "Sweet Swaps" to replace the refined/white flour, sugar, eggs and butter in traditional baked desserts. This product line offers a simple solution for people who want to easily bake healthy desserts. A consumer can simply follow any traditional, made from scratch style recipe for cookies, cakes, sweet breads, etc. and make 4 simple 1:1 'Sweet Swaps' for flour, sugar, eggs and butter. The result instantly and effortlessly becomes a vegan, paleo, keto, oil-free, gluten-free and sugar-free version of the original, while still maintaining a very similar taste, texture and baking experience to the original recipe. These products are intended to transform a family's favorite recipes into allergy-free "superfood" desserts designed to taste delicious and improve health. This product line has been formulated with researched ingredients that improve digestion, gut health, and oral health, reduce cholesterol and maintain steady blood sugar and insulin levels for sustained focus, energy and mood. This product line goes above and beyond the currently available healthy dessert options on the market and aims to transform desserts into foods that are physician designed and clinically tested to actually improve health and glycemic control, while eliminating the common food sensitivities of wheat, dairy and eggs.

BACKGROUND

Obesity is an epidemic in the U.S.; roughly two out of three U.S. adults are overweight or obese (69%) [1]. Obesity harms virtually every aspect of health. It shortens lifespan and contributes to chronic conditions such as diabetes and cardiovascular disease. The condition most strongly influenced by body weight is type 2 diabetes [2]. The Nurses' Health Study followed 114,000 middle-age women for 14 years and showed the risk of developing diabetes was 93 times higher among women who had a body mass index (BMI) of 35 or higher [2]. The risk of death from all causes, cardiovascular disease, cancer, or other diseases increased as BMI increased above the healthy range [3]. Abdominal obesity and weight gain during adulthood are linked with several cancers including breast, colon and rectum, endometrium, esophagus, kidney, ovary, and pancreas [4]. Obesity also carries a heavy social and emotional toll. An analysis of 17 cross-sectional studies found that people who were obese were more likely to have depression than people with healthy weights [5].

Unfortunately, our children aren't protected from this epidemic. Childhood obesity rates have tripled in the U.S. over the past 3 decades and one out of three children is overweight or obese [6]. Obesity can harm nearly every system in a child's body including heart, lungs, muscles, bones, kidneys and digestive tract, as well as the hormones that control blood sugar and puberty [7]. Children who are overweight or obese have substantially higher odds of remaining overweight or obese into adulthood, increasing their risk of disease and disability later in life [8].

Weight gain in adulthood is often too slow for most people to notice, about one pound per year, but certainly adds up over time [9]. The Western-style dietary patterns with more processed foods, red meat,

sugary drinks, sweets, refined carbohydrates, and potatoes have been linked to obesity and is one cause of this slow and insidious weight gain [10-13]. The Western-style dietary pattern is also linked to an increased risk of heart disease, diabetes, and other chronic conditions [14]. Milled, refined grains, sugar and the foods made with them like white bread, white pasta, processed breakfast cereals, cakes, cookies, sugary drinks and the like are rich in rapidly digested carbohydrates. These rapidly digested carbohydrates carry a high glycemic index and glycemic load causing a rapid increase in blood sugar and insulin [15]. In the short term, they cause hunger to spike and can lead to overeating. Over the long term, these rapidly digested carbohydrates increase the risk of weight gain, diabetes, and heart disease [16].

Fortunately, there is increasing evidence that the same healthful food choices and diet patterns that help prevent heart disease, diabetes, and other chronic conditions may also help to prevent weight gain. Choosing minimally processed, whole foods like whole-grains, vegetables, fruits, nuts, healthful sources of protein (fish, poultry, beans), and plant oils not only protect against weight gain but also improves overall health. These foods are primarily found within the Mediterranean diet which is well documented to protect against chronic disease and weight gain [17] and are the foundation of the ingredients in the Detox Desserts product line.

Most people enjoy desserts. Humans are programmed to like sweet tasting food and they are virtually impossible to eliminate without feeling deprived. Our ancestors needed the quick energy from rapidly digesting carbohydrates to run, fight, work and survive. This fast energy gave them a competitive advantage and we evolved appreciating the flavor and coveting the foods that provided this. Our culture has shifted from naturally sweet foods like fruits and honey to refined sugar, refined grains and saturated fats making up the main ingredients in modern desserts. Unfortunately, these ingredients are the primary cause of metabolic dysfunction, obesity, diabetes and heart disease.

