CalPoly Pomona

Transforming Purple Nutsedge: Sustainable Textile Applications from an Invasive Plant

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Why Biobased Fibers are Important:

Environmental Sustainability

Biobased fibers offer sustainable alternatives by utilizing renewable resources.

Biodegradability and Waste Reduction

Natural fibers decompose easily, reducing long-term environmental impact (Poole et al., 2009).

Health and Safety

Biobased fibers meet public health demands, producing antiviral and antibacterial materials affordably (Gough et al., 2021).

Advantages of Using Weeds as Fiber Sources:

Abundant and Easy to Cultivate

Weeds such as *Water hyacinth* and other invasive plants grow rapidly and require minimal agricultural inputs (Bordoloi et al., 2017).

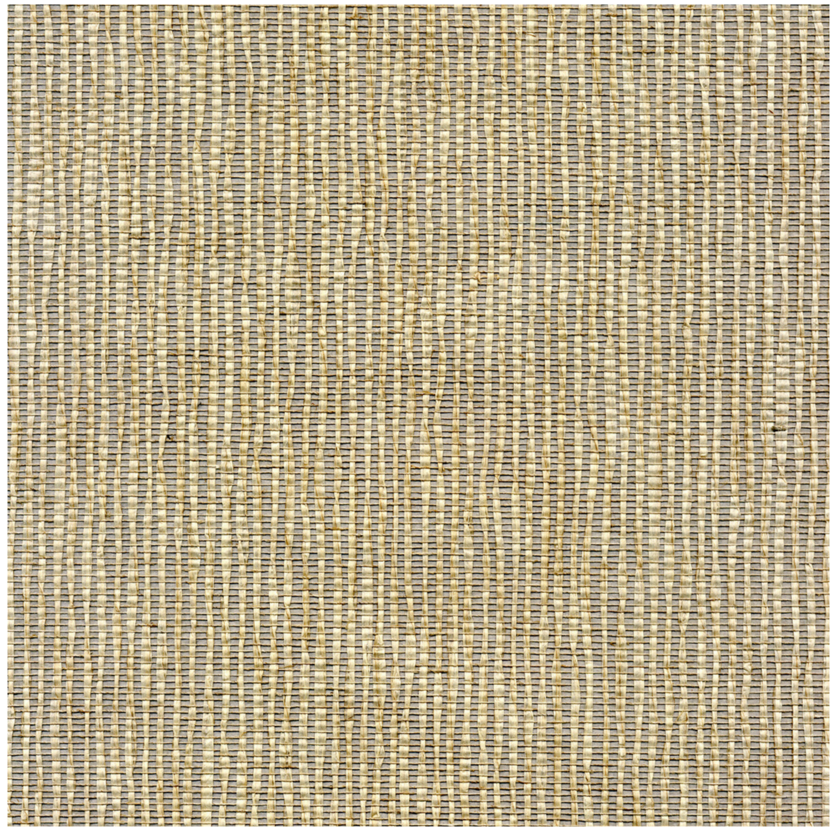
Sustainable and Renewable:

Weed fibers are renewable resources, offering an eco-friendly alternative to synthetic fibers.

Mitigating Weed Control Costs:

Combatting invasive weeds can be expensive, but repurposing them as fibers offers a sustainable solution to offset management costs.

Disdvantages of Using Weeds as Fiber Sources:



Variable Quality and Performance

Weed-based fibers often exhibit inconsistencies in fiber strength, moisture resistance, and mechanical properties due to natural variability (Makinde-Isola et al., 2023).

Environmental Risks of Invasive Species Cultivation

While weeds are easily available, promoting their use might unintentionally encourage their spread, exacerbating invasive species problems in certain regions (Girijappa et al., 2019).

Lower Compatibility with Existing Industrial Systems

Traditional manufacturing processes for synthetic fibers are not always compatible with natural fibers from weeds (Zah et al., 2007).

Textile Applications Incorporating Weeds

Himalayan Nettle
Girardinia diversifolia
This weed produces strong natural fibers used in textile manufacturing

Coatbuttons
Tridax procumbens:
This weed is used to color protein-based fabrics like wool and silk, (Bhandari & Rani, 2018).
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Railway Creeper
Ipomoea cairica
This weed has shown potential as a source of natural dyes

