Ag, Food & Health in the Future: Impact of technology and innovation
A researcher’s perspective

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Canada Research Chair in Fruit Bioactives & BioProducts
Health care cost in Canada: Over $100B per year
Paradigm Shift in Health Care is Needed!

Current: ‘Medical Model’
(later in life)
Medical Management with or without Dietary Advice of Chronic Diseases.
(no or less concern on “Food/Diet/Nutrition”)

Future: ‘Preventive Model’
(early in life)
Wide introduction and use of “Food/Diet/Nutrition” for Prevention of Chronic Diseases.
(a conservative cut-off targets for diverse risk factors)
Obesity Reviews 7: 271-293.

Genetics + Life style +

Dietary Factors
- Calorie
- Saturated fat
- Trans fat
- Fibre
- Fruits & vegetables
- Whole grain
- Sugar
- Calcium/Vitamin D
- Alcohol

Overweight & Obesity

Chronic Diseases
- Cardiovascular
- Cancers
- Type 2 Diabetes
- Stroke
- Neurodegenerative

Ag-FOOD-Health
‘Preventive Model’

Isoprenoids (Carotenoids)

Polyphenols

Minerals

Prebiotics & Probiotics

Alkaloids & Amino acids

Fatty acids & structural lipids

Carbohydrates & derivatives

Biologically Active Components in Diet
Polyphenols is becoming a household word!!

Polyphenols: your best night ever

Faculty of Agriculture
Over 100,000 research articles!

**FLAVONOIDS**

3-hydroxy flavonoids
- Flavonols
  - Quercetin
  - Kaemferol
  - Myricetin
  - Galangin
  - Fisetin
- Anthocyanins
  - Cyanidin
  - Delphinidin
  - Peonidin
  - Malvidin
  - Pelargonidin
- Catechins
  - Catechin
  - Epicatechin
  - Epigallocatechin
  - ECG
  - EGCG

3-deoxy flavonoids
- Flavanones
- Flavones

Isoflavonoids
- Genistein
- Daidzein
- Glycitein
- Formononetin

**FLAVONOIDS**

- Genistein
- Daidzein
- Glycitein
- Formononetin

- Naringenin
- Hesperitin
- Eriodictyol
- Luteolin
- Apigenin
- Chrysin
Our (Consumers) Challenges!

<table>
<thead>
<tr>
<th>Recommended Number of Food Guide Servings per Day</th>
<th>What Is One Food Guide Serving?</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vegetables and Fruit</strong></td>
<td></td>
<td>Fresh, frozen or canned vegetables: 125 mL (1 cup)</td>
</tr>
<tr>
<td>Children</td>
<td></td>
<td>Leafy vegetables: Cooked: 125 mL (1 cup) Raw: 250 mL (1 cup)</td>
</tr>
<tr>
<td>Teens</td>
<td></td>
<td>Fresh, frozen or canned fruits: 1 fruit or 125 mL (1 cup)</td>
</tr>
<tr>
<td>Adults</td>
<td></td>
<td>100% Juice: 125 mL (1 cup)</td>
</tr>
<tr>
<td><strong>Grain Products</strong></td>
<td></td>
<td>Bread 1 slice (15 g) Bagel 1/2 bagel (45 g) Flat breads 1 pita or 1 tortilla (35 g) Cooked rice, bulgur or quinoa 125 mL (1 cup) Cereal 44 g: 1/4 cup Hot: 175 mL (1 cup) Cooked pasta or macaroni 125 mL (1 cup)</td>
</tr>
<tr>
<td><strong>Milk and Alternatives</strong></td>
<td></td>
<td>Milk or powdered milk (reconstituted) 250 mL (1 cup) Canned milk (reconstituted) 125 mL (1 cup) Fortified soy beverage 250 mL (1 cup) Yogurt 175 g (1/2 cup) Kefir 175 g (1/2 cup) Cheese 50 g (1/2 oz)</td>
</tr>
<tr>
<td><strong>Meat and Alternatives</strong></td>
<td></td>
<td>Cooked fish, shellfish, poultry, lean meat: 75 g (2 oz/125 mL) Cooked legumes 175 g (1 cup) Tofu 110 g or 175 mL (1 cup) Eggs 2 eggs Peanut or nut butters 35 mL (2 tbsp) Shelled nuts and seeds 60 mL (1/4 cup)</td>
</tr>
</tbody>
</table>

**Make each Food Guide Serving count… wherever you are – at home, at school, at work or when eating out!**

- Eat at least one dark green leafy vegetable each day.
- Try for dark green vegetables such as broccoli, spinach, lettuce and kale.
- Choose vegetables that are prepared with little or no added fat, sugar or salt.
- Enjoy vegetables raw, halved or steamed, roasted, or lightly stir-fried.
- Have vegetables and fruit more often than juice.