The goal of Detox Desserts is to create a product line and method of baking that easily transforms modern desserts into healthy, whole-foods. The 1:1 Detox Desserts "Swaps" were created to replace refined flours, sugars and saturated fats in dessert recipes. In turn, eliminating the need to restrict dessert and encouraging adults and children to "indulge" in foods that actually work to improve their health and minimize disease. The product line combines ingredients from the Mediterranean Diet such as nuts, whole-grains, seeds, and extra-virgin olive oil, with added fiber from whole psyllium husks and inulin, and is safely sweetened with a blend of sugar alcohols and stevia. It also provides a simple way to remove common food sensitivities like wheat, dairy and eggs while maximizing the nutrient density of the desserts. This is a synergistic, science-driven product line designed to be used together for excellent baking results, taste profiles and health benefits. Its simplified 1:1 swap method will make it easy for every health-conscious consumer and baker to create healthy desserts in their own homes. More importantly, it makes removing deleterious ingredients easy for large scale facilities that serve children, elderly and the unwell. There is a large opportunity to bring appealing, yet health promoting food to schools, health-care facilities, restaurants and bakeries. Detox Desserts aims to improve the health of the population without restricting delicious desserts.

Although there are already 1:1 gluten-free baking replacements on the market, those gluten-free flours are made with refined grains and starches high in rapidly digested carbohydrates, which can still

cause blood sugar and insulin spikes. There are 2 different 1:1 Flour Swaps in the Detox Desserts product line. The Whole-Grain Flour Swap is a blend of gluten-free whole-grains and soluble fiber. The Grain-Free Swap is a blend of nuts and soluble fiber. Both Flour Swaps have a relatively large amount of whole psyllium husk which drastically increases the soluble fiber content and reduces net carbohydrates. The soluble fiber and lower carbohydrate content work to slow down the blood sugar response and helps the consumer to feel full, satisfied and nourished without imparting an undesirable flavor or texture on the baked goods.

The Grain-Free Flour Swap contains 9 grams of fiber and only 3 net carbs per ¼ cup. It consists of blanched almond flour (nutritional benefits of almonds discussed below) and whole psyllium husk but is mostly coconut flour. Coconut flour was chosen for its ability to decrease the glycemic index of all foods it is combined with, a phenomenon likely due to its naturally high dietary fiber content [18]. Relatively large amounts of whole psyllium husk were chosen as an ingredient in both the Whole-Grain and Grain-Free Flour Swaps over other types of soluble fiber because of its ability to act as a binding agent in baked goods (replacing gluten and egg) and its numerous, well-researched health benefits. Psyllium husk is generally well tolerated because it is less readily fermented and therefore causes less flatulence and abdominal bloating than other forms of fiber. Studies show a healthy diet supplemented with psyllium fiber improves fasting lipids, glucose, insulin and body composition [19]. A healthy diet with added psyllium husk provided dramatic improvements in metabolic syndrome risk factors, significant reductions in total cholesterol and LDL-cholesterol, reductions in weight, BMI and total body fat [19]. Psyllium husk's hypocholesterolemic properties have been well researched, with studies indicating that the effects do not depend on the amount of fat or cholesterol in the diet [20, 21]. Psyllium husk helps maintain glycemic control and prevents overeating because it decreases the hunger hormone, ghrelin, and slows gastric emptying time thus reducing postprandial glycaemia and insulin secretion [22, 23].

The Whole-Grain Flour Swap contains 4 grams of protein, 6 grams of fiber and 17 net carbs per ¼ cup serving making it higher in carbohydrates than the Grain-Free Flour but far less than refined white flour containing about 24g of rapidly digested carbohydrates and less that 1 gram of fiber. The Whole-Grain Flour Swap is made from gluten-free oats, buckwheat groats and whole psyllium husks. Gluten-free oats are generally well tolerated by most people and are high in the soluble fiber beta-glucan, which has numerous benefits including reducing cholesterol and blood sugar levels, relieving constipation, promoting healthy gut bacteria, and increasing feelings of fullness [24]. Buckwheat is a gluten-free pseudocereal (like quinoa and amaranth) and is also well tolerated by most people. Buckwheat is the richest source of rutin, an antioxidant with a number of benefits including reducing risk of heart disease by preventing the formation of blood clots and decreasing inflammation and blood pressure [25]. A study in 850 Chinese adults linked buckwheat intake to lower blood pressure and an improved blood lipid profile with reductions in LDL cholesterol and increased levels of HDL cholesterol [26].

