THE CANADIAN SCIENCE FAIR JOURNAL

ARTICLE

Natural Solutions for a Burning Issue

Wishva Kosgoda

Age 15 | Victoria, British Columbia

Finalist at Regional Science Fair, BC Nature Award, BC Teachers Award, Award from Dean of Science at University of Victoria.

Diabetes has become a burning global issue in recent years. According to the International Diabetes. Foundation (IDF) approximately 7.3 % of the world population is suffering from some form of diabetes. Due to the extremely high rate of diagnosis, diabetes is now considered an epidemic by the medical world. Diabetes is caused when the body either resists or does not produce enough insulin, which is a hormone essential to regulating blood glucose levels in the body (Harvard Men's Health Watch , 2011). Diabetes causes the blood glucose levels to be unbalanced resulting in numerous health conditions such as an increased risk of heart attacks, high blood pressure, blindness, kidney failure and nervous system disorders (R. Ferry Jr. M., 2019). Diabetes is medically defined by a fasting blood glucose levels higher than 7 mmol/l. This disease exists in three different forms: type 1 (caused by an autoimmune condition), type 2 (life-style, genetics, old age, etc.) and gestational (occurs during pregnancy). In addition, there is also a condition known as pre-diabetes where the blood sugar level elevates to a level higher than the normal range, but is still low enough not to be considered diabetes (Table 1). To help regulate blood glucose levels, doctors can prescribe different kinds of medical treatments which differ depending on which type of diabetes is present in the patient. For type 1 diabetics, insulin is needed as the body cannot produce its own. As a result, these patients must perform daily injections of insulin into their subcutaneous tissue. There are generally two main types of insulin used: long/slow and short/fast acting which are categorised based on the reaction time and the time insulin will stay effective in the body (R. Ferry Jr. M., 2019). It is also common for people with type 1 diabetes to use an insulin pump, which is a device that delivers continuous small automated doses of insulin, to help with treatment. Type 2 diabetics have a range of treatments they can use, including pills such as Metformin, insulin injections (similar to type 1 treatment) and controlling blood glucose levels through life-style changes such as diet and exercise.

Table 1: Blood glucose and HbA1C target levels as defined by (Harvard Men's Health Watch 2011) for, normal, pre-diabetic and diabetic categories. HbA1C is a measure of the average blood glucose over the last 120 days.

	Non-diabetic	Pre-diabetic	Diabetic
A1C levels (%)	< 5.7	5.7 – 6.4	> 6.5
Avg. Fasting blood glucose (mmol)	<5.6	5.6 – 7.0	> 7.0

INTRODUCTION

Unfortunately, there does not exist a cure for diabetes today. A healthy diet and exercise are a couple of ways that have been studied and are known to help maintain healthy blood glucose levels in the body to a certain extent. Use of any medication for a prolonged period could cause stress on the organs of the human body due to side effects or systemic action. For this reason, some patients with diabetes may opt to try some natural food supplements to help better control their blood sugar levels and reduce resistance to insulin. Currently, there is limited scientific evidence to show that these supplements have any impact on the blood glucose levels in the body.

RESEARCH QUESTION

Can certain supplements reverse or control diabetes? The objective of this research was to study the short-term changes in blood glucose levels of participants in response to a selection of natural food supplements. For this study, one human participant from each of these categories was used: "type 1 diabetic", "type 2 diabetic" and "non-diabetic". The following natural foods were tested on each subject. Amounts of each supplement were chosen arbitrarily:

Bitter Melon: Widely used to treat diabetes-related conditions in Asian countries. However, very limited human data exist on the effectiveness of bitter melon as a treatment for diabetes (Fuangchan, A. et. al (2011)).

Fenugreek Seeds: High fiber content and other chemicals in the fenugreek seed is expected to slow digestion and absorption of carbohydrates to the body and increases the amount of insulin released (Sharma, R. et. al (1990)).

Turmeric: It is believed that turmeric's active component, 'curcumin', could help stabilize blood sugar levels and make diabetes more manageable (Zhang, D. W. et. al (2013)).

