LIGNIN PROJECT - CHANGEMAKERS

We researched the production and read various articles about experiments regarding lignin nanoparticles. The following protocols show 2 different methods to extract Lignin Nanoparticles in a simple way, using basic lab materials.

https://www.mdpi.com/journal/colloids

METHOD 1

SYNTHESIZING LIGNING NANOPARTICLES

Nanomaterials help to create new strategies for biomass valorization
It is mostly burnt for energy purposes.

For the formation of nanoparticles involving the self-assembly of smaller subunits of lignin by non-covalent interactions, the structure of lignin is highly important. The structure of lignin further varies with the source, extraction process, and extent of condensation.

Lignin nanoparticles can have applications in agriculture, biocomposites, biomedical science, coatings, and many other fields

We suggest a simple method that can be used in any lab without any special equipment for lignin nanoparticle synthesis. Additionally, the simplicity of the method will help the upscaling process. As the method only involves one solvent during particle formation, it can also easily be used to study solvent–lignin interactions

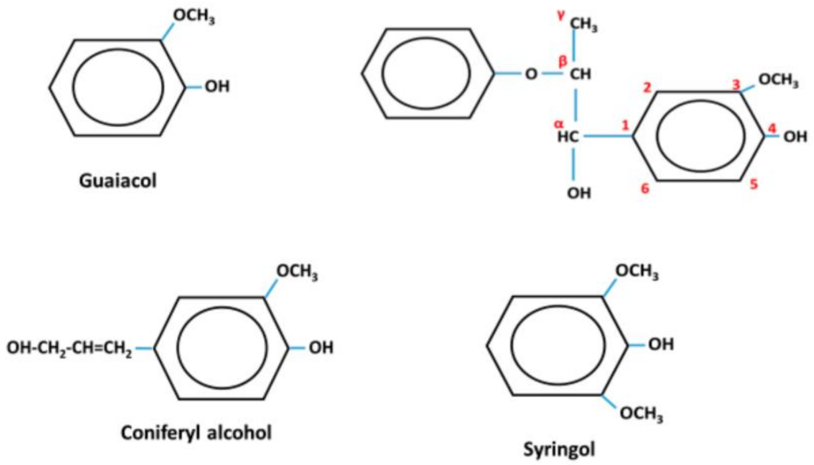


Figure 1. The monomers and numbering system used in lignin.

MATERIALS:

- Alkali lignin
- Syringe filters
- Dialysis bag

SYNTHESIS OF NANOPARTICLES:

1. Lignin was dissolved (0.05%) in DMSO under constant magnetic stirring for 1 hour.

2. The solution was then filtered through a 0.45 µm syringe filter to remove undissolved material.

3. The solution obtained was sprayed onto a liquid N2 cooled copper plate.

4. As the droplets strike against the Cu plate, they become lignin-entrapped frozen droplets.

5. The frozen mass was collected from a copper plate, suspended in water at 4 ◦C, and sonicated for 5 min.

6. This suspension was then lyophilized to obtain a dry powder, and this powder was suspended in deionized water and then sonicated for 3 min. This suspension was used for further study

PARTICLE SIZE DETERMINATION:

The lyophilized particles were suspended in deionized water and sonicated for 2 min. The suspension thereby obtained was measured for particle size using a Zetasizer nano.