The Detox Desserts 'Sugar Swap' has been formulated using erythritol, xylitol, inulin and stevia to have the exact sweetness and baking characteristics of white sugar without any undesirable aftertaste or gastro-intestinal related side-effects. The currently available sugar replacements on the market don't carry the same sweetness, flavor profile and baking characteristics that refined sugar has, often making them undesirable to both consumers and bakers. Further, these sugar replacements often cause notable gas and

bloating because of the tendency of the alcohols to draw water into the intestines. Sugar alcohols are a type of carbohydrate and have a chemical structure similar to sugar which makes them taste sweet. They are not absorbed or fully digested by the body, resulting in much fewer calories, much lower digestible carbohydrates and carry a much lower glycemic index. Humans don't have the enzymes needed to break down erythritol so it is absorbed by the body and then excreted by the urine unchanged without affecting blood sugar or insulin levels [27]. Studies in mice suggest that erythritol may not only serve as a glucose substitute but also be a useful agent in the treatment of diabetes to help manage postprandial blood glucose levels by inhibiting α-glucosidase in a competitive manner [28]. Erythritol also acts as an antioxidant in vivo and may help protect against hyperglycemia-induced vascular damage [29]. A pilot study with 24 participants showed erythritol consumption acutely improves small vessel endothelial function, and chronic treatment reduced central aortic stiffness, concluding that erythritol may be a preferred sugar substitute for patients with diabetes mellitus and cardiovascular disease [30]. According to the University of Sydney's Glycemic Index research, the glycemic index of xylitol is only about 8 but carries a similar sweetness to white sugar whose glycemic index is about 65 and higher based on dose/weight. Animal studies show intake of xylitol may be beneficial in preventing the development of obesity and metabolic abnormalities in rats with diet-induced obesity [31]. Sugar alcohols don't contribute to tooth decay and studies show they actually improve oral health by reducing the type of bacteria in the mouth that causes dental caries [32]. Inulin has been added to the Sugar Swap to slow carbohydrate digestion, increase fullness and satiety and decrease indigestion [33]. Inulin increases nutrient absorption and aids digestion by increasing the number of good bacteria in the gut, particularly Bifidobacteria and Lactobacilli [34]. One study concluded that inulin may have a two-pronged effect on the risk of diabetes by both promoting weight loss and reducing intrahepatocellular and intramyocellular lipids in people with prediabetes independent of weight loss [35]. Inulin also contains soluble fiber which acts collaboratively with the psyllium to further reduce the absorption of cholesterol as it moves through the digestive tract.

The intent of the 'Butter Swap' is to remove the cholesterol and dairy in baked goods by replacing the butter and unhealthy oils required in most dessert recipes. The Butter Swap is made from a base of blanched almonds and emulsified with a small amount of extra virgin olive oil (EVOO). Minimal added salt and organic natural flavors make it taste and bake like butter rendering finished baked desserts tasting very similar to those baked with butter. The Butter Swap maximizes the nutritional value while eliminating the common dairy food allergen and the saturated fats and cholesterol contained in butter. The Butter Swap can be used 1:1 for butter or oil in most traditional baked goods. Nuts are a calorie dense food but studies find that eating nuts does not lead to weight gain and may instead help with weight control, perhaps because nuts are rich in protein and fiber, both of which may help people feel full and less hungry [36-38]. Almonds provide post-ingestive metabolic and appetitive benefits and do not increase the risk for weight gain [39]. Almonds lowered serum glucose responses postprandially making them a diabetic safe food [40]. People who regularly eat nuts are less likely to have heart attacks or die from heart disease than those who rarely eat them [17], which is another reason they form the foundation for the Butter Swap. EVOO is the main component of the Mediterranean Diet and olive oil polyphenols have shown protective effects on cardiovascular risk factors. EVOO consumption decreased oxidative stress biomarkers and improved some features of the lipid profile [41, 42]. The multitude of positive effects on cardiovascular health was the reason EVOO was chosen to maintain a creamy consistency in the Butter Swap product.

