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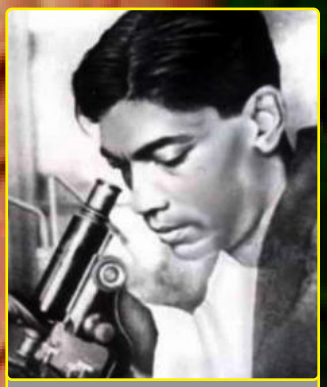

GOPAL CHANDRA BHATTACHARYA

AN INSPIRATION FOR BUDDING SCIENTISTS

SPURIOUS SPICES – ADDING WHAT TO OUR CUISINE!

HOLY BASIL:

THE QUEEN OF HERBS

FACILITY FOR ANTIPROTON AND ION RESEARCH (FAIR): THE UNIVERSE IN THE LAB

Editor-in-Chief:
Nakul Parashar

Editor:
Nimish Kapoor

Production:
Pradeep Kumar
Amitesh Banerjee

Expert member:
Biman Basu
Sumita Mukherjee

Address for correspondence:
Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India

Tel: +91-120-2404430, 35

Fax: +91-120-2404437

e-mail:
dream@vigyanprasar.gov.in

website:
http://www.vigyanprasar.gov.in

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Telefax: 22424396, 22526936.

Cover Design By: ANURADHA SEN

MY WORD

NAKUL PARASHAR

Independence from Corona

AS we step into the seventy-fourth year of independence, the nation with the rest of the world is racing against time to release itself from the clutches of COVID-19. Scientists, researchers, pharma companies, and many more continue to relentlessly work round-the-clock to find a vaccine against it, as a united front. As we write, there are more than one hundred and fifty-five vaccine candidates in various stages of trials. Twenty-three of these have reached the clinical (human) trials stage. Let's hope that we get some positive news very soon.

While we anxiously await positive results of Covaxin-19, the Indian attempt, several alternate medicine sources that can help boost our immunity system have come forth as well. Herbs amongst these are being propagated in a big way, especially as natural immunity boosters that keep infections at bay. Amongst these, Basil, popularly known as Tulsi, has gained immense popularity. Tulsi is found to be rich in vitamin-C and zinc. Keeping in mind that Tulsi has immense anti-bacterial, anti-viral and anti-fungal properties, the importance of Tulsi is more relevant now. If you look at the prominent symptoms of COVID-19, they are mainly respiratory-related ailments, fever, and pain in the joints. Camphene, cineole, and eugenol are found in Tulsi. This helps it to reduce cold and congestion in the chest. The presence of eugenol in Tulsi acts as an analgesic agent.

Along with Tulsi, several other locally found herbs have also gained prominence during this period as natural immunity boosters like Tinospora cordifolia or heart-leaved moonseed, dry ginger, turmeric, and many more. Our nation that way is full of such valuable herbs and information. There are several websites and sources that are full of useful information about them. CSIR's Traditional Knowledge Digital Library is one for them. Additionally, available in Hindi and English, Wealth of India is a multi-volume compendium. It is a result of many years of hard work that several scientists from NISCAIR have put into.

Well, as technology continues to gallop, we come across newer technologies almost daily. During the current pandemic, while searching for AI's application in the fight against COVID-19, I bumped into several research findings and initiatives. Amongst them, one of the most interesting was CORD-19 Search from Amazon Web Services (AWS). It is a new search website that uses machine learning to assist information seekers with tens of thousands of related research papers and documents. It uses natural language processing.

While we anxiously await the latest on vaccine-related developments, we cannot forget to remember people who have played important roles in shaping the course of Indian Science & Technology. August thus marks birthdays for two famous Bengali scientists – Acharya Prafulla Chandra Ray and the famous entomologist, Gopal Chandra Bhattacharya. As a founder of the Bengal Chemicals, PC Ray is known as the pioneer in making the nation self-reliant in the field of chemicals. GC Bhattacharya, on the other hand, spent most of his time at the Bose Institute as an entomologist and naturalist. Our obeisance to the legends.

After all, it's all about the humankind's race to gain independence from COVID-19. Yet, amidst all this, happy Independence Day to you!

Email: nakul.parashar@vigyanprasar.gov.in

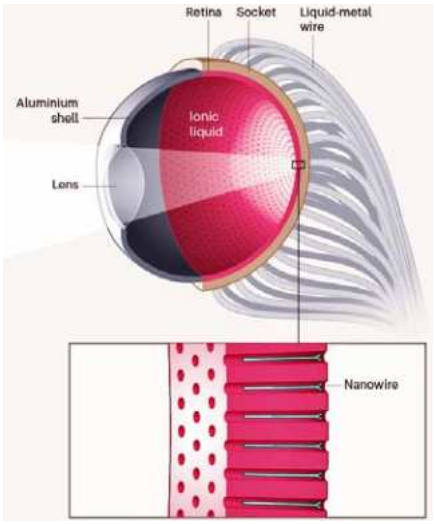
BIMAN BASU

RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

AN ARTIFICIAL EYE THAT MIMICS THE HUMAN EYE

An international team led by Fan Zhiyong and Dr. Gu Leilei and colleagues at the Hong Kong University of Science and Technology (HKUST) has recently developed the world's first 3D artificial eye with capabilities claimed to be better than existing bionic eyes, and in some cases, even exceed those of the human eyes, bringing vision to humanoid robots and new hope to patients with visual impairment.

The key component of any artificial eye is a sensor that detects light falling on it and turns it into electrical signals. Conventional image sensors used in cameras are flat, but this new device is hemispherical in shape, more like the retina of the eye. This makes the artificial eye, described as a



Artificial eye

'biomimetic electrochemical eye', more like the natural eye both in look and performance. Its core component is a high-density array of light-sensitive nanowires that serves as the retina. The nanometre-sized photo-sensors were created directly inside the pores of a hemispherical shell of aluminium oxide (Al_2O_3) by the researchers (Nature, 10 June 2020; DOI: 10.1038/s41586-020-2285-x).

Signals from the nanowire photo-sensors are carried by thin, flexible wires made of a liquid metal (gallium-indium alloy) sealed in thin soft rubber tubes to external circuitry for signal processing. These wires mimic the nerve fibres that connect the human eye to the brain. The artificial retina is held in place by a socket made from a silicone polymer, to ensure proper alignment between the wires and nanowires.

To complete the artificial eye, a lens combined with an artificial iris is placed at the front of the device, as in the human eye. The lens and iris combined with the retina at the back forms a spherical chamber (the 'eyeball'). The chamber is filled with an ionic liquid that mimics the vitreous humour – the gel that fills the space between the lens and the retina in the human eye.

A GENERATOR THAT WORKS UNDER LIGHT-AND-SHADE

We all know about photovoltaic cells used to generate electricity from sunlight. Researcher Swee Ching Tan and his team at the National University of Singapore (NUS) have now come up with a new device that exploits the contrast between bright spots and shade to create a current that can power small electronics. The greater the contrast between light and dark, the more energy such generators provide.

