Microwave-Assisted Extraction of Value-Added Ingredients from Natural Biomass
About Radient Technologies

• Experts in extraction and purification of value-added ingredients from natural biomass using “Microwave-Assisted Processing” (MAP™) technology

• Public Company listed on the TSX Venture

• Contract Manufacturing Services or Licensing Agreements

• Applications in multiple industries
  – Food, Cosmetic, Supplement, Pharmaceutical, Petrochemistry, Bioprocessing

• 5 Tonnes per day MAP™ processing facility in Alberta, Canada
The Core Radiant Solution

*Microwave Assisted Processing*

Conventional solvent extraction is a diffusion-driven process: relies on concentration gradients.

MAP™ causes instant in-core heating creating a pressure-driven process.
## MAP™ Extraction

<table>
<thead>
<tr>
<th>Conventional Extraction</th>
<th>MAP™</th>
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</thead>
<tbody>
<tr>
<td><strong>Mechanism</strong> is <strong>diffusion</strong></td>
<td>“Pressure-enhanced” mass transfer</td>
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<tr>
<td><strong>Concentration gradient</strong> of active in biomass vs in the solvent is the driving force</td>
<td><strong>Microwave energy</strong> is selectively absorbed by the residual water present in the biomass cells</td>
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<tr>
<td>Diffusion is <strong>slow</strong>, particularly as the active becomes more concentrated in the solvent</td>
<td>Results in <strong>rapid</strong> pressure buildup within cells leading to a pressure-driven mass transfer of actives</td>
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<td>Eventually reach an <strong>equilibrium point</strong></td>
<td><strong>Extraction is very fast and not limited</strong> by an equilibrium state – transfer continues as long as energy is applied</td>
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<tr>
<td>Requires <strong>high solvent</strong> ratios and <strong>multiple extraction</strong> stages to achieve reasonable recovery of actives</td>
<td>Result in short extraction times, <strong>reduced solvent</strong> requirements and <strong>fewer extraction</strong> stages</td>
</tr>
</tbody>
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Competitive Advantages

- Much faster extraction rates leading to
  - reduced processing time, increased throughput and reduced processing costs and capital costs;
- Efficient “single stage” extraction leading to
  - increased overall recovery / yield of valuable active compounds and reduced solvent and energy usage;
- Improved extraction selectivity and purity leading to
  - novel, differentiated products;
- Ease of commercial scalability; and
- Improved customer acceptance of products made through “cleaner, greener” technology.
Proven Technology

Input

• **Plant Sources**
  • Leaves
  • Seeds
  • Bark
  • Fresh / Dried

• **Single Cells**
  • Algae
  • Yeast
  • Fungi

• **Other Biomass**
  • Insects

Solvent

• **Alcohols**
  • Ethanol
  • IPA

• **Alkanes**

• **Ketones**

• **Esters**

• **Mixed Solvents**

• **Liquefied Gases**

• **Vegetable Oils**

Product

• **Lipids**
  • Fatty Acids
  • Oils

• **Terpenes**
  • Essential Oils
  • Sterols
  • Carotenoids

• **Phenolics**
  • Vanillin
  • Polyphenols

• **Alkaloids**

= the majority of industrially relevant natural products
Examples of MAP™ Results
Example: Phenolics

Polyphenols from Green Tea

MAP™ results in >95% recovery in < 10 min
Example: Alkaloids

Piperine from Black Pepper

MAP™ Extraction of Black Pepper
Raw Material = 3.8% Piperine
Examples of successful feasibility in every commercially-relevant class of natural products*

**Lipids**
- Essential Fatty Acids (borage oil)
- PUFAs
- Saw palmetto
- Edible vegetables oils (flax, canola, soybean)
- Algae Oils

**Glycosides**
- Flax → Lignans (SDG)
- Sennosides
- Rosavins
- Terpene acid glycosides
- Pregnane glycosides

**Alkaloids**
- Cyclopamine
- Black pepper → Piperine
- Opiates

**Phenolics**
- Green tea → Polyphenols
- Rosemary herb → Carnosic acid
- Blueberries → Anthocyanins
- Seaweed → Polyphenols
- Vanilla beans → Vanillin
- Grape polyphenols

**Terpenes**
- Microalgae → Carotenoid
- Taxus → Paclitaxel
- Paprika → Carotenoid
- Marigold → Carotenoid
- Cubebol → Sesquiterpene

**Proteins**
- Rice protein → Residual oil
Radient Facilities:

Edmonton, Canada

Head Office / Process Development Laboratory
(16,000 sq. ft.)

Manufacturing: 4035-101 St. NW
(20,000 sq. ft.)
Industrial-Scale MAP™ Extractor

200 kg/h Continuous Flow
Replication of laboratory-scale MAP™ extraction results at commercial-scale confirmed.
Radient reduces risk to its clients through the application of a proven three stage phased business development process:

1. **Feasibility**
   - Demonstrates proof-of-concept to client-defined product specifications

2. **Scale-up**
   - Demonstrates scalability and optimization via larger scale pilot testing

3. **Partnership**
   - Execute Supply Agreement or Licensing Agreement.
Contact Information

Denis Taschuk
President and CEO

Tel: 780-465-1318 ext 274
Fax: 780-465-1381
dtaschuk@radientinc.com

www.radientinc.com

Radient Technologies Inc.
8223 Roper Road NW, Edmonton, Alberta CANADA T6E 6S4