Cinnamon: Cinnamon may help people control blood glucose fluctuations in patient with diabetes, but hard to know if it can work for everyone. Researchers have studied the effect of cinnamon on blood sugar in animals, but not much in people (Allen, R. W. et. al (2013)).

PROCEDURE

The study began with the 'Control Experiment', where three participants (Participant 1: Type 1 Diabetic, Participant 2: Type 2 Diabetic and Participant 3: Non-Diabetic) consumed a controlled meal (1/3-Carbohydrate, 1/3-Vegetable, 1/3-Protein) for breakfast, lunch and dinner together with any usual medications they take. Hourly blood sugar levels were taken using a glucometer for up to 3-hours after each meal. Following this, on every other day, a natural supplement (Table 2) was given to each participant 1-hour prior to the three major meals. The meal contents and medications remained as similar as possible to the control experiment (CEXP). Again, hourly blood sugar measurements were taken for each participant. Tests with natural supplement were done every other day to minimize impacts of the previous day's natural supplement on subsequent tests. Table 2 below lists the experiment details.

2.1 Preparation of the Natural Supplements

Bitter Melon: 120-grams of chopped bitter melon dissolved in 900-ml of water kept overnight.

Fenugreek Seeds: 60-grams of fenugreek seed dissolved in 900-ml of warm water kept overnight.

Turmeric: 10-grams of turmeric dissolved in 900-ml of warm water kept overnight.

Cinnamon: 10-grams of turmeric dissolved in 900-ml of warm water kept overnight.

Each natural supplement served 9 (nine), 100-ml servings for the experiment. Each participant consumed 100-ml of the natural supplement, 1-hour before breakfast, lunch and dinner on corresponding day of experiments.

DATA ANALYSIS

Data collected after each major meal was treated as a separate set. Each set of readings were normalized with respect to the blood sugar levels at the beginning of the meal. This was achieved by dividing each blood glucose value by the blood glucose value at the beginning of the meal. The goal was to observe the fluctuation in the blood glucose value and normalization would allow to be able to compare values between data sets.

Table 2. Experiment Details

Experiment	Hypothesis	Independent	Dependent	Controlled variable
Control Experiment (CEXP)	Blood Sugar will peak 2-hrs after the meal.	Time	Blood Sugar	Meal Plan, Medication
Experiment 1 Bitter Melon	Blood Sugar will peak 2-hrs after the meal, but this peak will be lower than the CEXP.	Time	Blood Sugar	Meal Plan, Medication, Bitter Melon 100-ml, 1-hour before each meal
Experiment 2 Cinnamon	Blood Sugar will peak 2-hrs after the meal, but this peal will be lower than the CEXP.	Time	Blood Sugar	Meal Plan, Medication, Cinnamon 100-ml, 1-hour before each meal
Experiment 3 Turmeric	Blood Sugar will peak 2-hrs after the meal, but this peak will be lower than the CEXP.	Time	Blood Sugar	Meal Plan, Medication, Turmeric 100-ml, 1-hour before each meal
Experiment 4 Fenugreek	Blood Sugar will peak 2-hrs after the meal, but this peal will be lower than the CEXP.	Time	Blood Sugar	Meal Plan, Medication, Fenugreek 100-ml, 1-hour before each meal

Figure 1: Experiment Tools

RESULTS

Tables 3, 4 and 5 summarize the test results for participants 1, 2 and 3 while Figures 2, 3 and 4 show the average normalized blood sugar levels for each meal for participants 1, 2 and 3, respectively. The red curve in each graph show the average normalized blood sugar values for the control experiment (i.e. without any natural supplements, controlled meal, and usual medications). Test results are discussed relative to the reference blood glucose values.

Participant 1: Type 1 diabetic (Table 3 and Figure 2): Compared to the reference, the average normalized blood glucose value for breakfast was lower when using bitter melon and fenugreek. The turmeric treatment was slightly higher, and the cinnamon treatment dramatically increased the value compared to the reference. The average normalized blood glucose value for lunch was lower when using bitter melon, but increased with the cinnamon, fenugreek and turmeric. In terms of the dinner results, cinnamon, turmeric and bitter melon treatments lowered the average normalized glucose value while fenugreek was slightly raised.