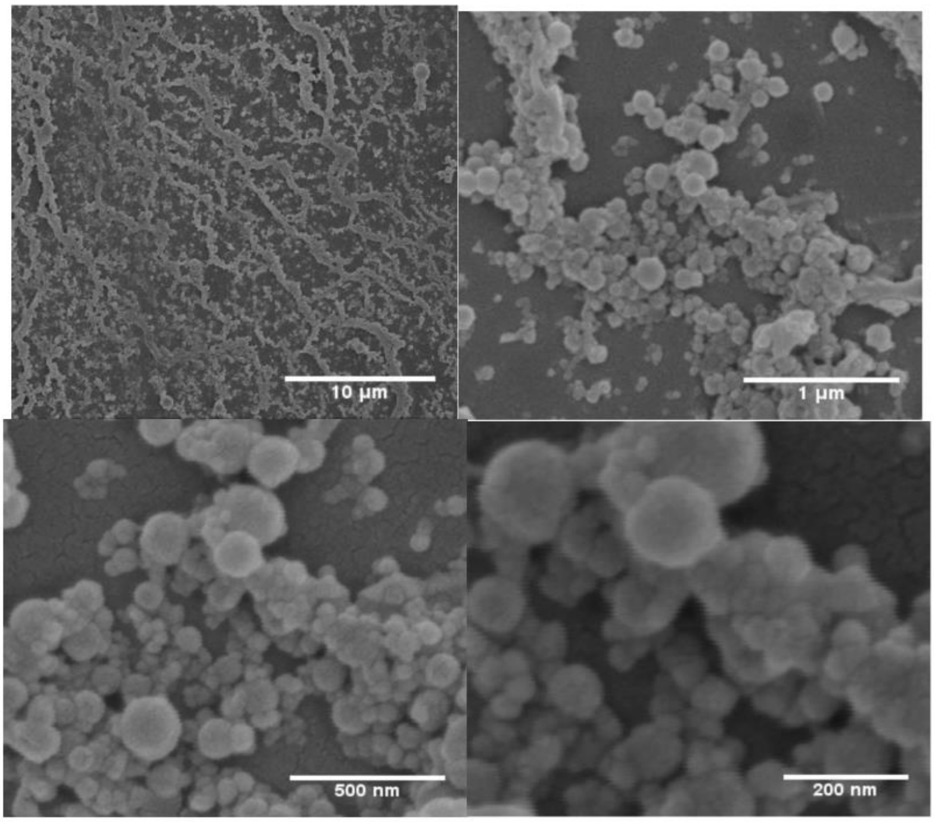


Figure 3. Particles prepared by spray-freezing, then dried at room temperature and neutral pH.

CONCLUSION:

It was shown that a simple lab scale set-up can yield lignin spherical lignin nanoparticles. These particles were self-assembled using a one drop, one particle approach. As the lignin nanoparticle is composed of cylindrical subunits of a few nanometers that form the spherical particle, the suggested approach can be used to study lignin and lignin–DMSO interactions that are mostly noncovalent. Additionally, the scalability of the process can be used to develop spray-freeing onto cryogenic-type reactors for lignin valorization.

The excellent solubility of technical lignins in DMSO is useful when valorizing technical lignins.

METHOD 2
https://www.researchgate.net/publication/338414765_Greener_synthesis_of_lignin_nanoparticles_and_their_applications
GREEN SYNTHESIS IN AQUEOUS HYDROTROPIC SOLUTION

To exploit a green way to produce polymer nanoparticles using biodegradable and renewable macromolecules instead of petroleum-based ones, we initiated a novel and facile method to synthesize lignin nanoparticles

- A green and facile method for producing lignin nanoparticles
- LNPs can be produced in water with a wide pH range at room temperature.
- LNPs can be produced from varieties of lignin species with high yields.
- The process can encapsulate various drugs with high efficiency.
- The resultant drug-encapsulated LNPs can realize the sustained release.