Tan and his team created the device, called a 'shadow-effect energy generator' (SEG), which utilises the contrast in illumination between lit and shadowed areas to generate electricity. They made the device by placing a super-thin coating of gold on silicon, which is the main material used to make solar cells. As in a solar cell, light shining on silicon energises its electrons, but with the gold layer, the excited electrons jump from the silicon to the gold. With part of the device shaded, the voltage of the illuminated metal increases relative to the dark area and electrons in the generator flow from high to low voltage. Sending the electrons through an external circuit creates a current that can power a gadget (Energy & Environmental Science, 18 February 2020 | DOI:10.1039/D0EE00825G). Using eight SEGs, the team ran an electronic watch in low light. The devices can also serve as sensors. They further explained that while commercially available solar cells can perform the role of this device in an outdoor environment, their energy harvesting efficiency drops significantly under indoor conditions where shadows are persistent.

Interestingly, say the researchers, "When the whole shadow-effect energy generator cell is under illumination or in shadow, the amount of electricity generated is low or none at all. But when a part of the SEG cell is illuminated, a significant electrical output is detected". The researchers also found that the optimum surface area for electricity generation is when half of the SEG cell is illuminated and the other half in shadow, as this gives enough area for charge generation and collection respectively.

Continued to page 18 →

Dr Harsh Vardhan releases White Paper on Focused Interventions for Make in India: Post COVID-19 by TIFAC

Dr Harsh Vardhan, Union Minister for Science & Technology, Health and Family Welfare and Earth Sciences on July 10, 2020 released a white paper on "Focused Interventions for 'Make in India': Post COVID-19" and "Active Pharmaceutical Ingredients: Status, Issues, Technology Readiness and Challenges", prepared by Technology Information, Forecasting and Assessment Council (TIFAC), at Nirman Bhawan, New Delhi.

Pointing out that "India has been largely successful in mitigating the impacts of COVID-19 so far", Dr Harsh Vardhan said, "We got the opportunity to position ourselves as a global manufacturing hub with a big push under 'Make In India' with adoption of appropriate technology and policy reforms and focused thrust in crucial sectors." The Minister said, "The current pandemic is global, but the solutions to the challenge should be local." Prof. Ashutosh Sharma, Secretary, DST, in his message, said, "The White Paper by TIFAC presents a compelling map of high priority sectors, technologies, and strategies to fuel growth in the time of COVID-19 and immediately beyond."

Indigenous Indian COVID-19 vaccines in the global race to end the pandemic

With the announcement of COVAXIN by Bharat Biotech and ZyCov-D Vaccine by Zydus Cadila the proverbial silver line in the dark clouds of COVID-19 appears at the horizon. The nod given by the Drug Controller General of India CDSCO (The Central Drugs Standard Control Organisation) for the conduct of the human trial for the vaccines marks the beginning of the end.

More than 140 candidate vaccines are under various stages of development. One of the leading candidates is AZD1222 developed by Jenner Institute of University of Oxford and licensed to AstraZeneca British-Swedish multinational pharmaceutical and biopharmaceutical company headquartered in Cambridge, England.

Parallelly, Indian institutions have also engaged in R&D for the development of vaccines in India. With the primary scientific inputs coming from ICMR's Pune-based institution National Institute of Virology and Hyderabad-based CSIR institution Centre for Cellular and Molecular Biology, six Indian companies are working on a vaccine for COVID-19.

IIT Mandi develops 98% efficient face masks from waste plastic bottles at nearly one tenth the cost

Researchers at Indian Institute of Technology (IIT) Mandi developed high-efficiency face masks out of waste plastic bottles. The PET bottles were successfully converted into a nanofibre membrane. This membrane can be layered with nylon on both sides to create the mask. Research scholars Ashish Kakoria and Sheshang Singh Chandel produced the mask under the guidance of Prof Sumit Sinha Ray. The nanofibre membrane is 250 times thinner than a human hair and can remove minute particles with 98% efficiency.

AIIMS Delhi starts tele-consultation guidance to State doctors on COVID-19 clinical management

Tele-consultation is a critical component of the clinical intervention protocol for COVID-19. To strengthen Government of India's efforts to reduce COVID mortality, a specialist team of doctors from AIIMS, New Delhi shall provide guidance on effective clinical management of COVID-19 patients in the ICUs of different State hospitals through tele/video consultation. These tele-consultation sessions for providing timely and expert guidance to the doctors in the States shall be conducted twice every week, on Tuesdays and Fridays.

For more information on S&T Efforts in India on COVID-19 please visit https://vigyanprasar.gov.in/covid19-newsletters/

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K. SRINIVASAN

HOLY BASIL:

THE QUEEN OF HERBS

The holy basil shrub (Tulsi; Ocimum sanctum) belonging to Lamiaceae family is native to South East Asia and has presumably originated in Indian subcontinent. It is revered as a sacred plant in India. Historically, it is widely used in Ayurveda and traditional folk systems of medicine in India for thousands of years. The two common varieties of Tulsi are Rama Tulsi and Krishna Tulsi. Both varieties are similar in smell and health benefits. Tulsi is incredibly beneficial for human health, primarily due to the unique composition of its essential oil, containing eugenol, camphor, flavonoids, and various terpenes.

Tulsi is undoubtedly pre-eminent among all the medicinal herbs used in Ayurveda. It is revered as an 'Elixir of life' being essential for both ritual and medicinal purposes. According to our traditional wisdom, Tulsi is a tonic for the body, mind and soul that offers solutions to all health problems resulting from our lifestyle. Daily consumption of Tulsi is said to prevent disease, promote general health, wellbeing and longevity. In traditional systems of medicine, different parts of Tulsi plant - leaves, stem, flower, seeds, and root have been recommended for the treatment of bronchitis, bronchial asthma, malaria, diarrhoea, dysentery, skin diseases, arthritis, eye diseases, fever, snake bites and scorpion stings. Different parts of the plant are recommended for treating various ailments: e.g., fresh flowers for bronchitis, leaves and seeds for malaria, whole plant for diarrhoea, nausea, and vomiting, ointment for eczema, alcoholic extract for stomach ulcers and eye diseases, and essential oil from leaves for insect bites.

Tulsi is rich in antioxidant compounds and micronutrients, which help the immune system from damage by virulent free radicals. The herb is known to cure fever and help treat respiratory congestive diseases.

Tulsi for keeping COVID-19 at bay

The strong disinfectant and germicidal potential empowers Tulsi as a great herb for boosting our immunity. 'Kadha' is a concoction made from Tulsi along with black pepper and ginger and is used as a popular home remedy for boosting immunity. Thus, Tulsi may help build the body's immunity against the coronavirus as well as other pathogens. Tulsi is rich in antioxidant compounds and micronutrients, which help the immune system from damage by virulent free radicals. The herb is known to cure fever and help treat respiratory congestive diseases. Tulsi's broad-spectrum antimicrobial activity (against bacteria, fungi, and virus) and being antagonistic to a range of pathogens suggests its usefulness as a natural hand sanitizer, water purifier, and preservative for food stuffs. Chewing of fresh Tulsi leaves daily would serve as a natural detoxicant for oral hygiene and as a mouth freshener.

