Oil-rich nuts are the latest material to be converted into biofuels and biochemicals

Nuts about green fuels

Not many people would have heard about cashew nut shell oil. For some of you reading this article, this might be the first time you have heard about it. One shouldn't feel bad about this, since it is a hidden gem.

The cashew nut shell oil obtained from the shell that covers the nut is a natural material source for biopolymer production. The shell is about 0.3cm thick, having a soft feathery outer skin and a thin hard inner skin. The cashew tree has very strict growing conditions and is limited to tropical areas.

Cashew nut shell liquid (CNSL) mainly consists of anacardic acid, cardol, cardanol and 2-methyl cardanol. Anacardic acid is a natural organic acid contained in the shell that acts like a shield to protect the kernel from insect and small animal bites. Cardanol is a monohydroxy phenol and cardol and methyl cardanol are dihydroxy phenols.

There are different extraction methods for CNSL. Some of them can change the chemical composition of the final CNSL product during the process or can be processed later. Raw CNSL is extracted using cold press or solvent extraction methods. It contains approximately 70% of anacardic acid, 18% of cardol, 5% of cardanol and 2% of 2-methyl cardanol.

Technical CNSL is extracted by using hot steam, which leads to a different composition by dercaboxylation of the anacardic acid in cardanol and obtaining a rough final composition of approximately 50% cardanol, 10% cardol, and others. Finally, distillation of the CNSL with high vacuum and temperature increases the cardanol content to high values and produces a lighter coloured-end product with an approximate composition of 82% cardanol, 8% cardol, 2% residol, 7% different homologue compounds and 1% 2-methyl cardanol.

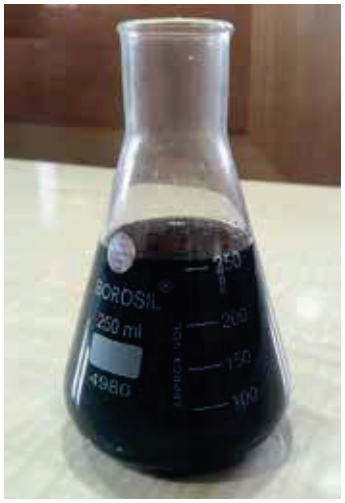
Cashew

CNSL, derivatives and residues

CNSL, thanks to chemical structure consisting of aromatic phenols with an aliphatic chain in meta position, is considered as a natural alkyphenol. This structure gives CNSL polymers produced using a catalyst and temperature especially good properties, such as high thermal resistance, good adhesion, hardness, water repellence, and certain flexibility, plus others.

One of the most well-known products made from CNSL is the friction dust that is used in friction materials such as brake pads, due to it maintaining the friction coefficient in high temperatures. Besides that, CNSL has been used to produce liquid polymers with different molecular weights as a binder. Also, CNSL is extensively used to modify phenolic resins for different applications, such as friction, tyre production, rubber compounds, coatings, adhesives, etc. Distilled CNSL, when used with amines, produces phenalkamines, which can be used as new epoxy hardeners. Also, CNSL can be used as biofuel either as burning oil or when blended into fossil fuel and biodiesel.

Wave SL Co. has been working to develop new polymers and applications for technical and distilled CNSL. During last year, the company launched a new CNSL polyol base for polyurethane (PU) and produced a solid CNSL resin as a binder. Its latest applications are for soap tensoactives for textile, leather and pesticides. Moreover, the excellent properties of CNSL biopolymers are part of a new generation of renewable chemicals. Chemical firm Wave SL's goal is to replace nearly any petro-based chemical, such as phenols, solvents, resins, and butanol, with green, environmentally-friendly chemicals that, among other things, will lower the exposure to potentially carcinogenic products, air and soil



CNSL oil

pollution, and other hazardous environmental effects.

Another by-product of CNSL production is the cashew nut shell cake, which is widely used as a biomass for heating processes. With its high calorific value at about 5000Kcal/kg and long shelf life, it is suitable for applications requiring high heating temperatures.

There are also some known usages of CNSL as an antioxidant added to animal feed. Antioxidants are used in animal feed in order to protect it against lipid peroxidation. CNSL is widely used as an antioxidant for lubricates, but the same characteristics are found to match similar purposes in animal feed.

There are two "cakes" one can make from cashew nut – cashew nut cake and cashew nut shell cake. The first can be used for animal feed since it is produced from bad, damaged and oil extracted kernels. The latter one is not suitable for animal feed, but as biomass for heating process with high calorific value, as already mentioned.

Future potential

For the low-tech industry, CNSL can be used as burning fuel instead of using diesel oil. Also, CNSL blended with a bit of high speed diesel (HSD) can be used as a renewable substitute for machinery-based engines with speeds lower than 750 RPM.

Another blend based on pyrolysis oil and CNSL lowers the density and viscosity of the CNSL, with ignition also occurring a fraction of a second faster. This blended mix is free from sediments, free-flowing, and does not need preheating like furnace oil.

Nowadays, InLightMe is on the verge of conducting research to modify CNSL in a way it can be use as biofuel blend for power plants and marine fuel – what can be called a bio-bunker fuel.

On the high-tech side, there have been attempts and research in order to determine if CNSL can be used as a biodiesel feedstock. Up until now, there has been no such commercial use for CNSL as a feedstock, as the technology is still at the research stage. With basic properties such as 2-8% FFA content, 2-5% moisture and impurities (M&I), and an iodine content of less than 200, one may think this is premium oil much like virgin vegetable oils or high grade UCO. Additionally, there are a few more advantages:

1. Relatively cheap compared to other agro-based feedstocks.
2. Non-edible oil, which complies with the new dossier submitted to the European Commission, which states that biofuels must be made from non-food resources.
3. In relation to the above, the biodiesel market has a new goal in the biodiesel market using waste as a feedstock. For example, Neste's MY Renewable Diesel is made out of 100% waste and residues.

But, for any advantage there are some disadvantages with CNSL-based biodiesel that need to be looked at. For example, it has:

1. High viscosity
2. High water content
3. High levels of sulfated ash
4. High acidity

So things are not as bright as it seems, but the huge potential is on the floor waiting for someone to pick it up, pre-treat it, and produce a cheap, high grade, profitable biodiesel to enter the market.

All in all, as one can see, one can do many things with CNSL. It brings great benefits to those in the biochemical and biofuel industry. CNSL brings a lot to the table including a suitable and sustainable solution for any fossil-polluting material you use nowadays. ●

For more information:
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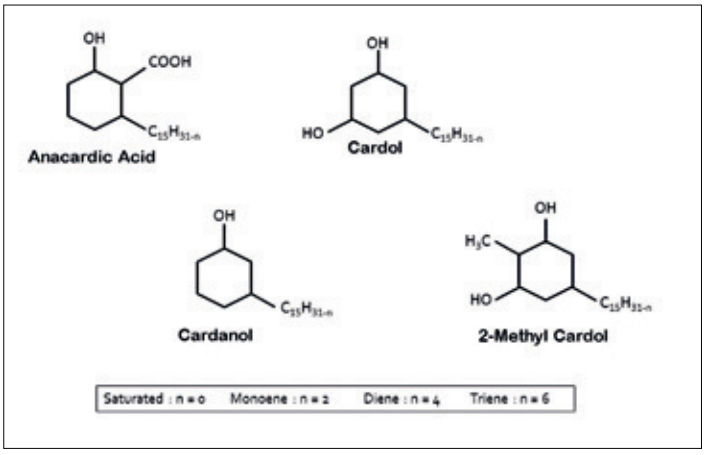

CNSL chemical structure

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