The ingredients in the ‘Egg Swap' aim to keep the healthy protein one would get from consuming an egg while eliminating the cholesterol and common egg food allergen. The Egg Swap is a mixture of pure almond protein powder, inulin, turmeric, stevia and organic natural flavors and is reconstituted with water. The pure almond protein powder similarly matches the protein content of an egg, the inulin improves gut health and nutrient absorption (discussed above), and the turmeric adds additional anti-inflammatory properties [43] and is a creative way to provide the familiar pale-yellow color of an egg. Both Flour Swaps hold more moisture than regular white flour so the reconstitution method for the Egg Swap adds the perfect amount of moisture to the Flour Swap in most recipes.

METHODS

This trial was designed to evaluate both insulin and blood sugar response of the Detox Desserts product line. Postprandial blood sugar response was assessed for 7 days in 30 healthy adult participants using a standard glucometer. Participants were asked to take morning/fasting blood sugar, eat the provided breakfast, then log 30-minute, 1-hour and 2-hour postprandial blood sugar readings. They were also asked to provide daily feedback on satiety, mood, focus, energy level, and bowel movements. Nothing but water was allowed to be consumed during the 2-hour testing window and participants were instructed not to engage in any vigorous activity during the testing window. Participants had no history of blood sugar problems or insulin resistance, were not on any blood sugar controlling medications and were generally considered healthy.

The trial compares 115 grams of traditionally made, store-bought frosted sugar cookies to 115 grams of Detox Desserts frosted sugar cookies using our proprietary method of baking and “Sweet Swap” ingredients. A typical oral 2-hour glucose load test uses 75 grams of glucose solution. This trial was designed to closely match that by using a 115 gram serving of store-bought frosted sugar cookies containing 78 grams of rapidly digesting carbohydrates in the form of white flour and refined/white sugar. Although the weight of the cookie serving is the same, the Detox Desserts cookies contain a much lower amount of net carbohydrates due to the high fiber content of the psyllium husk, whole-grains and nuts used in the Flour Swaps and the blend of sugar alcohols and stevia used in the Sugar Swap. By removing refined grains and sugar in dessert, one would assume blood sugar and insulin response would be much lower in a healthy person. Blood sugar response of both Grain-Free and Whole-Grain Detox Desserts cookies were also compared to a balanced macronutrient breakfast and a ketogenic breakfast. See Table 1 for the 7-day breakfast schedule of participants in the trial.

Due to the more cumbersome nature of insulin collection, insulin response for 6 of the 30 healthy participants was done separately to compare the same 115 gram Whole-Grain Detox Desserts, 115 gram Grain-Free Detox Desserts and 115 gram high carbohydrate store-bought cookies. Fasting insulin was collected using a standard venous blood draw, the participants ate the provided breakfast, then a second insulin level was collected 45 minutes postprandially in each participant on three separate days. Nothing but water was allowed to be consumed and no vigorous activity was allowed during the testing window. Insulin typically peaks 30-60 minutes after eating so this trial used the mid-point postprandial testing at 45 minutes.

RESULTS

Participants (N=30) were mostly female (n=22, 73%), with an average age of 45.6 (SD 11.42). Mean height was 66.45 inches (SD 4.2) and mean weight was 161.9 pounds (SD 36.8). The majority (n=20, 67%) had no medical conditions, and no participants had a history of blood sugar problems or insulin resistance. Table 1 includes blood glucose levels (BG) at all time points (fasting, 30-minute, 1-hour, and 2-hour) for each of the 7 days of the trial (See also Figures 1-3).

Table 1. Daily Blood Glucose Testing (N=30).

Day	**Breakfast Type**	**Fasting** Mean (SD)	**30 min**	**60 min**	**2-hour**
1	Balanced Macronutrient	103 (12)	107 (17)	105 (15)	102 (15)
2	Ketogenic	100 (9)	99 (17)	95 (10)	98 (13)
3	Whole-Grain Detox Dessert	98 (11)	108 (12)	103 (14)	107 (14)
4	Grain-Free Detox Dessert	99 (10)	100 (13)	101 (10)	99 (8)
5	Whole-Grain Detox Dessert	96 (10)	107 (9)	106 (16)	102 (13)
6	Grain-Free Detox Dessert	99 (8)	100 (11)	99 (14)	101 (10)
7	Store-Bought Frosted Sugar Cookies	98 (9)	131 (19)	128 (25)	110 (19)

Figure 1. Mean Blood Glucose Each of the Seven Days.