Multiple health benefits of holy basil

- ***Acts as a potent adaptogen to relieve stress***

Daily consumption of Tulsi leaves assists in coping with all types of stress in daily life. Tulsi, as a potent adaptogen, promotes resilience and relieves anxiety. It is scientifically validated that Tulsi helps in adaptation to all types of stress – chemical, physical, infectious, and emotional. The benefits of Tulsi on chemical stress are attributable to its ability to detoxify and protect the body from toxins/pollutants-induced damage, owing to its high content of phenolic compounds which are endowed with antioxidant properties. Stress during prolonged physical exertion, exposure to cold and noise pollution causes metabolic stress and disturbs the homeostasis. Intake of adaptogenic herbs like Tulsi protects further damage from such a metabolic disturbance through enhancing various cellular and physiological adaptive functions.

Tulsi has anti-depressant and anti-anxiety properties comparable to Diazepam and antidepressant drugs. A study has revealed that people who took 500 mg of holy basil extract per day felt less anxious, stressed, and depressed. Antioxidant compounds present in Tulsi, apart from repairing damages done by free-radicals, also minimise the stress caused by these oxidants. A study suggested that Tulsi reduces stress while it soothes the nerves, lowers blood pressure, and reduces inflammation. Potassium present in Tulsi at significant concentrations reduces blood pressure-related stress by replacing sodium and dilating the blood vessels. The phytochemical compounds present in Tulsi that help achieve these results are ocimumosides-A and -B, which have been identified as anti-stress compounds and may lower concentration of the stress hormone corticosterone in blood and create positive alterations in the neurotransmitter system of the brain. Another phytochemical present in this herb, namely, 4-allyl-1-O-β-D-glucopyronosyl-2-hydroxybenzene is also believed to lower stress parameters in animal studies.

- ***Natural immunity booster — Vitalizes our body***

Tulsi has significant anti-bacterial, anti-fungal and anti-viral properties which protect us from a variety of infections. Tulsi leaves extract increases the T-helper cells and natural killer cells activity, contributing to the boosting of our immune system. Tulsi, being rich in antioxidants, such as Vitamin C and β-carotene, and other phytonutrients viz., zinc can protect


Krishna Tulsi

our body against infections. These components of Tulsi protect the body from damages caused by free-radicals which are produced during cellular metabolism and are responsible for all degenerative diseases, including cancer. In the traditional Ayurvedic system, Tulsi is considered as a tonic to retain youthful vigour and prevent premature aging.

Protects against infection and treats wounds

Tulsi leaf extract helps in wound healing and acts as an anti-inflammatory and analgesic. Tulsi also functions as an antibacterial, antifungal and antiviral agent, hence active against many pathogens responsible for human infections. By enhancing immune responses, Tulsi would boost defense against infective threats. Studies have indicated that Tulsi would slow down the growth of HIV cells and also inhibit the development of certain cancer cells. Tulsi may help in the treatment of bacterial infections, such as urinary tract infections, cholera, measles, mumps, tuberculosis, gonorrhea, herpes, pneumonia, and fungal infections, as well as mosquito-borne diseases such as dengue, malaria and filariasis. Tulsi's effectiveness against water-borne and food-borne pathogens makes it suitable for the preservation of food as well as for water purification and as a hand sanitizer. Tulsi's antibacterial antioxidant, anti-inflammatory and analgesic activities make it useful in wound healing. It is particularly used after surgery to heal and protect the wounds. Research has validated that Tulsi may work against infections and wounds such as mouth ulcers.

Reduces fever

The undisputable therapeutic properties of Tulsi come from its essential oil containing bioactive compounds and the phytonutrients. Tulsi is an excellent antibiotic, germicidal, fungicidal, and disinfectant, and as such very effectively protects our body from bacterial, fungal and viral infections. Fever is caused due to infections from protozoa (malaria), bacteria (typhoid), viruses (flu), and even fungus. Tulsi has anti-bacterial and anti-viral properties which help to fight infections, thus reducing fever. It is a traditional practice in India to consume a decoction of Tulsi leaves and flowers during fever.

Protects the stomach

Tulsi counteracts the stress-induced ulcers. It naturally increases the stomach's defense by decreasing stomach acid, increasing mucus secretion, and prolonging the life of mucus cells. Tulsi accelerates wound healing in laboratory animals, particularly the ulcer in different ulceration models in animals. Tulsi may be a preferred alternative to many drugs used for peptic ulcers and having side effects. An animal study has shown that 200 mg of Tulsi extract reduces both the number and index of peptic ulcers significantly.

A study suggested that Tulsi reduces stress while it soothes the nerves, lowers blood pressure, reduces inflammation. Potassium present in Tulsi at significant concentrations reduces blood pressure-related stress by replacing sodium and dilating the blood vessels.

Rama Tulsi

Relieves symptoms of respiratory disorders

Tulsi, which contains several antioxidant phytochemicals, is not only effective in curing viral, bacterial and fungal infections of the respiratory system but also gives significant relief from congestion and other symptoms of respiratory disorders by virtue of the presence of components like camphene, eugenol, and cineole in its leaves/essential oil. Thus, it is an excellent treatment for curing almost all respiratory disorders including chronic and acute bronchitis. Tulsi is also beneficial in the treatment of asthmatic condition since it relieves congestion and facilitates smoother breathing. Scientific studies have also confirmed that holy basil possesses impressive anti-asthmatic abilities and would make breathing easier in such conditions.

Lowers the risk of diabetes

Tulsi plant can help reduce the blood sugar in pre-diabetics and can help prevent symptoms of pre-diabetes such as weight gain, hyperinsulinemia, high cholesterol, insulin resistance, and hypertension. Tulsi is understood to have the ability to control blood glucose as demonstrated by animal studies as well as human trials. Tulsi leaves administered to non-insulin-dependent diabetic patients exerted significant decrease in fasting blood glucose levels, postprandial blood sugar levels, urinary excretion of sugar as well as blood cholesterol level.

Lowers body cholesterol and prevents heart diseases

Tulsi can also help with weight loss and blood cholesterol levels. Animal studies have endorsed significant lowering of LDL-associated cholesterol and enhancing HDL-associated cholesterol. The essential oil of Tulsi is shown to lower stress-induced cholesterol accumulation in the kidney, liver, and heart in rats treated with Tulsi leaf powder. Tulsi contains vitamin C and other antioxidants such as eugenol, which protect the heart from the harmful effects of free-radicals. Additionally, the blood cholesterol

lowering property also contributes to the cardio protective potential of Tulsi.

● *Helps fight cancer*

Tulsi may inhibit the development of various cancers including oral cancer due to the presence of antioxidant phytochemicals like eugenol. Scientific research has revealed that people who regularly consume Tulsi leaves are less likely to be immune-compromised and less susceptible to developing cancer. Tulsi and its phytochemicals such as eugenol, rosmarinic acid, apigenin, myretenal, luteolin, β-sitosterol, and carnosic acid are likely to help prevent chemical-induced lung, liver, oral and skin cancers because they suppress oxidant stress in the body organs, induce cancer cell death (apoptosis), prevent blood vessel growth contributing to cancer cell growth and prevent metastasis (spread of cancer cells).

