The Relation of Total Resistant Starch Concentration in Potatoes

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Background

In Canada, the obesity rate has increased dramatically over the past twenty five years. The adult obesity rate has nearly doubled, and the obesity rate in children between the age of twelve and seventeen has almost tripled. Research done by the Public Health Agency in Canada has shown that children who are overweight and obese are likely to experience many health risks which will persist their entire life time. Some common diseases which arise as a result of obesity include heart disease and diabetes[1]. Type one diabetes is when the pancreas secretes little or no insulin for the body, resulting the need for an external source of insulin. Type two diabetes is when the pancreas secretes the insulin but the human body cannot use it. The prominence of diabetes in contemporary society provoked our interest in discovering a solution to optimize the nutritional health of those with diabetes. Those who suffer from diabetes must closely monitor their intake of carbohydrates[2]. Diets which include a large amount of carbohydrate rich food result in an overall increase of simple sugars consumed by the body. Potato starch is a common source of carbohydrate in the human diet. When digested, the glycosidic linkages which hold together the monomers of starch molecules will be hydrolized; resulting in the formation of the simple sugar glucose[3].

One of the problems associated with diabetes is that the patients cannot have a large amount of simple sugars. A large intake of simple sugars for a patient with diabetes would cause an imbalance in blood sugar level. This would pose health risks for the diabetes patient as their

[1] Tjepkema, Michael. Adult obesity in Canada: Measured height and weight. Retrieved Sept. 16, 2009, from <http://www.statcan.gc.ca/pub/82-620-m/2005001/article/adults-adultes/8060-eng.htm>
[2] Canadian Diabetes Association. What is Diabetes? Retrieved Sept 27th, 2009, from <http://www.diabetes.ca/about-diabetes/what/>
[3] Liu, Qiang et al. "Physicochemical properties of dry matter and starch from potatoes grown in Canada," Received 26 January 2007.

pancreas would be unable to supply a sufficient amount of insulin to balance out the blood sugar levels. Recent nutritional advances have encouraged people to include a large amount of fibre in their diet. The beta-4 linkages of cellulose fibre cannot be digested by the human body. This promotes the secretion of mucus in the intestines and assists with digestion[4]. Modern scientific studies indicate that the resistant starch found in potatoes behaves similarly to fibre when ingested by the human body. Resistant starch is the sum of starch and starch digestion products which are not digested by the human body in the small intestine. Therefore, the glucose monomers which make up the resistant starch will not enter the blood stream. There are four types of resistant starch. The first type occurs as a result of the inaccessibility of the starch molecules to the body. Type two resistant starch occurs in certain sources which exhibit properties of poor digestibility. The third type of resistant starch occurs as a result of physical reassocation, or retrogradation of molecules subsequent to cooking.

The fourth type of resistant starch occurs as a result of chemical modification. Different environmental conditions have been noted to effect the concentrations of resistant starch in different types of potatoes[5]. This experiment will seek to investigate the environmental conditions which will optimize the concentrations of resistant starch in varied breeds of potatoes.

Purpose

The objective of this project is to determine the effects of variations in environmental conditions to the resulting concentrations of resistant starch in the potatoes tested. This experiment will determine the concentration of resistant starch in different breeds of potatoes at different temperatures. The results of this experiment will inform the public of the optimal breed of potato and cooking process which will maximize the concentration of resistant starch.

[4] Di Giuseppe, Maurice et al., Biology 12, (Toronto: Thomson Nelson 2003) 33.
[5] Englyst, H.N., Kingman, S.M., and Cummings, J.H., Classification and measurement of nutritionally important starch fractions, *Eur. J. Clin. Nutr.*, 46, S33, 1992.

Hypothesis

It is hypothesized that the potatoes cooked without the peel will retain more resistant starch. The potatoes which were cooled to room temperature after cooking treatment will also have a higher concentration of resistant starch compared to the potatoes which were not cooled to room temperature.