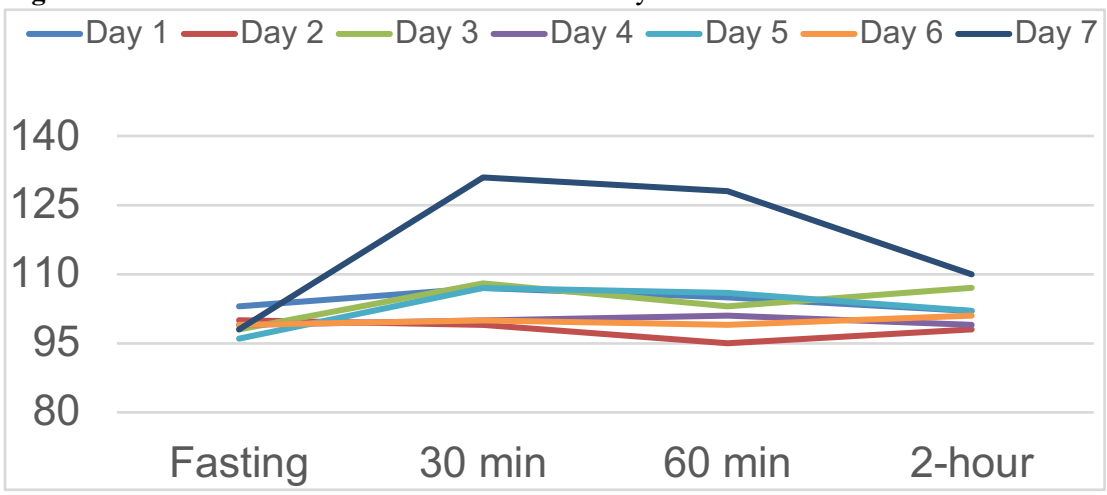


Figure 2. Mean Blood Glucose Each Breakfast Type.

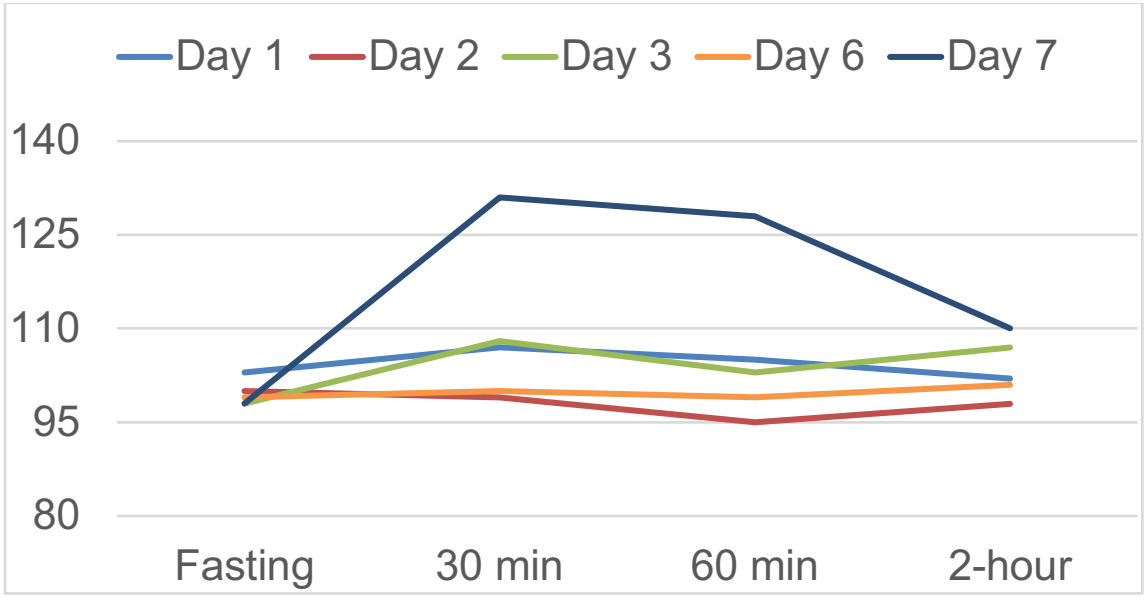
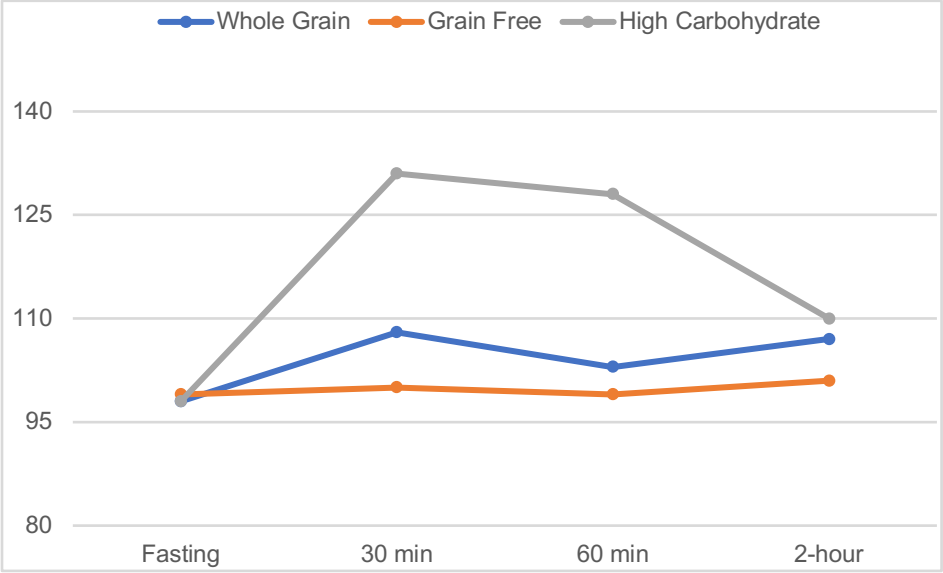