Participant 2: Type 2 diabetic (Table 4 and Figure 3): Compared to the reference, the average normalized blood glucose value for breakfast was lower when using turmeric, fenugreek and bitter melon, while cinnamon raised the value slightly. After lunch, the normalized blood glucose value was lower when using turmeric, fenugreek and bitter melon, while cinnamon raised the value slightly. After the dinner time meal, all of the treatments lowered the glucose value compared to the reference.

Table 3. Results for Type 1 Diabetic

Type1-Diabetic

Time (hr)	Reference	Normalized Reference	Bitter Melon	Normalized Bitter Melon	Cinnamon	Normalized Cinnamon	Fenugreek	Normalized Fenugreek	Tumeric	Normalized Turmeric
0	7.7	1.00	7.6	1.00	5.4	1.00	7.5	1.00	6.8	1.00
1	6.4	0.83	6	0.79	8.9	1.65	6.2	0.83	5.8	0.85
2	5.6	0.73	4.4	0.58	6.8	1.26	4.4	0.59	5.7	0.84
3	7	0.91	6.4	0.84	5.7	1.06	6.9	0.92	6.8	1.00
Overall Average Breakfast		**0.87**		**0.80**		**1.24**		**0.83**		**0.92**
0	6.8	1.00	7.8	1.00	7.4	1.00	6.7	1.00	6.1	1.00
1	4.8	0.71	4.9	0.63	9.4	1.27	4.7	0.70	5.7	0.93
2	4.4	0.65	4.3	0.55	6.5	0.88	4.6	0.69	4.3	0.70
3	6.5	0.96	7.4	0.95	6.4	0.86	7.2	1.07	6.2	1.02
Overall Average Lunch		**0.83**		**0.78**		**1.00**		**0.87**		**0.91**
0	5.8	1.00	5.8	1.00	7.8	1.00	4.4	1.00	8.4	1.00
1	6.4	1.10	5.4	0.93	8.5	1.09	5.9	1.34	11	1.31
2	7	1.21	4.1	0.71	7.7	0.99	4.7	1.07	7.4	0.88
3	5.5	0.95	3.9	0.67	6.7	0.86	3.8	0.86	6.1	0.73
Overall Average Dinner		**1.06**		**0.83**		**0.98**		**1.07**		**0.98**

Table 4. Results for Type 2 Diabetic

Type2-Diabetic

Time (hr)	Reference	Normalized Reference	Bitter Melon	Normalized Bitter Melon	Cinnamon	Normalized Cinnamon	Fenugreek	Normalized Fenugreek	Turmeric	Normalized Turmeric
0	9.1	1.00	10	1.00	9.8	1.00	9.4	1.00	6.8	1.00
1	11.2	1.23	9.9	0.99	12.3	1.26	9	0.96	7.6	1.12
2	8.9	0.98	9.5	0.95	10.1	1.03	8.7	0.93	6.7	0.99
3	7.2	0.79	6.2	0.62	7.2	0.73	7.8	0.83	5.4	0.79
Overall Average Breakfast		**1.00**		**0.89**		**1.01**		**0.93**		**0.97**
0	7.7	1.00	6.3	1.00	6.5	1.00	7.6	1.00	8.4	1.00
1	10.4	1.35	8.4	1.33	9.2	1.42	8.2	1.08	9	1.07
2	12.6	1.64	9.2	1.46	10.1	1.55	9.3	1.22	9.9	1.18
3	11.4	1.48	7.1	1.13	9.7	1.49	7.9	1.04	10.4	1.24
Overall Average Lunch		**1.37**		**1.23**		**1.37**		**1.09**		**1.12**
0	7.2	1.00	9.5	1.00	9	1.00	7.9	1.00	6.6	1.00
1	11.7	1.63	10.1	1.06	10.9	1.21	9.9	1.25	8.8	1.33
2	13.9	1.93	8.9	0.94	12.4	1.38	9.3	1.18	8.3	1.26
3	10.5	1.46	7	0.74	9.5	1.06	6.8	0.86	6.7	1.02
Overall Average Dinner		**1.50**		**0.93**		**1.16**		**1.07**		**1.15**