● *Provides skin care and fights acne*

Tulsi helps kill bacteria and remove infections, hence a great natural cure for skin disorders such as acne and other skin irritations. This property mainly comes from its essential oils, which are highly antibiotic, disinfectant, antibacterial, and antifungal. Among the therapeutic components including eugenol, camphene, γ-caryophyllene and methyl eugenol, the primary active compound of Tulsi oil is eugenol which is widely believed to help combat many skin disorders. When applied in coconut oil, Tulsi is absorbed better and hence more effective. Camphene in it gives a soothing and cooling effect. Rubbing Tulsi leaves or its oil on the body keeps mosquitoes and other insects away.

● *Provides eye care*

Our eyes are susceptible to viral, bacterial and fungal infections that would cause conjunctivitis, boils, and other problems of the eyes. Washing the eyes daily with Tulsi leaves-soaked water is prescribed in Ayurveda to fight against conjunctivitis - also commonly known as pink eye - due to its anti-inflammatory and soothing properties. Tulsi may also help prevent a range of eye issues such as cataracts, macular degeneration, glaucoma, vision defects, and ophthalmia. Topical administration of an herbal eye drop mixture containing turmeric and Tulsi extracts helps to counter the oxidative stress due to the high antioxidant content of its essential oils and insoluble protein formation in the eye lens that lead to lenticular opacity.

● *Other benefits*

Tulsi can also protect the body from radiation-induced damages. It protects the normal tissues against the destructive effects of radiation; hence it can be used after surgery to help heal wounds quickly and protect from infections. As an expectorant it is effective in curing cough and cold. Tulsi is an excellent remedy for cough; it soothes the throat, effectively reduces chest inflammation and facilitates to expectorate the mucus and thus decongest the respiratory tract. Its dried leaves can be mixed with food grains to be used as an insect repellent.

NUTRITIVE VALUE OF FRESH

TULSI

LEAVES (PER 100 G)

Major nutrient	Nutrient value	Phytonutrient	Nutritive value
Energy	23 KCal	B-Carotene	3.142 mg
Protein	3.15 g	Lutein-zeaxanthin	5.65 mg
Carbohydrate	2.65 g	Cryptoxanthin-B	46 µg
Total fat	0.64 g		
Dietary fibre	1.60 g		
Vitamin	**Nutrient value**	**Mineral**	**Nutrient value**
Vitamin C	18.0 mg	Calcium	177 mg
Niacin	902 µg	Copper	385 mg
Pantothenic acid	209 µg	Magnesium	64 mg
Vitamin B6	155 µg	Manganese	1.15 mg
Riboflavin	76 µg	Iron	3.17 mg
Thiamin	34 µg	Zinc	0.81 mg
Vitamin E	800 µg	Potassium	295 mg
Vitamin K	415 µg	Sodium	4.0 mg

(Source: USDA National Nutrient database)

Ways of consuming Tulsi herb

Tulsi leaves have a sweet, aromatic smell and a minty taste. Fresh leaves are less commonly used in cooking, but are used in garnishing sauces and soups. They are also commonly used to make flavoured juices and Tulsi tea. People preferably eat fresh Tulsi leaves raw to fight off cough or cold. One can also make Tulsi tea from the leaves, flowers, or dried leaf powder. Freshly brewed tea can be made by steeping Tulsi leaves in boiling water for a few minutes. Tulsi is also available in supplement form, usually in capsules. Tulsi is also used in the form of its essential oil. Essential oil of Tulsi is distilled from leaves and flowers of the plant. The essential oil extracted from Tulsi plant is used in lotions, soap, perfume, shampoo and conditioner

Nutritional value of Tulsi leaves

Tulsi leaves are a good source of potassium, calcium, magnesium, phosphorus, vitamin C, β-carotene, and vitamin K, besides providing sodium, iron, zinc, thiamin, riboflavin, niacin, folate, and vitamin B6.

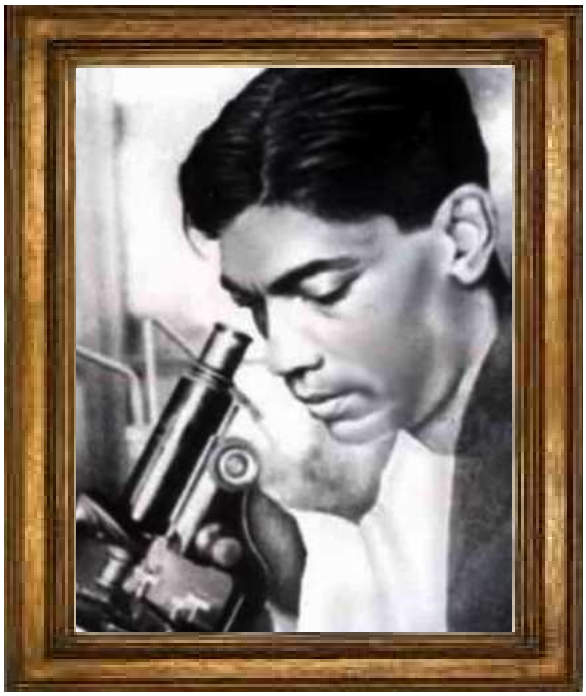
Dr K. Srinivasan retired as Chief Scientist at CSIR-Central Food Technological Research Institute, Mysore; he has been active in science popularisation through articles related to food, nutrition, and health. **E-mail:** ksri.cftri@gmail.com

SHIBJYOTI SENGUPTA

Gopal Chandra Bhattacharya: An Inspiration for Budding Scientists

Gopal Chandra Bhattacharya is considered one of the most eminent entomologists and nature scientists though he had no formal higher education. Sir Jagadish Chandra Bose was his mentor. He was a prolific popular science writer too. Bhattacharya was one of the founding members of Bangiya Bijnan Parishad. On his 125th birth anniversary, which falls on 1 August 2020, we pay our homage to this silent priest of science.

Born in Lonesing, a small village in Faridpur district of erstwhile East Bengal (under British rule), now Bangladesh, on 1 August 1895, Gopal Chandra Bhattacharya went on to become one of the pre-eminent entomologists and nature scientists without any formal higher education. He was from a poor family. His father Ambika Charan Bhattacharya was a priest by profession. Signs of poverty and hardship were evident everywhere. His turbulent childhood compounded further when he lost his father at the age of five. But his mother, Shashimukhi, with four sons to raise, faced the challenge with courage. Contrary to the social practices of rural Bengal back then, she politely refused her brother's offer to move into his house with her children. Resoluteness and wisdom were her strengths, which probably a young Gopal imbibed. At ten, he joined his father's profession to support the family.



Young Gopal Chandra

From childhood, he had a keen interest in nature. After discharging everyday's priesthood duties and attending school, young Gopal used to spend his spare time to observe plants, fishes and insects in awe. Abundance of flora and fauna of rural Bengal provided the perfect environment to breed curiosity into him to know about those fellow inhabitants. He was innovative and ingenious from childhood. In one summer, fishes were struggling to survive in a virtually dry small pond. He constructed a long pipe by joining the chopped off branches of a papaya tree and siphoned water from another pond to save the fishes.

