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The Chili bites like the Tarantula!

The unique flavour of chilies, green and red, invaluable in Indian cuisine, is part of the plant's protection system, says S.Ananthanarayanan.

More ominously, David Julius and colleagues at the University of California have discovered that the pungency of the chili has the same origin as the deadly sting of the Tarantula spider!

Stings and pain

Bites and stings of a variety of animals, scorpions, snakes, spiders, are known to cause shock, paralysis and death and their venom have been studied to identify the active toxic agents. The poisons are found to be mainly neurotoxin peptides, or proteins that block the way nerves communicate, or agents that prevent muscles from responding to signals from nerves. The result in most cases is asphyxiation, paralysis, drop in blood pressure, leading to death.

While knowing how the poisons work has helped develop antidotes for the poisons, the study has also enabled useful drugs to be created. In 1949, for instance, it was discovered that an enzyme in snake venom leads to dilation of blood vessels. This helped the development of drugs to control blood pressure.

Apart from blocking communications and causing death or immobilizing victims, these toxic bites also cause intense pain, which may be the immediate and more effective protection for the animals. This, pain causing part of the poisons of stings and bites has not been as well researched.

Receptors and toxins

The way nerve cells communicate is that the cells 'at rest' contain a concentration of 'ions', which are atoms or combination of atoms with an electric charge, which is different from the concentration outside the cell. There is thus a ***pressure*** of ions to flow into or out of the cell. But the walls of the cell 'at rest' do not allow ions to pass and equalize concentrations. This only happens when gateways in the cell wall get opened – and this happens when a neighboring cell sends a signal to a ***receptor*** of first cell. The receptor is an arrangement of atoms on the cell wall, which exactly fit the shape and the charges of the signal.

Once the signal comes, the cell wall opens up and charges rush in an out, to equalize. When this happens, the cells itself gets ready to send a signal to another neighboring cell, and so on. What the toxic proteins in the snake or spider poison do is to combine with these receptors and thus ***block*** the possibility of a signal being sent to the nerve cell.

Another kind of action of nerve cells is not just receiving signals from other cells but to react to the environment. This is the case of sensory nerves, which have receptors that get excited by sensory signals, such as pain when the body is injured.

Why the bite stings

Julius and colleagues examined the venom from twenty two scorpion and spider species, which have painful bites, to see it they contained activators of sensory neurons. The venom were screened against different receptors, including three which were known to get activated by plant derived irritants, such as ***capsaicin*** (the active component of chilli pepper), mustard oil and menthol.

It was found that the venom of ***psalmopoeus cambridgei***, a tarantula found in the West Indies activated the receptor which responded to chill peppers! Further analysis revealed that the tarantula venom contains three peptides, or amino acid chains (just like proteins) which were active in stimulating the capsaicin receptors. To confirm, the group tried out synthetic versions of the same molecules and they found them just as good.

The group also tried out injecting the toxins into mice and they found that they caused the same reaction as injecting the extract of chili. And injecting the stuff into mice deficient in the specific receptors caused no pain! It is quite clear that what causes the sting of spider bites and the sharpness of the chili has been identified.

So the chili pepper uses the same signaling mechanism as the West Indian spider to discourage predators. But the same mechanism gives chili peppers its distinctive effect on food and encourages farmers to cultivate the most pungent varieties!

A nerve cell is also a cell, like any other. This means it has all the apparatus of cells, including the nucleus, with the instructions, in DNA, of what enzymes to produce and hence how to manage the chemical balance in the cell. These instructions tell the nerve cell to produce a slight excess of positive, potassium ions and also of some negatively charged protein molecules. At the same time, the cell has a slight deficiency of positive, sodium ions and negative, chlorine ions. The relative concentrations of the different ions inside and outside the cell are shown in the diagram.