Figure 3. Mean Blood Glucose Detox Desserts vs. Store-Bought Cookies.



Whole-Grain Detox Desserts

Day 3 (Whole-Grain Detox Dessert) blood glucose (BG) was significantly lower than Day 7 (Store-Bought) at 30 and 60 minutes ($p < .001$). There was no significant difference in baseline BG ($p = .930$). The difference between means was 19% at 30 min, 22% at 60 min. Day 5 (Whole-Grain Detox Dessert) BG was significantly lower than Day 7 (Store-Bought) at 30 and 60 minutes ($p < .001$) and 120 minutes ($p = .045$). At 30 min, the difference was 20% and at 60 min it was 19% and at 120 min it was 8%. There was no significant difference in baseline BG ($p = .430$).

Grain-Free Detox Desserts

Day 4 (Grain-Free Detox Dessert) BG was significantly lower than Day 7 (Store-Bought) at 30 and 60 minutes ($p < .001$) and 120 minutes ($p = .003$). The differences were: 27% at 30 min, 24% at 60, 11% at 120. There was no significant difference in baseline BG ($p = .680$). Day 6 (Grain-Free Detox Dessert) BG was significantly lower than Day 7 (Store-Bought) at 30 and 60 minutes ($p < .001$) and 120 minutes ($p = .007$). There was no significant difference in baseline BG ($p = .486$). At 30 min, the difference was 27% and at 60 min it was 26% and at 120 min it was 9%.

Comparison to Macronutrient and Ketogenic

Overall, there were few significant differences between Detox Desserts and traditional macronutrient and ketogenic breakfasts. There were no significant differences in BG between Day 2 (Ketogenic) and Day 6 (Grain-Free Detox Dessert). The only significant difference between Day 4 (Grain-Free Detox Dessert) and Day 2 (Ketogenic) was at 60-minutes ($p = .004$) (See Table 1). Day 1 (Balanced Macronutrient) fasting glucose was significantly higher than Day 3 ($p = .009$) and Day 5 ($p = .008$) (Whole-Grain Detox Dessert) at baseline. Day 3 (Whole-Grain Detox Dessert) 2-hour BG was significantly higher than Day 1 (Balanced Macronutrient) ($p = .019$).