His life at Lonesing revolved around three activities—priesthood, academics and nature observation—till he matriculated in 1913. He was a gold medallist and a topper in Faridpur district. With the financial support of well-wishers, he was admitted to Ananda Mohan College in Mymensingh, now in Bangladesh. His college education was also supported by his well-wishers. But after studying there for a year, he had to leave the college and his formal education came to an end because of the First World War. Due to the War, the cost of living shot up and his well-wishers could not support him anymore. Struggle and deprivation seemed his constant companion since childhood. After a brief stint as a teacher in Panditsar High School, he came back to his village and joined Lonesing High School as a geography teacher.

Gopal Chandra's formal education had ended, but his informal education began. He got the opportunity to nourish and nurture his childhood curiosity about our cohabitants. In his spare time, he used to venture out in the village to observe nature. One such venture led him to discover bioluminescence, which eventually caught the attention of Sir Jagadish Chandra Bose. That incident altered the course of his life. In 1921, upon seeing his article on bioluminescence in a magazine, Sir Jagadish Chandra invited him to join 'Bosu Bigyan Mandir,' (now the famous Bose Institute) as a research assistant. He accepted the position. Meanwhile, he got married and worked briefly as a telephone operator in Calcutta (now Kolkata).

Joining Sir Jagadish Chandra Bose was akin to a dream come true for him; Bose was a true mentor to him. Indeed, what Sir Humphrey Davy was to Michael Faraday, Sir Jagadish Chandra Bose was to Gopal Chandra Bhattacharya. Both Faraday and Bhattacharya lacked formal education and were from poor families but blessed with natural scientific talent. Both faced humiliation at different stages of life by the establishment. Though at times they were morally down, these obstacles didn't deter them from pursuing science. Gopal Chandra used to say that in order to be a scientist, one has to 'stay hungry and stay foolish'.

At the Bose Institute, he started his research in botany. Gradually, he shifted his interest to entomology. He was known for his pioneering works on social insects' ethology (the scientific and objective study of animal behaviour).

Prior to him, hardly any research on ethology of social insects was carried out in India. Most of the scientific research works—prior to or contemporary of Gopal Chandra—were done on agricultural entomology, mainly management of desert locust and pest control.

Gopal Chandra's research concentrated on ethology of ants, spiders, butterflies, earwigs, frogs and many other creatures and insects. In total, he published 22 research papers in English, in Bose Institute's journal, Transactions, and many other peer-reviewed journals, including the globally revered Natural History magazine, Scientific Monthly, Journal of the Bombay Natural History Society and Bulletin of the American Museum of Natural History. Apart from these research papers, he wrote more than 800 scholarly articles in Bangla.

He was a prolific popular science writer too. He was one of the founding members of Bangiya Bijnan Parishad, established by Satyendra Nath Bose (after whom 'Boson' is named) in 1948. Because of his literary skill, he remained the editor of monthly science magazine Gyan O Bigyan (translates to 'knowledge and science'), till 1977, published by the Parishad. Being an editor is probably an understatement of his immense contribution to this magazine as well as popularisation of science, because in the history of Bangla science magazines, Gyan O Bigyan is the longest surviving one and is still published by the Parishad.

His fluent, lucid and compelling articles made science attractive and popular to young minds. Although all of his literary works are substantial, two books stand out: Banglar Keet Patanga (Insects of Bengal) for which he had received 'Rabindra Puraskar', the highest literary award in Bengal and Kore Dakho (Do it Yourself), to provide hands-on training in science fundamentals.

It is not possible to illustrate the magnitude of Gopal Chandra's work in a single article. So, we will focus only on his work surrounding three creatures: the ant, the tadpole and the earwig. According to the late scientist, Ratan Lal Brahmachari, these three researches are of world standard, but his works were never acclaimed or recognised internationally.

Ants

Gopal Chandra's work on reproduction and caste differentiation in the Nalso ant (Nalso pinpre in Bangla, scientific name Oecophylla smaragdina) was truly ahead of time. These arboreal ants are also known as weaver ants, as they weave leaves by the silk produced by larvae to make nest.

Nalso ants or weaver ants (Oecophyllyasmaragdina) working together to build a nest by stitching together leaves.

At the Bose Institute, he fabricated an artificial formicarium (ant farm) with cellophane and kept ants to study them. He emulated a natural environment inside the cellophane ant farm. This itself was an innovation because nowadays various types of patented 'formicarium' are available to study ants.

Most animal species can be divided into two forms: males and females; but ants can be classified into three forms – males, females and 'female workers'. Generally, female worker ants cannot reproduce, but female ants can reproduce. This is because female ants, called queen ants, can copulate, which workers cannot. Fertilised eggs of queen ants give birth to female worker ants and unfertilised eggs give birth to males. Existence of male and female ants can be explained by genetics, but how could one explain the existence of worker ants? It was a big question in genetics then.

Between 1939 and 1942, Gopal Chandra found that sometimes workers are capable of reproduction. It is natural that unfertilised eggs will produce males only, but he found that apart from male ants, substantial numbers of worker ants as well as a few queens were born from unfertilised eggs laid by worker ants. Queens were born only in summer – when the ants had access to newly sprouting twigs and certain trees infested with aphids and coccids. Workers fed the larvae with sap sucked up from aphids, and apparently a larger quantity of this special food led to queen formation. On further research, he discovered that controlled protein-rich food led to workers only, whereas special foods helped to produce queen, of course only in summer. A biological system of sex determination as observed in the ants where unfertilised haploid eggs develop into males and fertilised eggs into females is called haplodiploidy. In 1949-50, scientist A. Ledoux reported formation of worker ants and queen ants from eggs laid by free ranging African weaver ant Oecophylla longinoda—similar to the observations of Gopal Chandra but with a different species.

It is surprising that Ledoux's contribution was recognised internationally and has found place in the history of ant ethology, but there is no mention of Gopal Chandra, even though he had discovered the phenomenon around ten years before Ledoux.

As mentioned earlier, the First World War had robbed Gopal Chandra of formal education. The Second World War robbed him of international recognition as he could not publish his papers in international journals, particularly in Germany.

Earwigs:

Earwigs are odd-looking insects in the insect order of Dermapetra: Male

Earwings

earwigs have curved pincers at the end of their abdomens and females have straight pincers. They are not poisonous and they do not spread disease. These insects are known as unsocial insects, but contrary to intuition, the mother does take care of her eggs. It was reported in research abroad that the mother protects the egg clutch from mites, fungi and other intruders by continuously cleaning and relocating them if necessary. But Gopal Chandra reported another aspect of motherhood when he noticed that they plaster mud in their hind legs and use the dried mud like a heavy military boot to kick away any intruders. He sprayed water to wash out the mud but noticed that she again plastered her legs with mud. This observation signifies the intellect of earwigs to make and use tools. This discovery was also never given any mention in the international forum.