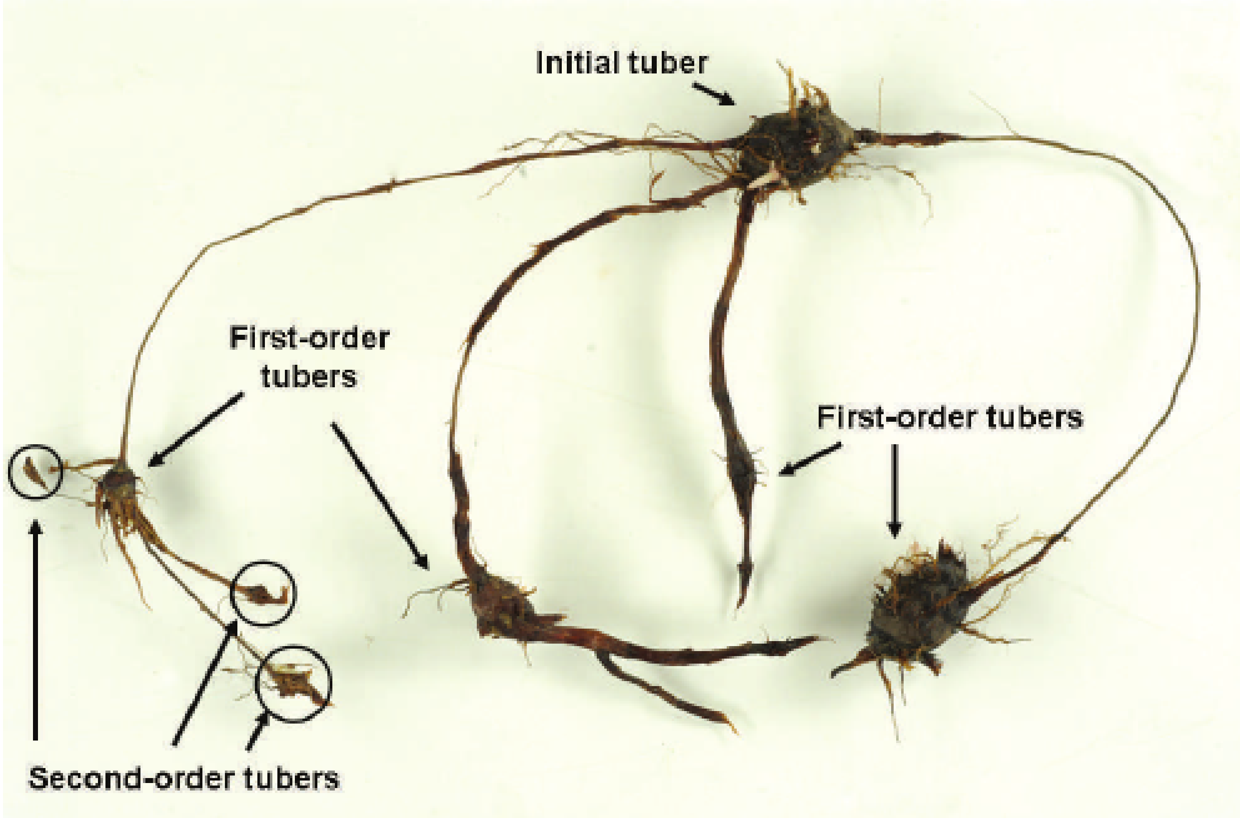
Cyperus rotundus Taxonomic Classification

- Family: Cyperaceae (sedge family)
- Genus: Cyperus (Taheri et al., 2021)
- Species: rotundus L.
- Common names: purple nutsedge, nutgrass, coco sedge, red nut sedge, coquito (Taheri et al., 2021)

Morphological Characteristics

Underground system:

- Extensive network of rhizomes and tubers
- Tubers are dark reddish-brown when mature
- Tubers measure 10-35 mm long and 12 mm thick
- Forms chains of interconnected tubers (Peerzada et al., 2015)



Morphological Characteristics

- **Leaves:**
  - Dark green, linear with grooved upper surface
  - No ligules or auricles
  - Three-ranked arrangement
- **Inflorescence:**
  - 2-4 bracts
  - Dark reddish-to-purplish-brown husked flowers
  - Three stamen and three stigma carpels
  - Triangular cross-sectioned culm (Peerzada et al., 2015)

Traditional and Current Uses

- **Traditional uses:**
  - Medicinal applications in China, India, Iran, and Japan
  - Essential oils from roots and food product from seeds
  - Used as soil binder in India (Taheri et al., 2021)
- **Modern uses:**
  - Some medicinal properties being studied:
    - Fever reduction
    - Anti-inflammatory properties
    - Pain relief
    - Anti-nausea effects

Distribution

- Native to India
- Present in at least 92 countries (Peerzada et al., 2015)
- Major regions:
    - Africa
    - Americas
    - South Asia
    - Southern/central Europe
- In US:
    - Primarily southeastern states
    - Virginia to central Texas
    - Parts of Arizona and California

Invasive properties

Reproduction capabilities:

