Russian Dandelion Seeds and Extraction processes

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Outline

- **Seed production**
  - Seed harvesting from wild fields;
  - Seed production on test plots

- **Technology and Processes**
  - Developing technologies and processes for latex and rubber extraction;
  - Byproducts: Inulin

- **Development of rubber extractors for the patented dry process**
  - Automatic and continuous rubber extractors
  - Lab-scale, pilot-scale and industrial scale
  - Biomass fibrillation devices
CURRENT GLOBAL ISSUES

• Life-threatening IgE–mediated latex allergy;
• Chinese tire demand;
• Shortage of land in the countries of *Hevea*, rubber tree;
• Higher prices for natural rubber and synthetic rubber;

SOLUTIONS

• *Taraxacum kok-saghyz* (TKS), commonly known Russian Dandelion *Scorzonera tau-saghyz* (STS) can serve as alternative sources.
• Our results indicate these plants can be the source for the world’s hypoallergenic latex, solid natural rubber, inulin and cheap ethanol needs.
KOK Technologies Inc., Canada (2009)  
US patent #7,540,438

- Buying the TKS roots from growers, farmers or contract growing;
- Green process in dry conditions and no chemicals used (patented);
- Proprietary rubber extractors (patent pending)
- Processing facilities with 4 production.
- “Know-How” for latex extraction.
Our experience

- *Taraxacum kok-saghyz (TKS)* – Rubber-24%; Inulin -36%.
- *Scorzonera tau-saghyz (STS)* – Rubber -40%; Inulin -20%.
- *Scorzonera uzbekistanica (SU)* – Rubber-33%; Inulin-19%.

These plants are perennial and were first discovered and industrially cultivated in 1930s and 1940s by the Soviets in Central Asia, Ukraine and Russia. All of these rubber plants produce high quality natural rubber comparable to that of *Hevea*. TKS was grown in the USA and Canada in 1940s.
FIG. 1. *Taraxacum kok-saghyz*, the most promising rubber-bearing plant which was cultivated as an annual commercial plant by Soviets in 1930s.
FIG. 2. Scorzonera *tau*-saghyz (STS) and Scorzonera *Uzbekistanica* (SU)
FIG 3. Test plot of TKS in Jizzax, Uzbekistan on May 2005
Planted: Young roots in October, 2004
High quality seeds from 2002-2006

**Funding** by US Civilian Research and Development Foundation (2003-2005)

**Coordination**: Kazakhstan

**Carried out by** Institute for Chemistry of Plant Substances, Tashkent, Uzbekistan

High quality seeds delivered to Delta Plant Technologies Inc., Seattle, USA

- **Oregon State University, USA**
- **Ohio State University, USA**
Main Criteria for cultivation

- Soil must be black mineral soils;
- Climate must be colder for TKS (summer dormancy);
- Natural habitat is cold and rainy in July. The area is surrounded by mountains from all sides.
- Young roots must be used for high quality seeds production;
- Phosphate fertilizers;
- Irrigation during first phase.

FIG 5. TKS seeds delivered to Delta
Technology and Processes

Latex extraction Technologies:

- **Soviet Technology**: Cutting the roots into slices and letting the latex flow into the extraction buffer and centrifugation. Latex is contained in canals in the plant tissue in TKS, STS and SU.

- **Cornish Technology**: Grinding the plant material in the extraction buffer (0.1-1% of NH₃ and 0.1% Na₂SO₃) with blender and centrifugation. Latex is contained in the parenchyma cells in Guayule.

**FIG. 6. Centrifugation step in latex extraction**
Figure 8. Film from Latex
Natural Rubber Extraction Technologies

Existing technologies:

1. Alkaline method which involves the following 3 steps: leaching with 2% NaOH, grinding in water and rubber recovery with steam,

2. Method of Centrifugation which involves the main 3 steps: grinding, microbiological fermentation and centrifugation.

3. Eskew technology:
   Extensive pebble milling in water in 1946 with subsequent centrifugation.

4. Solvent-based technologies: 3% rubber in solvent and explosive.
   Solvents were used by us for characterization purposes.

5. We have developed a new green technology. This technology is dry and no chemicals are used (US Patent #7, 540, 438 from June 2009).
FIG. 9. Natural rubber (solvent extraction)
Major Findings

• The rubber is high cis 1,4-polyisoprene
  ▫ The MW is comparable to Hevea
  ▫ The rubber contains microgel, similar to *Hevea*

• The plants contain significant inulin
  It was also previously reported

• These rubber plants also contain significant amount of proteins and small amounts of fatty acids and resins
Molecular Weight Characterization

Table. Summary of the analysis results for the rubber samples extracted with acetone and chloroform

<table>
<thead>
<tr>
<th>Samples</th>
<th>MW</th>
<th>Gel content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSR 20</td>
<td>2.5xE6</td>
<td>55</td>
</tr>
<tr>
<td>STS</td>
<td>1.7xE6</td>
<td>27</td>
</tr>
<tr>
<td>TKS</td>
<td>1.8xE6</td>
<td>34</td>
</tr>
<tr>
<td>SU</td>
<td>1.8xE6</td>
<td>92</td>
</tr>
</tbody>
</table>

• MW was determined in THF solvent by SEC method using HPLC
• Gel was the THF insoluble fraction
Inulin extraction schematic

Ground Roots

Hot Water Extraction

Chromatographic Separation and Identification

SSF

Distill

Ethanol
Analysis of Inulin

• STS - 18.9%
  ▫ galactose, mannose (aniline phthalate); sucrose and the traces of fructose (urea), fructooligosaccharides (inulin-like compounds)

• SU - 16.6%
  ▫ galactose, glucose, mannose (aniline phthalate); sucrose and the traces of fructose (urea) fructooligosaccharides (inulin-like compounds)

• TKS - 26%
  ▫ galactose, the traces of mannose (aniline phthalate); sucrose and the traces of fructose (urea) fructooligosaccharides (inulin-like compounds).

Identification was made using paper chromatography
Conversion into Ethanol

Ethanol was produced directly from inulin in ground roots (30g) using SSF technology

Obtained results are as follows:
STS - 5.7 g (19%).
SU – 5.4 g (18%).
TKS - 10 g (33%)
FIG. 10. Latex and natural rubber content of plants
FIG. 12. Rubber threads produced
FIG 13. Rubber threads washing
Lab-scale, Pilot-scale, and Industrial-scale

- We have subcontracted the design and building of this machine to Canadian Machine Manufacturing company.
- Lab-scale version is ready. It was tested with biomass.
- We have financial support from IRAP-NRC (Industrial Research Assistance Program of National Research Council Canada).
- Pilot-scale rubber extractors are under construction.
- Industrial-scale rubber extractor can be built on request.
Biomass fibrillation devices

- We are currently working on the application of rubber extractors into biomass grinding;
- The parameters are being optimized;
- Our extractors provide a unique grinding based on the frictional, rotational and gravity forces.
Conclusions, Recommendations and Future Plans

- TKS is the most promising commercial rubber plant for the natural rubber and ethanol needs of the world;
- Selection must be carried out in the wild fields;
- Avoid seed harvesting from the wild fields;
- Young roots must be harvested for the seed production;
- Commercialization of TKS in Canada, Russia and Kazakhstan;
- Commercialization of STS and SU in Uzbekistan;
- Patent commercialization on the dry rubber extraction technology.
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Publications by us


References