Table 5. Results for Non - vDiabetic

Non-Diabetic

Time (hr)	Reference	Normalized Reference	Bitter Melon	Normalized Bitter Melon	Cinnamon	Normalized Cinnamon	Fenugreek	Normalized Fenugreek	Turmeric	Normalized Turmeric
0	6.2	1.00	6.5	1.00	5.8	1.00	6.3	1.00	6	1.00
1	8	1.29	7	1.08	10.2	1.76	7.8	1.24	7.2	1.20
2	5.7	0.92	6.2	0.95	5.3	0.91	6.1	0.97	6.2	1.03
3	5.4	0.87	5.3	0.82	4.2	0.72	5.1	0.81	5.8	0.97
Overall Average Breakfast		**1.02**		**0.96**		**1.10**		**1.00**		**1.05**
0	6.3	1.00	6.5	1.00	4.8	1.00	6.3	1.00	6	1.00
1	9.4	1.49	9	1.38	11.7	2.44	7.8	1.24	9.2	1.53
2	6.4	1.02	6.3	0.97	10	2.08	7.1	1.13	6	1.00
3	6.9	1.10	6.2	0.95	6	1.25	5.6	0.89	5	0.83
Overall Average Lunch		**1.15**		**1.08**		**1.69**		**1.06**		**1.09**
0	5.6	1.00	6.1	1.00	6.9	1.00	6.7	1.00	5.6	1.00
1	8.9	1.59	7.6	1.25	10.2	1.48	7.3	1.09	9	1.61
2	8.2	1.46	6.4	1.05	7.8	1.13	6.1	0.91	6.1	1.09
3	7.7	1.38	5.4	0.89	5.4	0.78	5.8	0.87	5.6	1.00
Overall Average Dinner		**1.36**		**1.05**		**1.10**		**0.97**		**1.17**

