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DELIVERING CANCER DRUGS, BANG ON TARGET

Carbon nanospheres developed from lemon grass, used in Thai cuisine but found abundantly in India, can revolutionise the treatment of cancer, finds **T.V. Jayan**

Tiny hollow carbon balls, created in the lab of chemical scientist Sayan Bhattacharyya at the Indian Institute of Science Education and Research (IISER) in Calcutta, may assume a significant role in humanity's fight against cancer, if the researchers can replicate their lab feat in real conditions.

These porous carbon nanospheres —one-tenth the size of a dust particle — that the IISER scientists synthesised from abundantly available lemon grass, delivered anticancer drugs exclusively to cancerous cells in a controlled manner, making them an ideal vehicle for targeted delivery of cancer drugs. The experiments were carried out in lab-bred cancer cells.

More importantly, their study, reported in the journal *Carbon* last week, showed that the nanocarriers could be altered to spare healthy cells. The destruction of healthy cells while killing tumour cells has been the bane of modern cancer treatment. For this study, the scientists used doxorubicin, a commonly used anticancer drug.

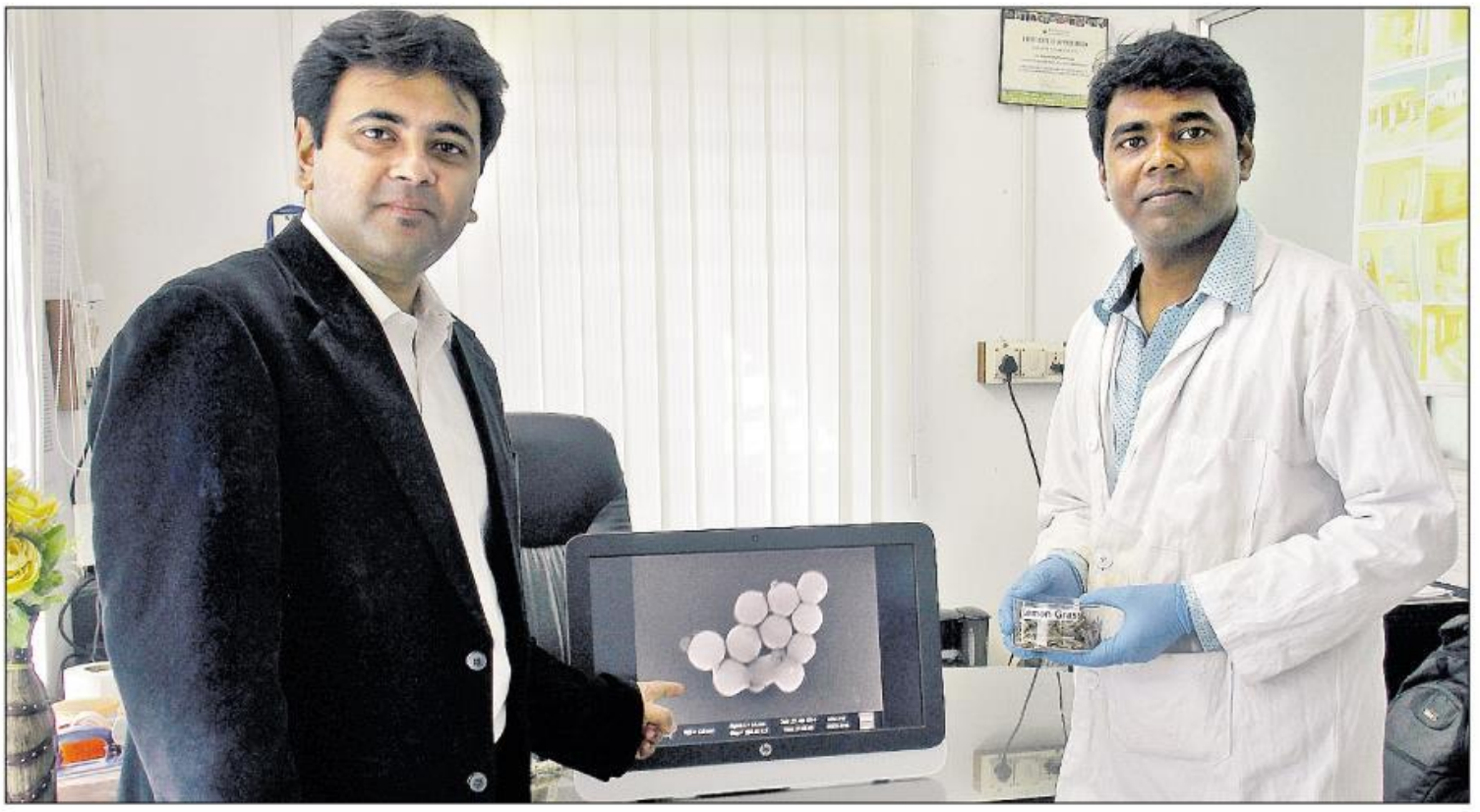
"We have shown that drug molecules can be trapped inside the pores of the nanospheres which have a uniform size of 150 nanometres (one nanometre is one billionth of a metre). Besides, these nanospheres release drug molecules inside the cancer cells in a controlled manner over a period of 24 to 48 hours," says Bhattacharyya, an associate professor at the department of chemical sciences at IISER.