- Single tuber can produce up to:
  - 100 tubers in one chain
  - 550-1200 tuber shoots in 3-4 months
  - 10-30 million tubers per hectare (Peerzada et al., 2015)

Competition characteristics:

- Strong allelopathic effects on other plants (Andrade et al., 2009)
- Efficient C4 photosynthesis
- Extensive underground network
- Rapid growth and establishment

Economic Impacts of *Cyperus Rotundus*

Crop Yield Losses:

- Reduces sugarcane yields by up to 75% and sugar yields by 65%
- Causes 23-89% yield losses in over 50 different crops, rice, maize, and vegetables (Peerzada et al., 2015)

Economic Impacts of *Cyperus Rotundus*

Management Expenses:

- Requires intensive cultivation practices
- Needs repeated herbicide applications
- Demands manual removal in organic farming
- Resistant to most conventional herbicides
- Cannot be controlled with plastic mulch (Peerzada et al., 2015)

How can we transform *Cyperus rotundus* from an agricultural challenge into a valuable textile resource?

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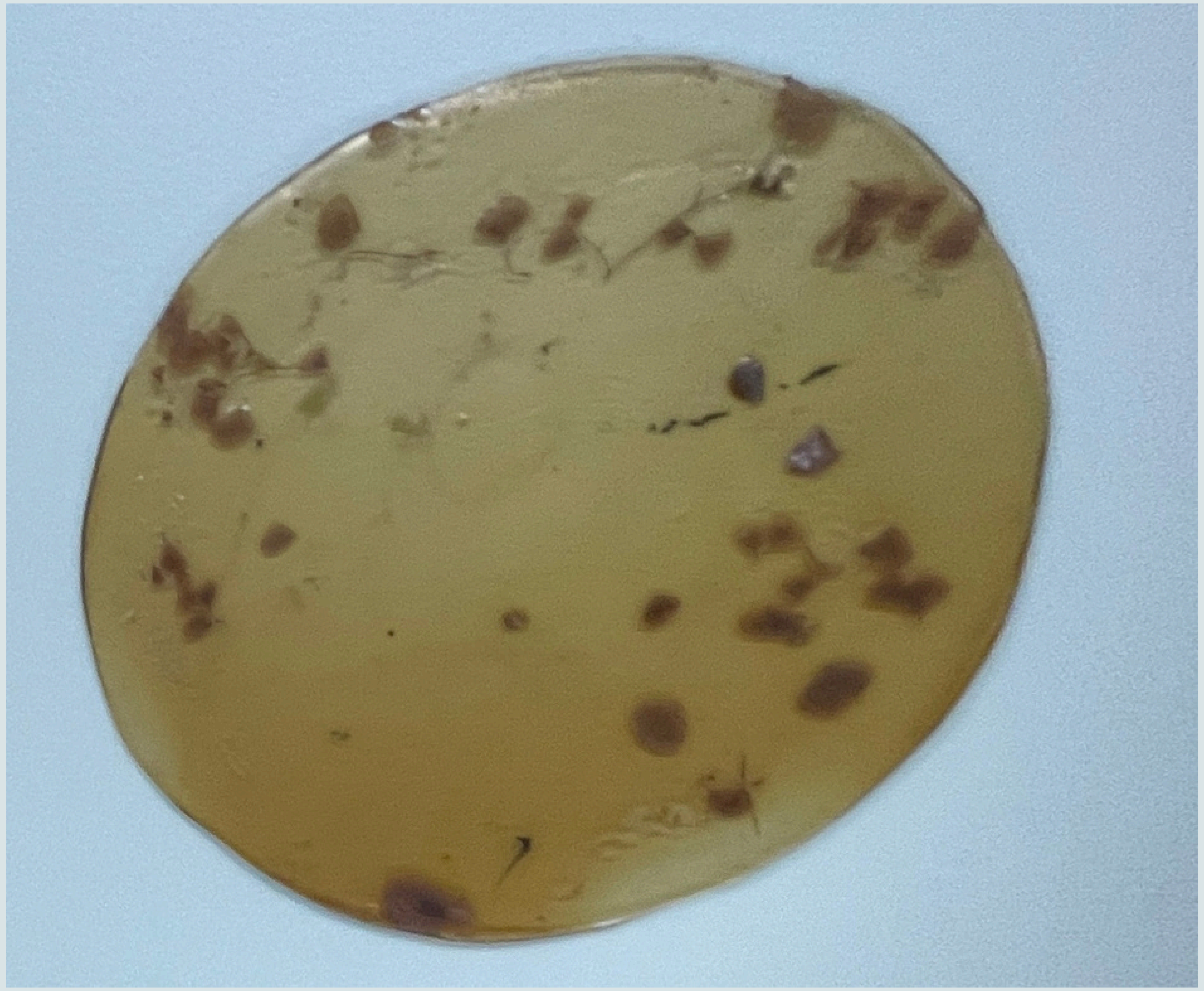
Biomaterial Using Cyperus Extract

This image shows a biomaterial made by combining agar with *Cyperus* extract. The agar provides a biodegradable matrix, while the extract adds natural pigments and organic elements. Visible particles reflect minimal processing, preserving the plant's properties.



