

Advent of Nano-herbal Medicine

IMAGINE combining the benefits of the latest advances in nanomedicine, including capabilities of target-specific drug delivery and enhanced biocompatibility, with the curative properties of medicinal herbs! Nano-herbal medicine is a synergistic therapeutic strategy for the treatment of diseases including cancer.

Nano-herbal medicines have two major components, namely, nanoparticles and bioactive compounds from plants. In general, particles with a size of 1-100 nm are called nanoparticles. There is a wide variety of them. Some are created from metals such as gold, silver, and iron. Then there are those based on phospholipids-based liposomes and non-ionic surfactant-based niosomes. Even some viruses are useful as nanocarriers of different drug molecules. Among these different types, metal-based nanoparticles, especially gold-based ones, have some interesting therapeutic advantages.

These particles can be painted with therapeutically active phytochemicals derived from plants, including polyphenols, organosulfur compounds and other secondary metabolites. These coating materials in turn act as stabilizers of the particles and prevent them from forming clumps. The phytochemicals provide the nanoparticles with sufficiently negative zeta potential so that the particles repel each other and stay as a colloidal suspension, thereby facilitating their easy intake by the tumour cells.

Research has shown that nanoparticles can be utilised for sending plant-based polyphenols to the site of tumours. Gold nanoparticles, for example, can selectively accumulate at the site of the tumour. What enables this so-called EPR effect (for Enhanced Permeability and Retention) of such nanoparticles? A solid tumour has some specific features. Its blood vessels are not as tightly sealed as normal vessels. This 'leakiness' of the tumour blood vessels means that size-optimised nanoparticles can move across these vessels and reach the tumour cells. Further, the drainage system in our body comprising lymphatic vessels is also defunct at the site of several tumours. This dysfunctional lymphatic drainage facilitates the prolonged occupation of the particles at the site of the tumour.

To add more tumour-specificity to the particles, they can be conjugated with some antibodies that target specific molecules present in cancer cells. Either way, gold nanoparticles are potential carriers for many therapeutic molecules with good biocompatibility

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Plant that makes Potties

PLANTS are generally considered inert, passive organisms rooted in the soil. Yet the wisdom of plants especially in using animals for accomplishing pollination of their flowers and seed-dispersal is sometimes mind boggling. However, whenever the services of animals are taken, they are adequately compensated nutritionally.

Plants also learned to use nitrogen and other nutrients present in animal faeces long back. Some plants produce fruits containing seeds meant to be swallowed by animals along with the pulp, only to be

expelled out undamaged along with their faecal matter (poop). This facilitates seed germination in far-off places, using the moisture and nutrients present therein.

Two pitcher plants, growing on the high mountains of Borneo of the Southeast Asia's Malay Archipelago, switched their diet from small insects to animal poop. At the heights that *Nepenthes lowii* and *Nepenthes macrophylla* inhabit, there exists a paucity of insects. They therefore learned to produce pitchers about four inches across, strikingly resembling the Western toilet bowl, complete with lid. Animals like the

mountain shrew are attracted towards the pitchers because of the sugary nectar secreted by the hair-like structures present on the lid. They defecate in the pitcher before they depart. Summit rats, woolly bats and the black eye, a small bird living in the mountains, have also been shown to visit the *Nepenthes* toilets.

In a recent study (January 2023) published in the journal

Toilet shaped pitchers of the carnivorous plant *N. lowii*.
Credit: A. Robinson



Ethanol Blending Petrol (EBP) An Alternative Fuel

ETHANOL is a biofuel produced from the fermentation of sugarcane, maize, wheat, etc. or by petrochemical processes like ethylene hydration. Ethanol can be used as an alternative fuel for transportation and also be used as a chemical solvent, in the synthesis of organic solvents and also act as an antiseptic and disinfectant in medical applications.

Ethanol is considered as one of the most suitable alternatives blending transportation fuels due to its better fuel quality, higher flame speed and environmental benefits. Ethanol blending helps in complete combustion and reduces polluting emissions like carbon monoxide, Particulate Matter (PM) and hydrocarbon emissions. Globally, the United State of America (USA) and Brazil are leading producers of fuel ethanol (84% of world production) followed by the European Union, China and India.