"What is exciting about this work is that the scientists have prepared the carbon nanospheres in such a manner that they distinguish 'bad' cells from good cells," says Sabyasachi Sarkar, honorary emeritus professor of chemistry, Indian Institute of Engineering Science and Technology, Shibpur.

Typically, both cancer and healthy cells reside side by side in the body. Chemotherapy drugs are not capable of differentiating between the two and destroy both equally. "This is the reason that sometimes it is said that a cancer patient has died of chemotherapy and not cancer," says Sarkar, who is not connected with the current research.

But when the drug is delivered via the carbon nanospheres invented by the IISER researchers, it prefers cancer cells to normal ones. This is very important, observes Sarkar.

According to Bhattacharyya, the carbon nanospheres that they synthesised from biowaste of cheaply available lemon grass have several significant aspects. First, the method of synthesis is not just inexpensive but also scalable. Second, it can help yield porous carbon nanospheres of uniform size. Moreover, the drug delivery method uses elemental carbon, which is inert and hence will have minimum side effects for the human body.



AIMING HIGH: Sayan Bhattacharyya and his doctoral student Sutanu Kapri at their lab in IISER

The IISER team, which includes Bhattacharyya's doctoral student Sutanu Kapri and Sankar Maiti, an assistant professor of biological sciences, illustrated that the nanocarriers can be made to spare the healthy cells through clever designs. First, they chemically bound folate (B vitamin) molecules on the surface of the carbon nanospheres.

The IISER team illustrated that nanocarriers can be made to spare healthy cells through clever design

Since tumour cells grow rapidly, they need more vital nutrients than normal cells. So they tend to have receptors for absorbing nutrients in circulation. One such receptor abundantly present in cancer cells is the folate receptor. "Having folate molecules attached to the surface help these nanocarriers loaded with drug molecules to get hitched to the tumour cells," says Bhattacharyya. Once inside the tumour cell, the drug molecules are released in a steady manner, eventually leading to the destruction of the cell.

Also, the scientists cleverly exploited the acidic nature of cancer cells for efficient delivery of the drug molecules. During the experiments, they designed the nanospheres in such a way that they deliver maximum drug molecules in an acidic environment. Normal cells, which have a neutral environment, receive very little or no drug.

Bhattacharyya admits that this is not the first time that targeted delivery of cancer drugs has been attempted. Researchers in different parts of the world, including some groups in India, are trying to develop improved drug delivery vehicles based on polymeric materials, noble metals and other carbon nanomaterials.

The hollow carbon nanospheres, he claims, however, have several advantages. Polymer materials and noble metals when used for drug delivery, for instance, can be highly reactive and cause side effects. The carbon-based nanomaterials such as carbon nanotubes, nanodiamond, graphene or fullerene are relatively expensive to make and the processes used for their synthesis more often than not are not scalable, he says.

Apart from lemon grass, the scientists also synthesised similar carbon nanospheres from waste human hair gathered from local salons.