Procedures

1. Treatment of Potatoes - Two varieties of potatoes were boiled under varying cooking conditions. Potato samples were frozen at –80^{o}C then freeze dried.

Treatment 1: Potato salad at room temperature, without peel

Treatment 2: Potato salad at room temperature, with peel

Treatment 3: Potato salad cool to room temperature, then fridge for 16 hours, without peel

Treatment 4: Potato salad cool to room temperature then fridge for 16 hours, with peel

2. After cooking the potatoes were freeze dried and samples were the ground into a fine powder.

3. Measurement of Moisture Content of Potatoes

4. Measurement of Starch Digestion – The Megazyme Method was used to determine the resistant starch concentrations in the potato samples.

5. The total starch content (TS) –content was calculated to observe differences in the rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS) in different varieties of potatoes. (TS- Magazyme method, RDS and SDS- Englyst method)

Results and Observations

The purple majesty and stampede russet obtained similar results of starch concentration with varying preparation methods. All assays were performed in duplicate, increasing the consistency of the results. Purple Majesty contained higher slowly digestible starch (SDS) and resistant starch (RS) content than Stampede Russet for both Treatments 1 and 2. Stampede Russet contained a higher SDS and RS content than Purple Majesty for Treatments 3 and 4. Potatoes without peels contained more SDS and RS than potatoes with peels. The results from Treatment 4 did not correlate with the rest of the data due to experimental error. Further experiments will be done to obtain the accuracy of the results for this treatment. In both cases, Treatment 3 resulted in the highest slowly digestible starch and resistant starch content. The experiment concludes that there is a higher concentration of slowly digestible starch and resistant starch in potatoes which are cooled in the fridge.

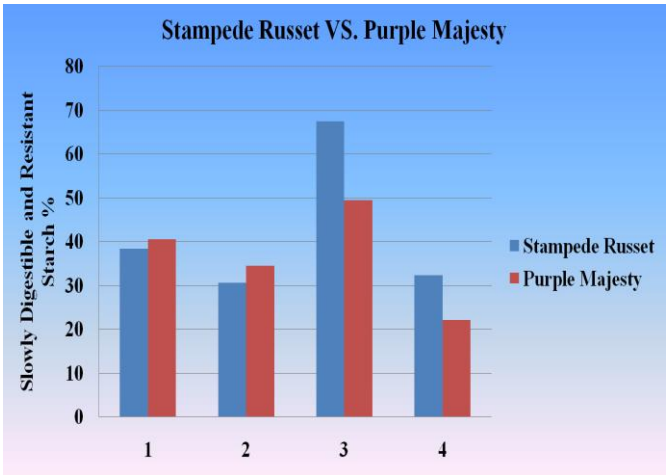

Figure 1: SDS and RS concentrations in Stampede Russet and Purple Majesty

Conclusions

Resistant starch is beneficial to patients with diabetes in two ways. The first occurs when the food containing the resistant starch is digested. A lower blood glucose response would be anticipated on the basis of the consumption of resistant starch alone. The second benefit occurs after the consumption of the resistant starch. The previous consumption of a type two resistant starch will enhance insulin sensitivity in a subsequent, non resistant starch containing meal. The

benefits of resistant starch extend beyond aiding patients with diabetes. Resistant starch is also beneficial in the maintenance of a healthy lifestyle. Resistant starch in the small intestine will act as a fermentation substrate. Depending on the type of resistant starch, if it is hydrolyzed in the colon glucose will be released and rapidly fermented. This will produce the short chain fatty acids acetate, propionate, and butyrate. Acetate and propionate may benefit metabolic actions in the liver. Butyrate has a beneficial effect on the tissue of the colon as it is a preferred energy source for absorbing epithelial cells.[6] This fermentation process can also be beneficial to immune functions. These benefits encouraged us to investigate the relationships between environmental conditions and resistant starch concentrations in potatoes.

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[6] Smith, J.G. and German, J.B., Molecular and genetic effect of dietary derived butyric acid, *Food Technol.*, 87, 1995.

Appendix

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