Tadpole metamorphosis:

Gopal Chandra found that controlled application of Penicillin on tadpoles delayed or completely stopped their metamorphosis into frogs. Subsequently, he cultured the intestinal flora of treated and untreated sets of tadpoles with Penicillin and found there are no bacteria present in the intestine of Penicillin-administered tadpoles, but presence of bacteria was noticed in the tadpoles which were not administered with Penicillin – these bacteria produce vitamin B_{12}. He then gave vitamin B_{12} to eight-month-old Penicillin-administered tadpoles and noticed reoccurrence of metamorphosis. So, the role of vitamin B_{12} was somehow defined as a possible factor in the metamorphosis of tadpoles. But, in the process of metamorphosis the role of hormones was well defined. So, the question arose: what is the relation among the hormone, the vitamin and the bacteria? What controls the secretion of hormones? In a separate research on frog Gopal Chandra found that a special species of tadpole of Rana tigrina eats larvae of mosquito, which indicated that farming of Rana tigrina could be useful to control mosquito-related hazards.

Gopal Chandra experimented with the effect of Penicillin on tadpole metamorphosis.

Banglar Keet Patanga, one of his most popular books on insects of Bengal.

Gopal Chandra in old age

Gopal Chandra's researches opened the doors to the potential for deeper and wider exploration — for example, ecological services of the insects or simply biodiversity. Nowadays, world-wide researchers are raving about the use of the Nalso ant (Oecophylla smaragdina) for biological pest control which may substantially reduce the hazards of chemical pest control.

During the International Congress of Entomology (Amsterdam, August 1951), the 'International Union for the Study of Social Insects' was formed, and Gopal Chandra was offered to lead the Indian chapter from 'Faculte des Sciences de Paris'. But records of any follow-up action aren't available.

In recognition of his contribution to science, Calcutta University conferred upon him an honorary D.Sc. in 1981. In 2005 the West Bengal Government instituted an award in his name to popularise and promote science in Bengali.

Gopal Chandra Bhattacharya was a great scientist and had the potential to earn international fame. But inadequate opportunities, and to some extent, the neglect and indifferent attitude of the establishment denied him the opportunity to do justice to the talent that he was blessed with. Nonetheless, whatever he had achieved stands as an inspiration to the budding scientists of today, particularly from the weaker sections of the society. His roots were soft but firmly planted. And one should not forget the role of Sir Jagadish Chandra Bose in making of Gopal Chandra Bhattacharya.

On his 125th birth anniversary, which falls on 1 August 2020, let us pay homage to this silent priest of science by honouring his famous motto: "Stay hungry and stay foolish".

ACKNOWLEDGMENT:

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2. Late Prof. Ratanlal Brahmachary

The author is science activist and treasurer of Gopal Chandra Bhattacharjee Bigyan Prasar Samiti, Kolkata. **Email:** sen_gupta@hotmail.com

POULOMI DAS, SAYANTAN JASH, DIPANJAN GHOSH

Spurious Spices – Adding What to our Cuisine!

Indian spices are world-famous for the flavour and taste they impart to the food. Indian foods are largely appreciated for their spicy flavour and taste. The presence of spice in our food functions on multiple levels: to keep the food free from germs, to trigger the enzyme activity, to function as an appetiser and to preserve the food naturally.

Recently, in the wake of the COVID-19 outbreak, our spices have come into focus for their several properties. While there is no medicine or even vaccine for COVID-19 as of now, preventive measures which boost our body's natural defence system will be needed. Enhancing individual immunity with the help of Ayurveda, our age old plant-based methods of treatment, play an important role in maintaining optimum health. In many ancient Ayurvedic scriptures, certain Indian spices have been suggested as preventive measures against viral infections. After thorough investigation, supported by Ayurvedic literature, scientific publications and clinical trials, the Ministry of Ayush, Government of India has recommended use of spices like haldi, dhania, jeera, and lashun (Garlic) in cooking during this pandemic crisis.

But of late, excessive use of pesticides and chemicals on crops and vegetables has degraded their nutrional values. Spices are often adulterated with sawdust, marble dust, chalk powder, chemical dyes, industrial starch, common salt, etc. Unfortunately, we can do little to prevent it, but there are simple methods to test if a spice is adulterated.

(Photo: Souvick Mukherjee)

Turmeric

Turmeric (haldi) is a common and essential ingredient of Indian cuisine. It is obtained from the dried rhizome of the turmeric plant (Curcuma longa) of the family Zingiberaceae. Its natural aroma is most appetising. Curcumin, the common colouring substance present in it, is also used as a textile dye and often in cosmetics.

Turmeric has medicinal importance too. It contains Curcuminoids, a group of phenolic compounds that are frequently used to make medicines employed against a large array of diseases from skin disorders to menstrual problems. Antioxidant and anticarcinogenic potentiality of turmeric is now clinically established. Its inhibitory action on growth of bacteria and fungi is also proven. In recent studies, its potentiality to reduce cholesterol level and effectiveness against Alzheimer's disease has also been proved.

Mixing adulterants with powdered turmeric is quite easy. In many cases, powders of dried tubers of other related species of Curcuma like C. zedoaria, C. xanthorrhoea, C. malabarica, C. aromatica, etc., are mixed with powder of Curcuma longa as adulterants. These organic adulterants have nearly identical yellow colour but inferior-quality curcumin content. Sometimes, salts of metals like lead, arsenic and tin, which are highly toxic, are mixed with turmeric.

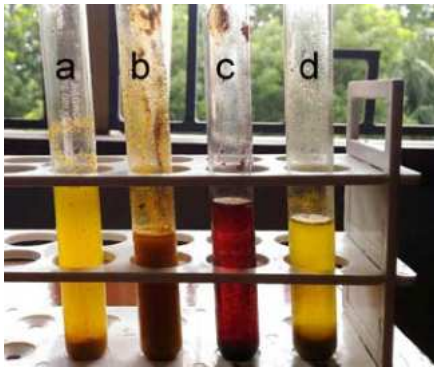
Chemicals like aniline dye, metanil yellow and lead chromate are the most commonly used adulterants in turmeric powder for their bright yellow appearance. Lead chromate is a strong oxidising agent giving out toxic fumes of chromium when heated. It is highly dangerous for lungs and gastrointestinal tract and is known to cause cancer. Industrial aniline dye is also toxic and can cause DNA damages and ultimately cancer.

Fortunately, there are some homely as well as laboratory-based methods to check the purity of turmeric powder.

DETECTION OF ADULTERANTS IN TURMERIC POWDER

Take a pinch of turmeric powder in a test tube or in a glass. Mix it with a small amount of water followed by a few drops of hydrochloric acid. If the solution gives off bubbles, then it indicates presence of chalk powder as an adulterant.

Take a little turmeric powder in a glass and then add a little amount of water and concentrated hydrochloric acid. Shake the mixture vigorously. A violet or pinkish colour will appear instantly which will disappear if diluted with distilled water if the turmeric is pure. If the powder is adulterated with metanil yellow, then the colour will persist.



Biochemical tests of turmeric showing a Chalk powder adulteration positive, b & c Metanil yellow adulteration positive and d. Lead chromate adulteration negative results (Photo: Poulomi Das)

Mix a teaspoon of turmeric powder with some water. Then add a few drops of spirit (ethanol) to it. If aniline dyes are present as adulterant, the yellowish colour of the solution will disappear immediately.

