Anti-Diabetic Blueberries

Dixon Springs Summer Internship Program
Anita Lucius
Background

- **Diabetes**
  - 6th leading cause of death in US
  - Affects over 18 million people

- **Complications**
  - Renal disease
  - Ophthalmic disease
  - Cardiovascular disease
  - Endocrine/metabolic disease
  - Peripheral vascular disease
  - Neurological disease
  - Other diseases
Anti-Diabetic Effects

- Phenolic compounds
  - Resveratrol
  - Anthocyanin

- Health benefits and potentials
  - Reduce hyperglycemia
  - Improve $\beta$-cell function
  - Protect against $\beta$-cell loss

- $\beta$-cells in pancreas are responsible for insulin secretion
  - Lowers blood glucose level when it is high
Good Anti-oxidant Sources

- Chokeberries
- Cranberries
- Strawberries
- Blueberries
- Purified anthocyanin
Clinical Studies

- Human studies: significant improvements in both healthy subjects and those with existing metabolic factors
  - LDL oxidation
  - Lipid peroxidation
  - Total plasma antioxidant capacity
  - Dyslipidemia
  - Glucose metabolism

- Rat studies
  - 50 mg anthocyanin / kg rat administered
  - Significantly reduce blood glucose level in both normal and streptozotocin-induced “diabetic” rats
Hypothesis

- Consumption of blueberries benefits Type-2 diabetics by lowering blood glucose level or hyperglycemia due to the neutraceuticals in blueberries.
General Objective

- To determine the effectiveness of berry consumption on lowering blood glucose level and to generate a new blueberry product that is more suitable for diabetic patients
Support Objectives

- To determine the total sugar content in berries
- To determine the total phenolic content in berries to determine antioxidant capacity
- To determine $\alpha$-glucosidase and $\alpha$-amylase inhibitory effects using in-vitro tests
- To do a market research on diabetic products that has not been available in the market
- To determine which berry genotype is suitable for the product (i.e. has the highest antidiabetic effects)
- To determine at which ripening stage is the blueberry most suitable for the product
Blueberry Genotypes Used

- Bluetta
- Coville
- Herbert
- Collins
- Earliblue
- Bluecrop
- Blueray
- Berkley
- Stanley
- Pemberton
- Jersey
- Darrow
- Patriot
- Late Blue
- Blue Chip
- Elliot
- Blue Haven
- Blue Jay
- Spartan
- Bluetta
Blueberry Caviar

- Product with caviar-like properties
- Made with spherification
- Sodium alginate forms cross links with calcium ions
- Market research:
  - Sodium alginate and calcium chloride are sold to consumers on the Internet
  - Currently no spherified product is available on groceries store in US
Spherification

Mechanism of gel formation through the interaction between calcium ions and sodium alginate.
Work Plan

- **Week 1 (May 24-May 28)**
  - Harvest semi-ripe blueberries
  - Get to know the workplace (where equipments are, etc.)

- **Week 2 (May 31-Jun 4)**
  - Begin blueberry extraction for analysis

- **Week 3 (Jun 7-Jun 11)**
  - Harvest ripe blueberries
  - Blueberry extraction and analysis
Work Plan

- **Week 4 (Jun 14-Jun 18)**
  - Continue analysis
  - Do sensory test on products (any unpleasant bitter taste from unripe blueberries, too sour, etc.)

- **Week 5 (Jun 21-Jun 25)**
  - Extraction of antioxidants
  - Make blueberry juice out of best 4 blueberry genotypes

- **Week 6 (Jun 28-Jul 2)**
  - Begin spherification
Work Plan

- Week 7 (Jul 5-Jul 9)
  - Begin reverse spherification

- Week 8 (Jul 12-Jul 16)
  - Figure out the best recipe

- Week 9 (Jul 19-Jul 23)
  - Determine shelf stability of products
  - Begin writing report
Work Plan

- **Week 10 (Jul 26-Jul 30)**
  - Continue to determine shelf stability of product
  - Continue writing report
  - Perform additional tests on blueberries (i.e. physical attributes: size, color, etc.)

- **Week 11 (Aug 2-Aug 6)**
  - Finish report
Protocols – Blueberry Selection Criteria

- Compare results using bar chart
  - α-amylase inhibition, α-glucosidase inhibition, total phenolics and total sugar content

- Enzyme inhibition and total phenolics are top priority as compared to total sugar content
  - Sample A has higher sugar content but high enzyme inhibition capability and high total phenolics
  - Sample B has lower sugar content but low enzyme inhibition capability and high total phenolics
  - Sample A is preferred than Sample B
Protocols – Enrichment of Blueberries

- Adding more antioxidants into blueberry juice
  - Extract antioxidant using ethanol
  - Remove ethanol using rotary evaporator
  - Add antioxidant extract into blueberry juice before spherification
Anticipated Problems

- Degradation of spherified products
  - Oxidation
  - Microorganism (consider Pasteurization)
  - Storage condition: max temp 25, air moisture <60%, aqueous medium

- Continuation of spherification during storage
  - “caviar” solidifies
Anticipated Outcome

- Unique blueberry product safe for diabetic consumption
- Increases the variability of diabetic foods in the market
- Increases the selling value of blueberries sold by Dixon Springs
Deliverables

- Blueberry caviar with enriched antioxidants
  - Can be eaten with other food products such as crackers and ice cream – provide healthier snacks for general population

- Experimental data for different blueberry genotypes at 2 different ripening stages
References

References

- [http://www.voltaggiobrothers.com/discussion_posts/list/2/1748/1](http://www.voltaggiobrothers.com/discussion_posts/list/2/1748/1)
- [http://www-unix.oit.umass.edu/~mcclemen/581Carbohydrates.html](http://www-unix.oit.umass.edu/~mcclemen/581Carbohydrates.html)