- Make at least half of your grain products whole grain daily.
- Try whole grain breads, oatmeal or whole wheat pasta.
- Choose grain products that are lower in fat, sugar or salt.
- Compare the nutrient facts table on labels to make wise choices.
- Enjoy the true nature of grain products. When adding sauces or spreads, use small amounts.

- Drink skin, 1%, or 2% milk each day.
- Non-fat (0%) milk with every meal is recommended for children.
- Drink lactose-free or non-dairy milk.
- Select lower-fat milk alternatives.
- Compare the nutrient facts table on products to choose the one you prefer.

- Have meat alternatives such as beans, lentils and tofu often.
- Try at least two Food Guide Servings of fish each week.*
- Chicken breast, skinless or skin on, canned, or cooked.
- Select lean meat and alternatives prepared with little or no added fat or salt.
- Use the visible lean from meat. Remove the dark skin if possible.
- Use cooking methods such as sautéing, baking, poaching that require little or no added fat.
- If you need lean meats, sausages or processed meats, choose those lower in salt, saturated and fat.

* Health Canada advises that eating lean protein means eating fish, chicken or turkey without the skin.

Enjoy a variety of foods from the four food groups.

Satisfy your thirst with water!

Drink water regularly. It's a calorie-free way to quench your thirst. Drink more water in hot weather or when you are very active.
Ag, Food and Health in the Future

Fruits: Opportunities and Challenges:

- New fruit crops and cultivars: “Superfruits”
- Value-added food products: healthier, convenience BUT taste good:
  - Minimally processed;
  - Functional beverages and smoothies;
  - Snack products and nutrition bars etc.;
  - Bakery products with incorporated fruit ingredients.
- Health food ingredients and additives
- Natural health products with health claims
- Novel fruit processing technologies to preserve bioactives
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Ag, Food and Health in the Future
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Ag, Food and Health in the Future

Natural Health Product (NHP):

1. Brain Health
2. Cholesterol Lowering
Apple Flavonoids-derived NHP

Natural Health Products:

- Brain Health
  Patent application PCT 61/333091

- Arteriosclerosis
  Patent application PCT/CA2011/000623
Stroke

- Stroke is the third leading cause of death in North America.
- It is the leading cause of adult disability in Canada.
- No approved pharmacological treatments to protect neurons from degeneration following stroke or to promote recovery of neurological function following a stroke.
- Stroke costs the Canadian economy $2.7 billion a year.
Apple Flavonoids and Stroke

Hypoxia-Ischemia (HI) Mouse Model of Stroke

The left common carotid artery was permanently occluded.

50 minutes of 8% oxygen at a flow rate of 6L/min
Apple Flavonoids and Stroke

Hypoxia-Ischememia (HI) Mouse Model of Stroke

Rotarod

Day 1  Day 2  Day 3  Day 4

3 doses of AF4
(50 mg/kg/d)
or Control

50 min HI
“Stroke”

Rotarod

Day 18

Perfusions

Histology

NeuN
Oral Administration of Apple Bioactives Protects from Brain Injury

Striatum (modulation of movements & motor performance)
Cardiovascular Disease
Effect of Apple Flavonoids on Lipid Profiles: A Hamster Study
## Effect of Apple Flavonoids on Lipid Profiles: A Hamster Study

<table>
<thead>
<tr>
<th>Diet</th>
<th>Serum lipid profile * (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TG</td>
</tr>
<tr>
<td>Normal Control</td>
<td>87.5 ± 25.1 c</td>
</tr>
<tr>
<td>Atherogenic Control</td>
<td>144.5 ± 56.61 ab</td>
</tr>
<tr>
<td>AF diet</td>
<td>128.5 ± 49.6 b</td>
</tr>
</tbody>
</table>

* Data are presented as mean ± SD. Values with different subscripts in each column are significantly different.
Apple Flavonoids-derived NHP

Natural Health Products:

Brain Health
Patent application PCT 11/333091

Artherosclerosis
Patent application PCT/CA2011/00623
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Natural Health Product (NHP):

Challenges:
- Commercialization – Entrepreneurships
- Cost of manufacturing – GMP
- Health claims: Regulatory requirements
- Consumer awareness, affordability and acceptance
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Value-added Products

1. Healthier Snacks
2. Functional Beverages
3. Bakery Ingredients
Ag, Food and Health in the Future

**HIGH** in Vitamins, Minerals, Fibre, Antioxidants, flavor

**LOW** in Na, Calories, Fat

**NO** artificial food additives

Convenience
36% Oil

Nutrition Facts

Serving Size 1 oz.