There is a simpler way to check adulteration in turmeric powder. Take some amount of warm water in a glass and add to it a teaspoon of turmeric powder without stirring and leave the set-up for about 20 minutes. If the water becomes cloudy, it indicates possible adulteration. But if the powder settles down at the bottom leaving clear water above, it should be inferred that the turmeric powder is pure.

Red chilli

Red chilli (lal mirchi) is another inseparable spice of Indian cuisine. It is the dried and pulverised fruit of some varieties of chilli peppers (Capsicum annuum) of the family Solanaceae. Chillies add pungency (actually a sensation, not a taste), colour and flavour to many dishes. Capsaicin, an active chemical compound obtained from red chillies, has a drastic skin and eye tormenting ability.

Red chilli is a good source of vitamins A and C. From ancient times, it has been used for various therapeutic purposes. Recent research has revealed that chilli has some antifungal and antimicrobial activities. Chillies provide topical pain relief for muscle soreness, skin irritations, and rheumatism. It is used internally for cold stage of fevers, asthma, and stomach upset. It also acts as an antioxidant to strengthen the immune system and heal injuries and infections. The capsaicin compound found in chilli powder increases fat burning skills of our body and even can reduces the risk of skin and stomach cancer. Chilli powder acts as an anti-inflammatory agent and helps reduce swelling of sore joints and increases blood flow.

But how safe is the red chilli powder we buy from the market? Sometimes powders of seeds from Capsicum frutescens and Piper nigrum are used as organic adulterants. Crushed wood or husk is also used to increase the weight of packaged chilli powder.

But powdered brick is the most common adulterant for red chilli powder because of its similar texture and colour. Often artificial colours like red lead salt and Rhodamine B are added to give it a bright hue. Besides these, common salt, starch and even soap stone powder are also used for adulteration. Presence of powdered brick in chilli powder may cause stomach disorders. Among artificial colours, red lead salt causes metal toxicity like lead poisoning, and Rhodamine B can cause cancer. There are some simple ways to check whether the packaged red chilli powder is adulterated or not.

(Photo: Souvick Mukherjee)

DETECTION OF ADULTERANTS IN RED CHILLI POWDER

Pour a teaspoon of chilli powder in a glass of water. After stirring, if it becomes reddish brown then it indicates presence of brick powder, which settles down after few minutes at the bottom of the glass.

To detect the presence of starch in chilli powder, add a few drops of iodine solution to an aqueous mixture of chilli powder. If it shows a bluish colour change, it confirms the presence of starch as an adulterant.

Take a glass of water and sprinkle a pinch of red chilli powder on the water. If some coloured streaks are noticed, then it indicates presence of artificial colours as adulterants.

Take a small amount of chilli powder in a test tube and add dilute nitric acid to it. Filter the solution and add two drops of potassium iodide to the filtrate. If a yellow-coloured precipitate is formed, then it indicates the presence of lead salts.

To detect Rhodamine B as a chemical adulterant, take some chilli powder in a test tube and add almost double amount of acetone. If the solution shows red colouration immediately, then it indicates the presence of Rhodamine B.

But the simplest way to detect adulteration is to add a teaspoon of chilli powder to a glass of plain water. If the water changes its colour or any gritty matter settles at the bottom or the water becomes cloudy, then it indicates adulteration. Pure red chilli powder does not really dissolve in water, so the water should remain clear.

Coriander

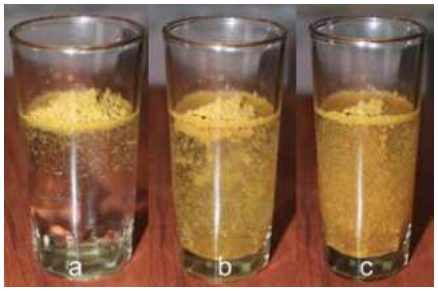
As a basic spice, coriander (Coriandrum sativum) of the family Apiaceae is very popular in our kitchen. Coriander (dhania) is commonly available both as whole dried seeds and in ground form. The seeds have a lemony citrus flavour when crushed, due to presence of different polyphenols and terpenes.

Although vitamin content in coriander seeds is generally low, they provide significant amounts of dietary fibre and minerals such as calcium, selenium, iron, magnesium and manganese. Due to the presence of rich amounts of antioxidants and other plant-based chemical compounds, coriander is used as a disease preventing and health promoting agent. The antioxidants in coriander seeds promote heart health by lowering bad cholesterol levels and increasing good cholesterol. They also widen blood vessels to reduce blood

(Photo: Souvick Mukherjee)

pressure. Coriander is used for digestion problems including stomach upset, loss of appetite, nausea, diarrhoea, bowel spasms and flatulence. It is also used to treat haemorrhoids, worms, toothaches, measles and arthritis pain. Studies show that linalool, a major compound in coriander seeds, can reduce anxiety in humans. It can also treat infections caused by bacteria and fungus. Its use to prevent food poisoning has also been reported. Coriander seeds contain phthalides which increase the levels of anticancer protective enzymes.

Sometimes damaged seeds and other seeds looking like coriander are added with coriander seeds. They may be less nutritious and may even be health hazards. In powdered form, coriander is adulterated by dirt, sawdust, and even dried cattle dung. These adulterants can cause stomach disorders and intestinal and liver problems. Sometimes common salt is added to coriander powder to increases its weight. Artificial colours and chemicals are also used to enhance the colour of the powder. These chemicals have strongly negative impact on our health and cause various diseases like heavy metal poisoning and even cancer. Like other spices, here also there are some simple ways to detect adulterants in coriander.



(Photo: Debasish Oraon)

Detection of adulterants in coriander

Addition of any damaged or other seeds to coriander seeds can be identified after examining through naked eye.

Pour some amount of coriander powder in a glass of water. Dung, dirt or sawdust-like adulterants will float and can be easily detected.

To detect artificial colours, sprinkle a pinch of coriander powder on the surface of water in a glass. If coloured streaks are produced, then it indicates the presence of artificial colours and chemicals.

For specific chemical tests, add a few drops of concentrated hydrochloric acid to a small amount of coriander powder. If magenta colour is produced, then it indicates presence of oxides of lead.

Add a small amount of coriander powder to a glass of water. If it makes the solution cloudy or there are floating particles on surface of water, then it confirms adulteration. Pure coriander powder never mixes with water but settles at the bottom of water separately.

(Photo: Souvick Mukherjee)

Cumin

Cumin (jeera) is a very healthy as well as important spice, which is actually the seed of cumin (Cuminum cyminum) plant of the family Apiaceae. Cumin has its distinctive flavour, which has been described as earthy, nutty, spicy and warm.

Modern studies have confirmed some of health benefits from cumin seeds. It is a very good source of iron, manganese, zinc, copper, magnesium, calcium, potassium and phosphorus. Many vitamins including vitamin A, C, E, K, Thiamine, Riboflavin, Niacin, and Pyridoxine are present in cumin seeds. It contains very low amounts saturated fats, sodium and cholesterol.