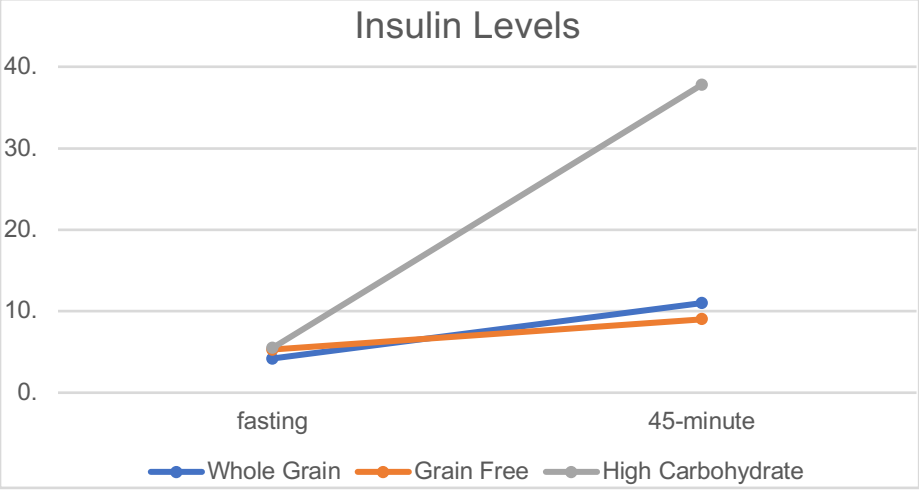
Insulin Levels

Mean insulin levels are reported in Table 2 (See also Figure 4). There was no significant difference in baseline insulin, as well as no significant difference between Whole-Grain and Grain-Free insulin. High Carbohydrate Sugar cookies 45-minute insulin was significantly higher than Grain-Free (p=.003) and Whole-Grain (.006).

Table 2. Mean insulin levels. (N=6).

Food	**Fasting** Mean (SD)	**45 Min**	**Difference (p)**
Whole-Grain	4.2 (2.5)	11.0 (5.8)	.020*
Grain-Free	5.3 (2.5)	9.0 (4.1)	.016*
High Carbohydrate	5.5 (2.3)	37.8 (16.1)	.003*

Figure 4. Mean Insulin Levels.



Satisfaction, Bowel Movement, Mood

Table 3 reports reported individual's satisfaction, whether or not they had a bowel movement, and if they expressed having a positive mood after consuming the day's breakfast.

Table 3. Reported satisfaction, bowel movement, and mood. (N=30).

Day	**Positive Satisfaction** N (%)	**Bowel Movement**	**Positive Mood, Focus, Energy**
1	23 (77%)	23 (77%)	19 (63%)
2	22 (73%)	25 (83%)	19 (63%)

3	18 (60%)	26 (87%)	20 (67%)
4	20 (67%)	26 (87%)	23 (77%)
5	18 (60%)	23 (77%)	18 (60%)
6	19 (63%)	21 (70%)	21 (70%)
7	7 (23%)	23 (77%)	12 (40%)

DISCUSSION

Results of this clinical trial confirm desserts made using the Detox Desserts 'Sweet Swap' ingredients cause minimal to no blood sugar and insulin elevation. Desserts made with the Grain-Free Flour Swap function as hypothesized and cause no blood sugar elevation and can be considered ketogenic in healthy people. Desserts made with the Whole-Grain Flour Swap function very similarly to a healthy, balanced macronutrient meal and only cause a minimal rise in blood sugar. Both Flour Swaps effect on insulin is minimal and drastically lower than desserts made with refined sugar and flour. Maintaining low fasting and post-prandial blood sugar and insulin levels are important for a healthy metabolism, weight control and preventing type 2 diabetes.

Trial participants overwhelmingly reported deeper satiety and satisfaction with Detox Desserts which prevents overeating. When used as a complete baking system, the ingredients work together to maintain strong glycemic control providing the participants with sustained energy and improved focus and mood. The test subjects in this trial reported no adverse GI side effects with the Detox Desserts' ingredients. In fact, people reported overall improved gut functioning with more regular and healthier bowel movements with daily consumption of Detox Desserts. It is hypothesized that the addition of inulin to feed healthy gut bacteria, in the Egg and Sugar Swaps as well as the whole psyllium husk in the Flour Swaps seem to counteract the potential GI related side effects of sugar alcohols even in people who have had side-effects with other sugar alcohol products in the past.

Although diabetics were not tested in this study, and further research will be conducted, this author would conclude that desserts made with the Grain-Free Flour Swap would indeed be safe for anyone with impaired glucose tolerance. Depending on the level of glycemic dysfunction, the Whole-Grain Flour is also likely safe, but in moderation. Combining the well-researched and health promoting aspects of the ingredients derived from the Mediterranean diet with the negligible effects on blood sugar and insulin, this author concludes that the Detox Dessert product line is indeed safe for anyone needing tight glycemic control and would likely have a positive effect in people with cardiovascular disease, obesity and digestive problems.

In conclusion, the Detox Desserts easy 1:1 ingredient swap system can be considered a viable solution for any baker or food service provider to easily transform dessert recipes into healthy foods designed to minimize disease, maintain glycemic control and improve general health and sense of well-being.

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