- Calories 150
- Calories from Fat 90

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat 10g</td>
<td>16%</td>
</tr>
<tr>
<td>Saturated Fat 1g</td>
<td>6%</td>
</tr>
<tr>
<td>Polyunsaturated Fat 4.5g</td>
<td>6%</td>
</tr>
<tr>
<td>Monounsaturated Fat 4.5g</td>
<td>6%</td>
</tr>
<tr>
<td>Trans Fat 0g</td>
<td></td>
</tr>
<tr>
<td>Cholesterol 0mg</td>
<td>0%</td>
</tr>
<tr>
<td>Sodium 180mg</td>
<td>7%</td>
</tr>
<tr>
<td>Potassium 330mg</td>
<td>9%</td>
</tr>
<tr>
<td>Total Carbohydrate 15g</td>
<td>5%</td>
</tr>
<tr>
<td>Dietary Fiber 1g</td>
<td>4%</td>
</tr>
<tr>
<td>Sugars 0g</td>
<td></td>
</tr>
<tr>
<td>Protein 2g</td>
<td></td>
</tr>
</tbody>
</table>

- Vitamin A 0% • Vitamin C 10%
- Calcium 0% • Iron 2%
- Vitamin E 6% • Thiamin 2%
- Niacin 6% • Vitamin B6 4%
- Phosphorus 4% • Magnesium 4%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>2,000</th>
<th>2,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>Less than</td>
<td>65g</td>
<td>80g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>Less than</td>
<td>20g</td>
<td>25g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Less than</td>
<td>300mg</td>
<td>300mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>Less than</td>
<td>2,400mg</td>
<td>2,400mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>3,500mg</td>
<td>3,500mg</td>
<td>3,500mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>15g</td>
<td>15g</td>
<td>15g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>25g</td>
<td>25g</td>
<td>25g</td>
</tr>
</tbody>
</table>

Calories per gram:
- Fat 9 • Carbohydrate 4 • Protein 4
Alternative Health Snacks?
Ag, Food and Health in the Future

Health Food Ingredients and Additives
Apple-derived *Omega-3 Stabilizer*

- World market $1.6bn by 2014
- Multiple double bonds → Oxidation
- Safety concerns of synthetic antioxidants
- Demand for natural food antioxidants
Apple-derived *Omega-3 Stabilizer*

A Process of Manufacturing the natural food antioxidant

WO 2009/076776 A1

Faculty of Agriculture
Fibre- and Antioxidant-enriched Food Ingredient
Ag, Food and Health in the Future

Functional Beverages
Table 7.6 Serum lipid profiles of SHRs during 5-week dietary intervention period

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Serum Lipid Profile (mg/dL)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TCz</td>
<td>HDL-C</td>
<td>Non HDL-C</td>
<td>TG</td>
</tr>
<tr>
<td>Atherogenic Control (AC) + water</td>
<td>130.31^a ± 26.58</td>
<td>39.46^a  ± 12.26</td>
<td>90.85^a ± 25.00</td>
<td>105.72^a ± 13.73</td>
</tr>
<tr>
<td>AC + Blueberry Vinegar Beverage</td>
<td>101.91^ab ± 30.95</td>
<td>58.57^b  ± 13.53</td>
<td>43.34^b ± 26.82</td>
<td>79.63^b ± 19.59</td>
</tr>
<tr>
<td>AC + Cranberry Vinegar Beverage</td>
<td>85.93^b ± 14.24</td>
<td>62.56^b  ± 6.36</td>
<td>23.26^b ± 13.34</td>
<td>61.51^bc ± 18.03</td>
</tr>
<tr>
<td>AC + Tomato Vinegar Beverage</td>
<td>102.58^ab ± 25.05</td>
<td>63.15^b  ± 9.08</td>
<td>39.44^b ± 19.78</td>
<td>74.10^bc ± 14.23</td>
</tr>
<tr>
<td>AC + Apple Vinegar Beverage</td>
<td>95.40^b ± 30.66</td>
<td>58.25^b  ± 13.68</td>
<td>37.15^b ± 30.97</td>
<td>59.35^c ± 9.25</td>
</tr>
<tr>
<td>AC + Acetic Acid</td>
<td>89.30^b ± 29.50</td>
<td>50.35^ab ± 10.60</td>
<td>43.11^b ± 23.72</td>
<td>67.06^bc ± 34.77</td>
</tr>
</tbody>
</table>

xSerum lipid profiles of SHR are expressed as mean ± SD (n=12)
yAll the treatment groups were containing the same concentration level of acetic acid (0.5%)
zTC: Total Cholesterol, HDL-C: HDL Cholesterol, Non HDL-C: Non HDL Cholesterol, TG: Triglycerides

a^c Means followed by a different letter within each row is significantly different (Tukey’s Studentized Ranged test [P<0.005])
Consumer Acceptance