As per the recommendations of the National Policy on Biofuels-2018 under the Ethanol Blending Petrol (EBP) programme, the target for ethanol blending is 20% within pure petrol by 2030. Currently, petrol with 10% ethanol blend (E10) is being retailed by various oil companies in India based on the availability of ethanol. However, sufficient quantities of ethanol are not available, so around 50% of the total sold petrol is 10% ethanol blended (E10) and the remaining is pure petrol (E0).

In India, petrol vehicles (2-wheelers and 4-wheelers) are designed for running on pure petrol and can be material-wise (plastic and rubber components) compatible with 10% ethanol blended petrol (E10). However, for 20% ethanol blended petrol (E20), the vehicle's material should be compatible and tuned for it accordingly. Therefore, newer vehicles based on (E20) will have to follow the BS-VI (Bharat stage Emission Standards) as the Ministry of Road, Transport and Highways (MoRT & H) has notified E20 fuel as automotive fuel and fixed its emission norms.

As per NITI Aayog reports, the cost of E20 compatible vehicles is expected to be higher by Rs 3000 to Rs 5000 in the case of four-wheelers and Rs 1000 to Rs 2000 in the case of two-wheelers as compared to ordinary vehicles.

The challenges for the implementation of the Ethanol Blending Program (EBP) are less production of ethanol fuel & its compatible vehicle, limited availability of water resources required for ethanol production and handling issues in terms of its safe handling & storage.

However, by reducing the dependence on imported fossil fuels, domestic biofuels provide energy security as well as a low-carbon economy to the country. Successful implementation of the E20 programme will reduce the demand for petroleum and thus reduce the import cost for petroleum products. It will lead to a net saving of around US 4 billion dollars per annum i.e. Rs 30,000 crores.

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Annals of Botany, Alastair Robinson and his team at the Curtin University, Australia, demonstrated the rationale behind this unique change seen in the pitcher plants. They observed that plants that collected animal poop were richer in nitrogen compared to their insectivorous cousins. According to Robinson, "We found that nitrogen capture is more than two times greater in species that capture mammal droppings than in other *Nepenthes*. Insect prey is scarce on tropical peaks above 2200 m, so these plants maximise nutritional returns by collecting and retaining fewer, higher-value nitrogen sources like tree-shrew droppings."

Interestingly, the two toilet pitcher plants also offer ample niche space for the tiny poop

loving moss. Poop mosses belong to the family *Splachnaceae* live their short lives growing on feces. One species of poop moss, *Tayloria octoblepharum*, was discovered growing on the two species of poop-eating pitcher plants in Borneo.

Knowledge of animal poop has also been put to other interesting applications by other mosses. The Pink stink dung moss, a native of the US, emits an odor of dung that attracts flies that help disperse its spores. When the flies subsequently land on animal poop the spores get transferred and grow there. A moss that lives in nutrient poor Antarctic soil obtains its nitrogen from fossilised penguin poop.

The South African plant *Ceratocaryum argenteum* is a brilliant strategist and produces

seeds that resemble in size, shape and smell, feces of the local antelope called Bontebok. The dung beetles mistake the seeds for antelope dung, roll them away like the dung ball and bury them. This helps the plant not only in the dispersal of its seeds but protects them from destructive fires. The habitat of *C. argenteum* is swept regularly by fires and this looks like a very well thought out plan on the part of the plant. A closely related species the *Ceratocaryum pulchrum* also produces similar seeds and attracts the dung beetles.

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For almost 60 years, his 'law' about microchip evolution held good

Gordon Moore, semiconductor pioneer and author of 'Moore's Law', which foretold the pace of semiconductor development, passes away.