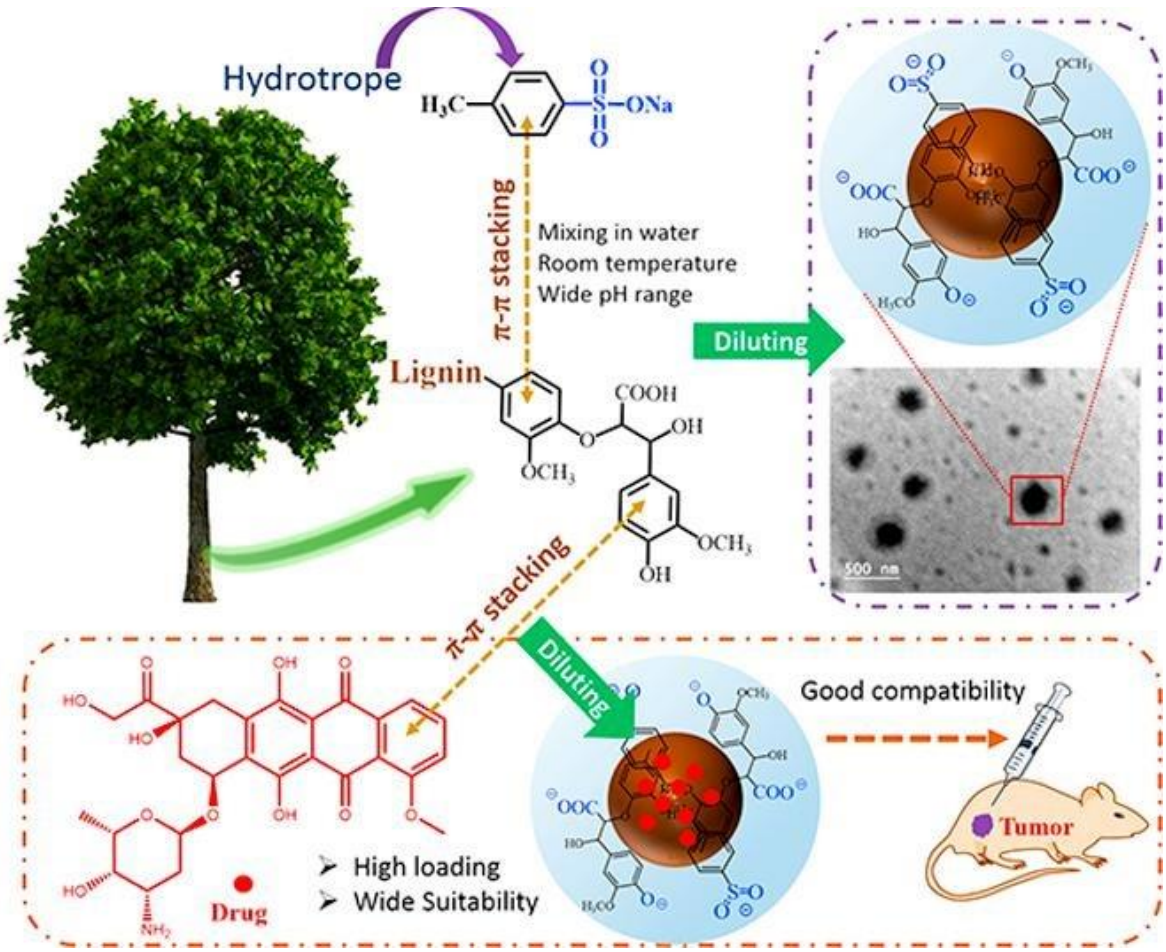
1. The LNPs, having a hydrodynamic diameter ranging from ca. 80 to 230 nm, were formed by self-assembly in a recyclable and non-toxic aqueous sodium p-toluenesulfonate (pTsONa) solution at room temperature, with a lowest concentration of up to 48 g/L.

2. We eliminated the unfavorable factors of restricted processing pH and lignin species by taking advantage of the hydrotropic chemistry and the synergistic dissociation of the entrapped pTsONa and intrinsic phenolic hydroxyl and carboxylic acid moieties of the LNPs.

3. Because of the hydrotropic system, various water-soluble or water-insoluble drugs can be dissolved and encapsulated in the LNPs with an encapsulation efficiency of up to 90%.

4. The drug-encapsulated LNPs also showed great properties, with sustained drug-releasing capability and biocompatibility.

Furthermore, the unloaded drugs could be easily recycled for multiple use, thereby achieving environmental sustainability. This synthesis approach with a broad processing window could realize the industrial scale-up production of LNPs and have wide potential applications, including but not limited to versatile drug/bioactive macromolecule loading in the biomedical field.



WHAT DO WE DO ONCE WE HAVE LNP?

- Conversion of raw lignin into nano lignin leads to improvement in properties.
- LNPs can be synthesized by a variety of physico-chemical-biological methods.
- LNPs have excellent antibacterial, antioxidant and UV-shielding efficacy.

With the production of lignin nanoparticles, we will be able to create synthesized plastics and further synthetic materials. This will help us reduce the Earth's amount of plastic and recycle waste materials.

Lignin for papermaking:

Process of lignin extraction from different biomass, the biomass is cut into small size and placed in a conical flask. A mixture of 85% organic acid is added to the biomass in the flask at a fiber to liquor ratio of 1:8 and allowed to boil on a water bath for 2 h. After 2 h,the flask and its content is allowed to cool to room temperature. Fibers were filtered in a Buchner funnel and washed with 80% acid and hot distilled water.