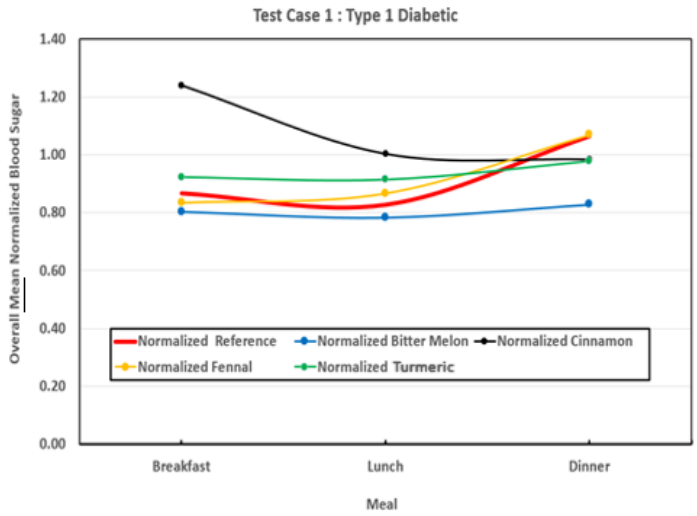

Figure 2: Participant 1 – Type 1 Diabetic

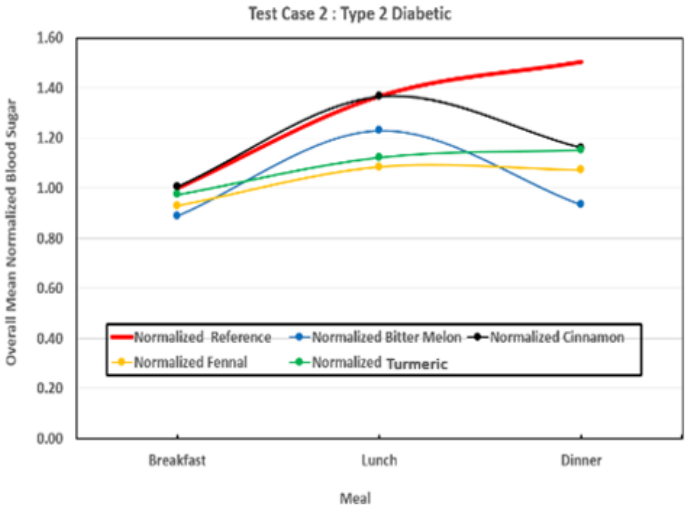

Figure 3: Participant 2 – Type 2 Diabetic

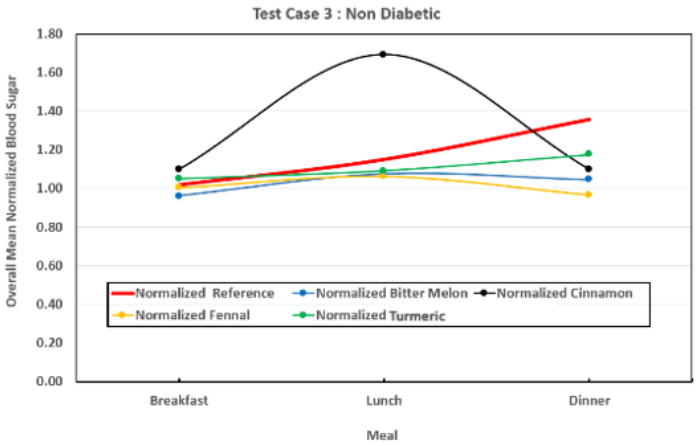

Figure 4: Participant 3 – Non-Diabetic

Participant 3: Non-diabetic (Table 5 and Figure 4): Compared to the reference, both the fenugreek and bitter melon lowered the overall normalized glucose value after breakfast, while cinnamon and turmeric raised the blood glucose levels. After the lunch meal, cinnamon significantly raised the overall normalized glucose value, while the other natural supplements lowered the value. After the dinner time meal, the fenugreek and bitter melon lowered the overall normalized glucose value compared to the reference, whereas the cinnamon and turmeric had the opposite effect.

DISCUSSION

These results indicate that overall, almost all of the natural supplements reduced the peak blood glucose levels in all three participants at least one out of the three mealtimes tested. However, some supplements gave better results than the others. This could be due to numerous reasons, but one example could be that the doses of the tested natural supplements were chosen arbitrarily. This limitation could be corrected in future experiments by conducting dose-response experiments to evaluate the response of blood glucose levels to the change in concentrations of the natural supplements. Overall, in my experiment the bitter melon and fenugreek treatments showed better results over cinnamon for all participants. In terms of the group results, the type 2 diabetic and non-diabetic showed the best response to the natural supplements. The type 1 diabetic's blood glucose values were the least impacted. Similar to the mechanism of action of different types of insulin, there may be long and short-term effects of the supplements on blood glucose values. For example, the cinnamon supplement seemed to work more effectively later in the day around dinner time. I chose this project because diabetes affects my family in various ways. Most of my family members have it so I wanted to find ways to help alleviate their suffering. It is understood that a healthy lifestyle and medication is a priority in controlling diabetes. Medication may also need to be used, however prolonged use of medication can stress the organs in a human body. According to the results of this study, certain natural supplements could potentially be used as an aid in blood glucose control. However, these natural supplements should not be used to replace standard diabetes treatment. It is important to talk to your doctor before using any supplements to prevent any potential risks. For type 2 diabetic patients, these supplements may help limit the medications they take which in turn could reduce unwanted side effects. The greatest benefit in using these natural supplements may be in pre-diabetic cases, where they have the potential to avoid or delay a diagnosis of type 2 diabetes. Although my study was limited to short-term impacts, long-term impacts of these natural supplements on blood glucose control is worth studying. Looking

back at this project now with a better understanding of science, there are several extra steps I would have taken. For instance, I did not have a standard routine/procedure for the participants to follow which could have minimized several extraneous variables. Some influencing variables include stress, temperature, emotions, and sleep. These factors are all known to adversely affect blood glucose control but are difficult to control for. Repeating this experiment with a larger number of participants would be important as well and would provide statistically significant results to analyse. Lastly, a more in-depth scientific study on the various chemicals components in these supplements could help develop natural and possibly more affordable medications for diabetic patients that may have minimal side effects in comparison to fully synthetic drugs.

