SERVICEBERRY - ANTI-DIABETIC EFFECTS

A joint effort by Blackfeet Community College, MT
Alabama A & M, AL
Auburn University, AL
USDA-ARS, MS

Presented by: Dr. Suresh Mathews, Ph.D
Auburn University
Obesity Trends* Among U.S. Adults
(*BMI ≥30, or about 30 lbs. overweight for 5’4” person)

1990

1998

2007

No Data           <10%           10%–14% 15%–19%           20%–24%            25%–29%            ≥30%

Legend
County-level Estimates of Diagnosed Diabetes for Adults aged ≥ 20 years: United States 2005
DIABETES:
The Burden in Montana
Figure I-1: American Indian reservations and small urban counties in Montana.
Figure 1-1. Prevalence of diabetes for all Montanans, Montana Indians and the US, 1990 to 2006.

*Question changed in 1994 to exclude females with gestational diabetes.
Figure 1-3. County Level Estimates of Diabetes Prevalence -- Percentage of Adults in Montana by Quartiles, 2005
Diabetes: Current therapeutic agents

**Insulin secretagogues:**
sulfonylureas (Amaryl, Glucotrol) and meglitinides (Nateglinide/Starlix) stimulate pancreas to release insulin

**Incretins:** Stimulate insulin release (Byetta, Januvia)

**Biguanides:** suppresses hepatic glucose production via AMPK activation (Metformin/Glucophage)

**TZDs:** improve insulin sensitivity (Rosiglitazone/Avandia), Pioglitazone/Actos

**α-Glucosidase inhibitors:** delays digestion and absorption of carbohydrates in GI tract (Acarbose/Precoze)
Toward a wholly nutritional therapy for type 2 diabetes

Biological Complementary Therapies: A Focus on Botanical Products in Diabetes
Diabetes Spectrum Volume 14, Number 4, 2001

Biomarkers and functional foods for obesity and diabetes

Systematic Review of Herbs and Dietary Supplements for Glycemic Control in Diabetes
Diabetes Care, volume 26, number 4, April 2003

Review
Medicinal plant species with potential antidiabetic properties
A Unique Partnership
USDA Tribal College Research Grant

Walking up the North Glacier mountains, MT.
L to R: Dr. Sam McDonald, Wilbert Fish, and Rao Mentreddy
Saskatoon Serviceberry
Amelanchier alnifolia Nutt.

Family: **Rosaceae**, Rose
Genus: **Amelanchier**
# Serviceberry - Amelanchier alnifolia Nutt.

## SAMPLE COLLECTION

<table>
<thead>
<tr>
<th>No.</th>
<th>Plant part</th>
<th>Date</th>
<th>Location/Sample collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leaves</td>
<td>6/22/04</td>
<td>Birchcreek, Browning. 1:30 PM, 62°F, patchy clouds; dry rocky hillside.</td>
</tr>
<tr>
<td>2</td>
<td>Leaves with very few berries</td>
<td>7/13/04</td>
<td>East Glacier, hillside; 10:30 AM, 90°F, slightly cloudy.</td>
</tr>
<tr>
<td>3</td>
<td>Leaves with few buds</td>
<td>7/7/04</td>
<td>East Glacier Lodge (10m W of Browning). hillside 10:30 AM 62°F;</td>
</tr>
<tr>
<td>4</td>
<td>Leaves with berry buds</td>
<td>7/16/04</td>
<td>Cut Bank Creek (20 m NW of Browning) at the bridge off Hwy 89 and Star School Rd. 9:30 AM, 88°F, no clouds.</td>
</tr>
<tr>
<td>5</td>
<td>Twigs</td>
<td>6/22/04</td>
<td>Birchcreek area (30 m of Browning), dry rocky hillside, no wind. 1:30 PM, 62°F; Mission area (10m S of Browning); 3:00 PM, 67°F; humid.</td>
</tr>
<tr>
<td>6</td>
<td>Leaves</td>
<td>7/13/04 &amp; 7/16/04</td>
<td>East Glacier, hillside; 10:30 AM 90°F, slightly cloudy; Cut Bank Creek (see No. 4)</td>
</tr>
</tbody>
</table>
Plants collected, separated, air-dried by BFCC

Sent to USDA-ARS for extraction & fractionation

Extracts sent to Auburn University
Alpha glucosidase inhibition

Delayed glucose absorption

Better blood glucose control

A: Ethyl acetate extracts  B: Aqueous extracts

(A)

Inhibitory activity, %

Acarbose

ARXXXIII 12
Subfractionation of Extracts 2B & 5B

SAMPLE 2B
Leaves with few berry buds
- MeOH:H₂O extraction
- Partition bet. H₂O and EtOAC
- H₂O fraction
  - EtOAc fraction
  - Further fractionation (med press chromatography)
- Further fractionation (med press chromatography)
  - 17-1
  - 17-2
  - 17-3
  - 17-4
  - 17-5

SAMPLE 5B
Twigs
- MeOH:H₂O extraction
- Partition bet. H₂O and EtOAC
- H₂O fraction
  - EtOAc fraction
  - Further fractionation (med press chromatography)
- Further fractionation (med press chromatography)
  - 17-6
  - 17-7
  - 17-8
  - 17-9
Serviceberry extracts inhibit alpha-glucosidase activity

Delaying the intestinal absorption of glucose may be one mechanism that mediates the anti-diabetic activities of serviceberry
Insulin

Glucose uptake into muscle and fat

Glycogen synthesis
Protein synthesis
Glycolysis
Gluconeogenesis
Glycogenolysis
Lipolysis
Glycogenolysis
Water fractions of serviceberry leaves and twigs demonstrate an increase in glucose uptake in skeletal muscle cells.
Major Pathophysiologic Defects in Type 2 Diabetes

Islet-cell dysfunction
Glucagon (alpha cell)
Pancreas
Insulin (beta cell)

Hepatic glucose output
Liver

Insulin resistance
Glucose uptake in muscle and fat
Liver
Muscle
Adipose tissue

Hyperglycemia

Del Prato S, Marchetti P. Horm Metab Res. 2004;36:775–781.
KEY ENZYMES IN GLUCONEOGENESIS

Glucose-6-phosphatase, Fructose-1,6-bisphosphatase, and PEP carboxykinase

Serviceberry extracts activate AMPK and inhibit hepatic gluconeogenesis
Serviceberry extracts

- Increased glucose uptake into muscle
- Decreased glucose production by liver
- Decreased absorption of glucose from intestine
- Better blood glucose control
Identification of Bioactive component

- Decreased intestinal glucose absorption
- Increased glucose uptake
- Decreased glucose production by liver
- ???
Additional Funding opportunities:
USDA-NIFA
National Institutes of Health
On Tribal Sovereignty

- Promote, sustain, and safeguard traditional knowledge, cultural expression, and genetic resources
- Tissue-culture lab at BFCC
- Micropropagation of serviceberry
- Student/research assistant training
- Faculty sabbaticals

Walking up the North Glacier mountains, MT.
L to R: Dr. Sam McDonald, Wilbert Fish, and Rao Mentreddy
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- Teayoun Kim

[Logos and images of individuals]