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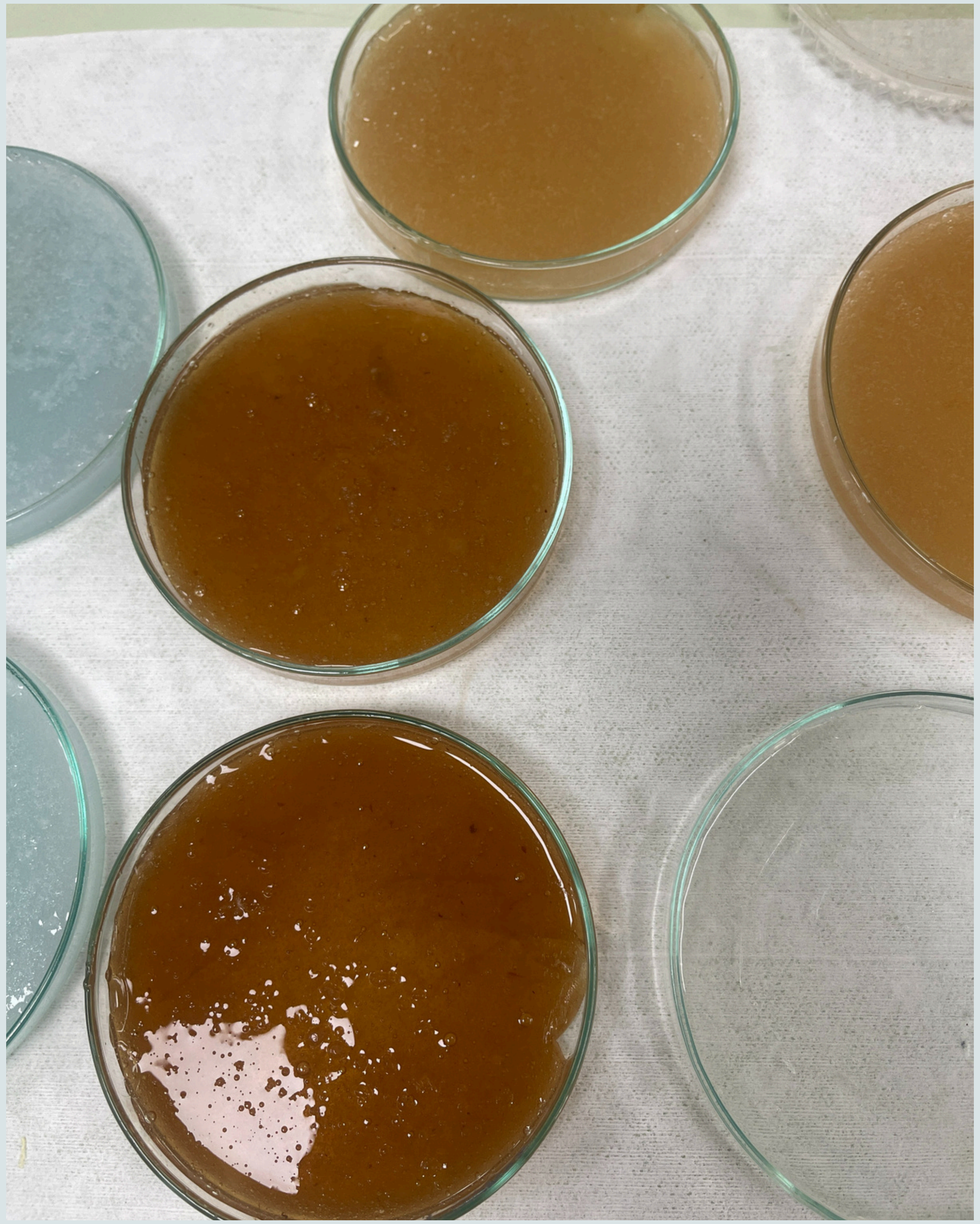
Biomaterial Using Pure Agar

The image features petri dishes with clear agar solutions, demonstrating purity as a control in biomaterial experiments. The absence of particles ensures consistent structure, making it suitable for testing transparency, texture, and biodegradability.



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Textured Mold Using Agar

This image presents a textured mold created using agar. The agar was poured and shaped to capture intricate patterns, resulting in a flexible, translucent structure.

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