ACKNOWLEDGEMENTS

I would like to thank, my parents for all the support, and for nurturing my curiosity of medical sciences, teaching me Excel, and for pushing me to do my hardest. My three anonymous test patients for giving me their time and effort. Finally, Arbutus Global Middle School, Principal, and Vice Principal for supporting me in the science fair.

REFERENCES

Broadbent, B., Salomon, S. H., Rapaport, L., & Millard, E. (n.d.). *Alternative Diabetes Treatments: Chromium Picolate, Bitter Melon, Cinnamon, and More: Everyday Health.* Retrieved from https://www.everydayhealth.com/type-2-diabetes/living-with/alternative-diabetes-treatments-chromium-picolate-bitter-melon-cinnamon-more/

News & Events. (n.d.). Retrieved from http://www2.warwick.ac.uk/newsandevents/pressreleases/research_says_diabetics

Prediabetes. (2020, January 21). Retrieved from https://www.mayoclinic.org/diseases-conditions/prediabetes/diagnosis-treatment/drc-20355284

Publishing, H. H. (2011, January). *Harvard Men's Health Watch*: January 2011. Retrieved from http://www.health.harvard.edu/newsletters/harvard_mens_health_watch/2011/january

Robert Ferry Jr., M. (2019, August 14). *Type 1 vs. Type 2 Diabetes Symptoms, Signs, Diet, Tests & Treatment.* Retrieved from https://www.emedicinehealth.com/diabetes_mellitus_type_1_and_type_2/article_em.htm

Fuangchan, A., Sonthisombat, P., Seubnukarn, T., Chanouan, R., Chotchaisuwat, P., Sirigulsatien, V., . . . Haines, S. T. (2011). *Hypoglycemic effect of bitter melon compared with metformin in newly diagnosed type 2 diabetes patients. Journal of Ethnopharmacology*, 134(2), 422-428. doi:10.1016/j.jep.2010.12.045

Allen, R. W., Schwartzman, E., Baker, W. L., Coleman, C. I., & Phung, O. J. (2013). *Cinnamon use in type 2 diabetes: an updated systematic review and meta-analysis. Annals of family medicine*, 11(5), 452–459. https://doi.org/10.1370/afm.1517

Sharma, R. D., Raghuram, T. C., & Rao, N. S. (1990). *Effect of fenugreek seeds on blood glucose and serum lipids in type I diabetes. European journal of clinical nutrition*, 44(4), 301–306.

Zhang, D. W., Fu, M., Gao, S. H., & Liu, J. L. (2013). *Curcumin and diabetes: a systematic review. Evidence-based complementary and alternative medicine* : eCAM, 2013, 636053. https://doi.org/10.1155/2013/636053

ABOUT THE AUTHOR - WISHVA KOSGODA

Wishva is currently a Grade 10, student in the Challenge Program at Mount Douglas Secondary School. She is fascinated and inspired by nature and the secrets it holds. Wishva has been competing in science fair since grade 6 (4 years) and has placed first in her category twice. Science and Nature are just two aspects of Wishva's interests. She is a platinum award winner for both Kumon math and reading programs and has won awards as a piano performer/composer at the Greater Victoria Performing Arts Festival. Her piano compositions are inspired mainly by nature. Wishva also does modern, ballet and contemporary dancing both attached to school and studio. During free time Wishva enjoys writing, reading, dancing, drawing, mastering piano and flute, music composing, and cooking. She is also an accomplished field athlete, specialized in throwing events (Shot Put, Disc and Hammer) and won third place at provincials for discus. She aspires to work in the medical field as an adult and believes her path has yet to be formed.