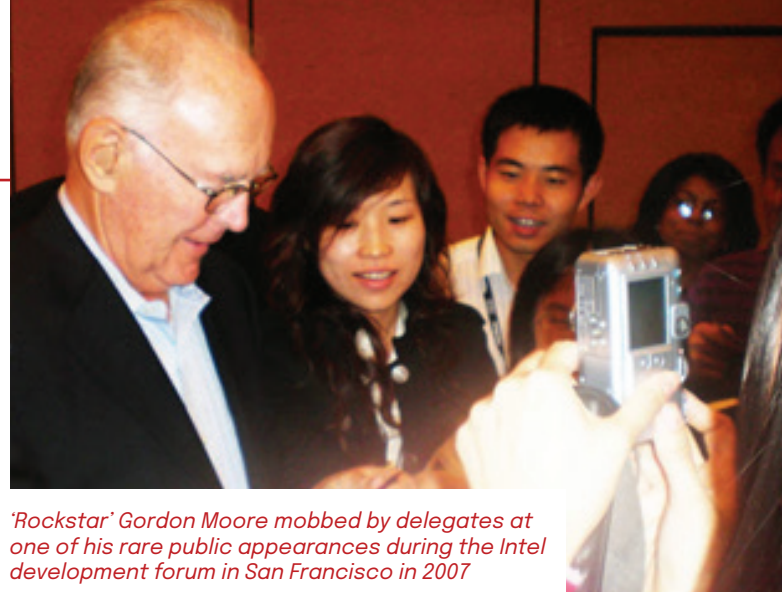
PREDICTING the future of technology has always been a dicey business – and most tech soothsayers have been known to be woefully off mark. Not Gordon Moore.

Co-founder of two iconic American electronics companies – Fairchild and Intel – Dr Moore was one of the small group of engineers who made possible the birth of the microprocessor in the early 1960s – and its transition from a research device to a commercial product that sold in billions.

Invited by *Electronics* magazine to write an article on future directions of the electronics industry, Dr Moore contributed a piece for the 19 April 1965 issue with the title “Cramming more components onto integrated circuits”. In it he postulated a theory that the number of transistors on a chip will double approximately every year, while the cost of a transistor will drop by half.

His prediction proved to be very nearly accurate and after a decade, Professor Carver Mead of the California Institute of Technology, began calling it “Moore's law”. The name stuck – and incredibly for another half a century, Moore's prediction was spot on – though he “revised” it in the 1970s to suggest that the doubling might take 18-24 months, rather than 12.

As microchip fabrication evolved, silicon foundries could increase the density with which they could pack in the transistors. In 1970, density



'Rockstar' Gordon Moore mobbed by delegates at one of his rare public appearances during the Intel development forum in San Francisco in 2007

was defined as 10 micrometers or microns where 1 micron was 1-millionth of a meter. The densest chip in use today is Apple's M1 Ultra which packs 114 billion transistors on a slab of silicon the size of a matchbox. The density is now 5 nanometers where a nanometer is one billionth of a meter. Major foundries in Taiwan like TSMC are already working to manufacture chips to 3 to 4 nanometer accuracy by next year. And that is as far as they can go.

Why? Because 58 years after “Moore's Law” it looks as if a physical limit to shrinking transistors further has nearly been reached.

In 2006, 38 years after he co-founded Intel, Dr Moore retired from the company and had been pursuing philanthropic work from his base in Hawaii. In 2007, a year after retirement, Gordon Moore was seen in one of his last public appearances at the annual Intel Development Forum in San Francisco. This writer was fortunate to have attended this event as a media representative and could barely get a few minutes with Dr Moore – he was mobbed everywhere like a rock star by delegates.

“It was never intended to be an immutable law. I'm glad it worked out so far – but I won't be surprised if it hits a physical barrier soon,” he told me.

Experienced engineer that he was, he recognised that the laws of Physics will ultimately catch up with any semiconductor fabrication process.

In India today, when we are on the cusp of launching an indigenous semiconductor fabrication industry, Moore's Law as well as its approaching limitations will continue to challenge and inspire. Because he remains one of the most important forces shaping the information technology industry.

How poetic that Dr Gordon Moore passed away peacefully shortly before his Law reaches its own expiry date. He died on 24 March 2023 of natural causes at the age of 94.

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