

d-Limonene Products

Mother Nature has been very generous in endowing citrus fruits with so many useful compounds. Vitamin C comes to mind immediately. But, as witnessed by CitruPar, there are many other compounds contained in the seeds and pulp of citrus fruits. For instance such glucosides as citrus flavonoids and limonoids.

d-Limonene is a terpene found in the oil extracted from the peels of oranges and other citrus fruits and where it is present only in the dextrorotatory form. The levorotatory isomer is found in bergamot and eucalyptus oils. Compared to the d-form it is virtually inactive.

d-Limonene is a substance that has been exhaustively studied. Its toxicology is well known. For instance, the acute oral DL_{50} in rats is 4400 mg/kg. Moreover, its properties are considered environmentally friendly.

Fundamentally, the compound is a biodegradable solvent, degreaser and cleaning agent. Its affinity for grease and oil combined with very low toxicity makes d-limonene an effective alternative to petroleum-based and chlorinated solvents. Today, d-limonene products are being used in a wide range of industrial, institutional, commercial, medical and residential cleaning applications. Diverse industries such as aerospace, automotive, electronic components, inks, paints and adhesives are all using d-limonene in their manufacturing processes.

The basic product of our d-limonene line, **LimoSol-90**, is being marketed as a solvent, degreaser and cleaning agent. As such it does not require any pesticide registration. It is appropriate to start the product descriptions with this product:

LimoSol-90 is an emulsion concentrate containing 90% of d-limonene. While it can be used "as is", it should be diluted with water in almost every case.

We have found that a dilution of 1:10 or 1:20 (10% or 5% strength) is optimum for the vast majority of cleaning jobs, including tile floors, kitchens, bathrooms, etc. It is also indicated for use in repair shops where it will take care of most cleaning and degreasing jobs. One special indication is the use in veterinary establishments owing to the fact that a 5% solution will kill fleas and ticks. There is no limit to the indications, as they range from clinics and hospitals to hotels, offices and all kinds of institutions.

Sometimes it may be necessary to use a stronger concentration, for instance in the case of solidified petroleum residues. In such cases a 1:5 dilution (20% strength) is usually the answer. Keep in mind that the product requires time to soak in and slowly dissolve the petroleum residues.

A dilution of 1:100 (1%) is often sufficient for routine cleaning of floors in households, warehouses, offices, and manufacturing plants. However, grease spots require a greater concentration.

It is a good idea to periodically pour about 500 ml of a 5-10 % solution into grease traps and floor drains. Also toilets and kitchen and bathroom sinks.

The product has been used to clean up oil spills on land, including beaches. When applied on oil spills, LimoSol will act as a solvent of hydrocarbons. In case of large

areas it is better to apply large volumes at a relatively low concentration (1%) in order to soak the contaminated ground. Time is required to obtain good results. If necessary, repeat. High concentrations of spilled oil must be treated with a greater strength of diluted LimoSol-90. For instance 20%.

LimoSol-10 contains, as the suffix implies, 10% of d-limonene. It is a ready-to-use product. We have developed a 10% microemulsion that will be marketed in a manual sprayer. The microemulsion is an almost clear liquid that does not separate into layers, as ordinary emulsions would. It is expected to have this product commercially available early in 2001.

LimoSol-10 is particularly indicated for household cleaning jobs that will make the homemaker's life easier. Just by spraying a few squirts on kitchen counters and cabinets, bathroom fixtures and tile walls will do the job. Leave on if continued action is desired. Otherwise, just wipe off. By the way, the LimoSol-10 treatment will also kill all kinds of crawling insects (even flying insects if the spray catches them). This is a side benefit not claimed on the label.

Other LimoSol Indications: As mentioned before, LimoSol is being marketed as a cleaner, solvent and degreaser, and not as a pest control product. Therefore, the following indications of LimoSol may not be claimed in most places, unless a specific registration or authorization is obtained. It should be noted, however, that the EPA has recently registered d-limonene products with some of the indications listed below. It should be emphasized that the insecticidal properties of LimoSol are the direct result of its solvent characteristics. This means that LimoSol will work only as a contact insecticide. It is the contact with the exoskeleton and the respiratory tract that often produce almost instantaneous results.

□ Control of ticks and fleas on domestic animals: The application (spraying) of a 5 % LimoSol-90 solution on cats and dogs will get rid of such parasites. In extreme cases the answer is to dip the animal into a 1 to 5 % solution. Make sure that all the areas the pets have access to, especially their sleeping places, are well treated with LimoSol-90.

□ Control of flying insects: Provided direct contact is made with flies and mosquitoes, the knockdown is almost instantaneous with a 5 to 10 % solution.

□ Control of ants: Direct application of a 5 to 10 % solution will kill ants immediately. The control of different species of ants in their mounds may require different strategies too lengthy to cover here.

□ Control of lice (in school children, etc.): LimoSol-90 has been amply used for that purpose in Venezuela. A one percent solution applied to the scalp of the children resolves the problem without any complications or toxicity.

□ Control of ectoparasites on livestock: LimoSol-90 is very effective in the control of ectoparasites of farm animals. A 1 to 5 % spray works very well, but more work is required to determine the effective percentage solution for dipping cattle. This indication is very promising, as it may replace the extremely irritating (and expensive) treatment with pyrethroids.

□ Control of agricultural pests: While LimoSol is generally quite effective in the control of

all kinds of agricultural pests, the problem is that it is bound to be phytotoxic. After all, it is a solvent! The use of LimoSol-90 for the control of agricultural pests on broad leaf crops should be ruled out. There may be valid indications on grass crops. One valid case concerns the control of mole crickets in Florida. This insect normally lives at the root level of the pasture, but comes up in the evening to attack the aerial parts. The application of a 0.6 % solution sprayed all over the field was effective without any phytotoxicity. It should be pointed out that this treatment does not require the removal of the cattle from the field, as would have been necessary if an organo-phosphate had been applied.

□ **Weed control:** Due to its solvent properties, LimoSol-90 is very effective for the post-emergent control of weeds, particularly of broad-leaf weeds. Trials conducted in Florida suggest that LimoSol-90 can be used as an herbicide by itself. While this would be an excellent ecological solution to the problem of weed control, it may be too expensive. LimoSol-90 has also been used to enhance the activity of glyphosate, adding 1 liter per hectare of the product to the tank mix.

New d-Limonene Formulations: On the basis of our work and experience with d-limonene over a number of years, we have developed and evaluated several formulations in Venezuela where such products have been in the local registration process for over two years. According to the latest information, they may have been approved by the time this text reaches our readers. These products are all for domestic, industrial and/or sanitary use (not for agricultural use). A brief description of such products follows:

□ **OranSol:** This product has been developed as an all-purpose domestic insecticide. There are two versions: (a) a manual spray, and (b) an aerosol. This product acts as a contact insecticide to control all kinds of flying and crawling insects.

□ **Limonex:** This d-Limonene product has been developed as a mosquito larvicide that can be applied on surfaces of stagnant water where mosquito larvae grow.

□ **VectorSol:** This d-limonene product has been formulated for the use with ULV applicators for the control of vectors of dengue, yellow fever and malaria.