Anti-oxidation and Anti-obesity Properties of Ginger

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Scientific classification:

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Clade: Commelinids
Order: Zingiberales
Family: Zingiberaceae
Genus: Zingiber
Species: Z. Officinale
Binomial name: Zingiber officinale

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• Native to South-East Asia
• Cultivated all over the world

Ginger Grown at Randolph’s farm at VSU

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World Ginger Production (Top 10 Countries)

2010

- China: 24%
- India: 23%
- Indonesia: 6%
- Other Countries: 6%
- Philippines: 2%
- Bangladesh: 4%
- Sri Lanka: 1%
- Nepal: 13%
- Thailand: 10%
- Nigeria: 10%

2016

- India: 45%
- China: 15%
- Indonesia: 10%
- Mali: 5%
- Nepal: 5%
- Bangladesh: 5%
- Cameroon: 3%
- Thailand: 3%
- Japan: 0.5%
- Nepal: 3%

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TOP 10 GINGER IMPORTING COUNTRIES

2016

% SHARE

<table>
<thead>
<tr>
<th>Country</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>12.54</td>
</tr>
<tr>
<td>USA</td>
<td>11.19</td>
</tr>
<tr>
<td>Netherlands</td>
<td>10.66</td>
</tr>
<tr>
<td>Pakistan</td>
<td>10.04</td>
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<tr>
<td>Germany</td>
<td>6.02</td>
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<tr>
<td>UAE</td>
<td>5.7</td>
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<tr>
<td>Russia</td>
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<tr>
<td>UK</td>
<td>4.14</td>
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<tr>
<td>S. Arabia</td>
<td>3.1</td>
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<tr>
<td>Malaysia</td>
<td>2.54</td>
</tr>
</tbody>
</table>
Proven Health Benefits of Ginger

- Cough and Cold symptoms
- Nausea, Especially Morning Sickness
- Muscle Pain and Soreness
- Chronic Indigestion
- Osteoarthritis
- Blood Sugars and Diabetes
- Cholesterol Levels and Heart Disease Risk Factors
- Cancer
- Infections
Anti-oxidation activity
Goal of the Study

To investigate quantitative and qualitative difference between immature (locally grown) and mature ginger (imported).

Immature Ginger

- Perishable, very tender, less fibrous, and very pungent
- Easily attacked by fungus.

- Phytochemical profile?
- Health benefits?
Objective

• To determine influence of harvesting times on phenolic contents, and anti-oxidation properties.

• To characterize anti-obesity properties.
Experimental

- Ginger was harvested bi-weekly from the First week of October, 2017 – January, 2018 (16 weeks).
- Samples were freeze-dried, grounded and extracted in Methanol

- Total polyphenol: Folin-Ciocalteu Reagent
- Anti-oxidation activity: DPPH and ABTS assay
- Anti-obesity: *In vitro* assay-3T3-Li adipocytes
Results
Antioxidation Activity of Ginger Extract (DPPH Assay)

- Weeks: 2, 4, 6, 8, 10, 12, 14, 16
- M Trolox Eq./g sample
- 0, 20, 40, 60, 80, 100, 120, 140, 160
- * symbols indicate significant differences
Baby ginger has higher phenolic contents and superior anti-oxidation properties
Obesity

OBESITY IS NOW A GLOBAL EPIDEMIC!

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Ginger Fights Obesity
Effect of Ginger on Fat Deposition

3T3 L1 Cells (pre-adipocytes) → Differentiation (High Glucose, Insulin, Dexamethasone) → Adipocytes

- 3T3L1 cell (- Ginger)
- Adipocytes (- Ginger Extract)
- Adipocytes (+ Ginger Extract (50 µg/ml))
- Adipocytes (+ Ginger Extract (100 µg/ml))

Lipid Droplet analysis
Fatty Acid analysis

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Effect of Ginger Extract on Oil Droplet Formation

Control cells

Adipocytes (-Ginger)

Adipocytes (50 µg/ml)

Adipocytes (100 µg/ml)

Control

Adipocytes (-Ginger)

Adipocytes (50 µg/ml)

Adipocytes (100 µg/ml)

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Effect of Ginger Extract on Adipogenesis

Lipid droplets (%)

0 μg/ml  50 μg/ml  100 μg/ml

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Fat Synthesis
Fat Synthesis

![Graph showing Δ9 Desaturase Activity for different conditions: Undifferentiated, Differentiated, Diff + GE (50 μg/ml), Diff-GE (100 μg/ml). The graph indicates significant differences between conditions, with different letters (a, b, c) indicating significance.](image-url)
Fat Synthesis
Inhibition of Cellular Oxidation in 3T3 Adipocytes
Effect of Ginger on the Molecular pathways of Fat Production

- SREBP-2
  - Acetoacetyl CoA thiolase
  - Acetoacetyl CoA
  - HMG CoA synthase
  - HMG CoA reductase
  - Mevalonate kinase
  - Phosphomevalonate kinase
  - Mevalonate PP decarboxylase
  - GPP synthase
  - IPP isomerase
  - FPP synthase
  - Squalene synthase
  - Squalene epoxidase
  - Lanosterol synthase
  - CYP51
  - Lathosterol oxidase
  - DHCRC
  - Cholesterol

- SREBP-1c
  - Acetyl CoA synthetase
  - Acetyl CoA carboxylase
  - Malonyl CoA
  - Fatty acid synthase
  - Long chain fatty acyl elongase
  - Stearoyl CoA desaturase
  - NADPH

- Malate
  - Malic enzyme

- NADPH
  - Saturated fatty acids
  - Monounsaturated fatty acids

- G6PD
  - Glucose-6-P
  - 6-P-glucuronate

- PGDH

- Squalene
  - LDL receptor

- Triacylglycerides and phospholipids
Conclusion

1. Phenolic contents and anti-oxidation activity is highest in baby Ginger.

2. The phenolic contents and anti-oxidation activity decreases as ginger gets matured (almost 50% around 4-5 months).

3. The ginger extract inhibited fat accumulation in Adipose cells and has a potential to be an effective agent against obesity.
Acknowledgement

- Dr. Wondi Mersie: Director ARS, VSU
- Dr. M. Ray McKinnie: Dean, Agriculture
- Dr. Jewel Bronaugh and Dr. Omar Faison: Executive Director-CAREO

The funding for this project was provided by a grant from Center of Agricultural Research, Engagement and Outreach (CAREO)