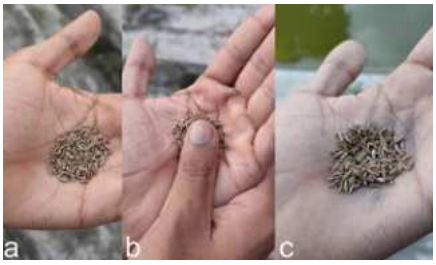
The most common traditional use of cumin is for indigestion and reducing food-borne infections. Cumin has various medicinal properties. In recent research, some new benefits, such as promoting weight loss and improving blood sugar and cholesterol control have also been revealed. Cumin also helps in protecting skin against fungal and microbial infections due to its disinfectant and antifungal properties. Cumin seeds are used to produce medicines that help in treating problems like common cold, diarrhoea, colic, inflammation of the bowels and muscle spasms. Also, its anti-carcinogenic properties have been recently reported.

Cumin seeds are usually adulterated with grass seeds covered with charcoal dust. In addition, wood and sawdust are also added to increase the weight. Artificial colours and chemicals are also used to increase the hue of the cumin powder.

Detection of adulterants in cumin

First, rub the cumin seeds vigorously with your palms. If your palms turn black, it indicates adulteration with grass seeds coloured by charcoal dust.

To detect other adulterants, add a teaspoon of cumin powder to a glass of water and let it stay still for a few minutes. If it adulterated, adulterants will float on the water surface. Pure cumin powder never blends with water but settles at the bottom of the glass.



(Photo: Debasish Oraon)

Last words

Modern life lacks many things, especially time! That's why most of us prefer to avoid grinding the spices at home where we need them daily in cooking. So, most of the companies market them in pouches in the form of both powder and paste. We need to remain alert to avoid the perils of consuming these impurities that may put our life at stake.

About the Authors

Poulomi Das is a popular science writer, presently pursuing MSc in Dietetics and Nutrition from NSHM Knowledge Campus, Kolkata. **Email:** poulomi2016das@gmail.com; Sayantan Jash is a popular science writer and radio-talker, presently pursuing MSc in Botany from The University of Burdwan, Bardhaman, West Bengal. **Email:** sayantan.jash98@gmail.com; Dr. Dipanjan Ghosh is a well-known science writer, science communicator and one of the Editors of the journal Indian Science Cruiser published from Kolkata. **Email:** dpanjanghosh@gmail.com

JYOTI SHARMA AND SANJEEV KUMAR VARSHNEY

Facility for Antiproton and Ion Research (FAIR): The Universe in the Lab

The Facility for Antiproton and Ion Research (FAIR) is one of the world's biggest under-construction particle accelerator facility at GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany, for international cutting-edge research with antiprotons and ions to perform research in the fields of nuclear, hadron and particle physics, atomic and anti-matter physics, high-density plasma physics, and applications in condensed matter physics, biology and the bio-medical sciences. It will be one of the largest and most complex accelerator facilities in the world that will have the unique ability to provide particle beams of all the chemical elements (or their ions) as well as antiprotons.

Being built on a site of approximately 150,000 m2, 25 unique buildings with an underground accelerator tunnel of 1,100-metre circumference, the facility will also have additional experimental rings and stations with several kilometres of beamlines in total. The construction work began in the summer of 2017.

Components of FAIR

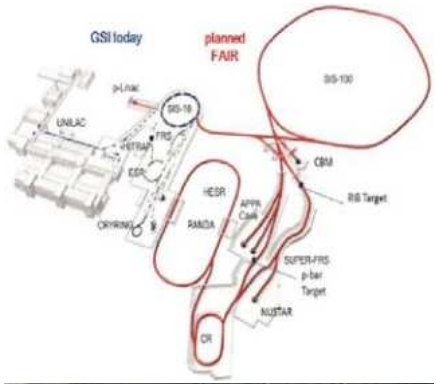
There are four experimental pillars in FAIR experiments at Darmstadt: Nuclear Structure, Astrophysics and Reactions (NUSTAR), Compressed Baryonic Matter (CBM), Particle Magic with Antimatter (PANDA), and Atomic, Plasma Physics and Applications (APPA) offering various unprecedented forefront research in hadron, nuclear, atomic and plasma physics and applied sciences. Over 2,500 scientists and engineers are involved in the design and preparation of the FAIR experiments.

GSI — The first stage of acceleration

The existing GSI accelerators will serve as the first acceleration stage. The linear accelerator UNILAC, which is 120 metres long, accelerates particles to speeds as high as 20% of the speed of light. The SIS18 ring accelerator, which has a circumference of 216 metres, accelerates particles to speeds as high as 90% of the speed of light. The ions can then be shot from the SIS18 into the SIS100 ring accelerator.

The SIS100 ring accelerator – The key component

The 1100-metre-long tunnel for the SIS100 particle accelerator will be located up to 17 metres underground. A supply tunnel will be located next to the actual accelerator tunnel with room for structures such as the lines for liquid helium, power supply units, and possible devices for controlling the quality of the ion beam. It can accelerate the ions of all the natural elements in the periodic table to speeds as high as 99% of the speed of light. The magnets that keep the ions in their paths are superconducting and are cooled to —269°C by liquid helium.



Facility for Anti proton and Ion Research (FAIR) under construction at GSI (https://www.researchgate.net/figure/Facility-for-Anti-proton-and-Ion-Research-FAIR-under-construction-at GSI_fig6_297368774; picture-alliance/dpa/GSI Helmholtzzentrum)

Storage rings

Connected to the SIS100 ring accelerator is a complex system of storage rings and experimental stations. Researchers can store particles such as antiprotons and special isotopes that are created when the accelerated ions hit a production target. This capture prevents these rare and valuable particles from being lost. The researchers can also conduct new experiments with these particles every time they fly past.

Nuclear Structure, Astrophysics and Reactions (NUSTAR)

The FAIR facility was planned to create extreme conditions such as very high pressure, temperatures and densities in the lab which occur during stellar explosions and collisions. The planning of NUSTAR is based on the understanding of atomic nuclei.

Exotic nuclei and the heavy element Crystals of the PANDA detector for the detection of particles (https://www.gsi.de/en/researchaccelerators/fair/research.htm

In stars, the atomic nuclei of lighter elements continuously fuse to create heavier elements and produce energy. In this way, almost 70 elements were created in stars and stellar explosions that included all the elements up to the 26th element in the Periodic Table and heavier elements such as gold and lead. The scientists at NUSTAR aim to study the properties of these exotic nuclei by using measuring devices and Super Fragment Separator (Super-FRS).

Compressed Baryonic Matter (CBM)

The CBM experiment will help in understanding the phenomenon of formation of huge supernova followed by an incredibly dense central core of

a neutron star. It weighs around one million times the Earth, though having a diameter of a city only. Scientists are planning to use the CBM experiments to find out how matter changes at such densities. At FAIR, scientists will create such highly compact matter on a tiny scale to test the theory. To do this, scientists will make two heavy nuclei collide with high energy so that they are pressed together to form an extremely dense 'fireball'. It will be too fleeting to be studied directly, but the subsequent explosion can be observed. It will create up to 1,000 new particles, most of them very ephemeral. Some of these particles will immediately decay into pairs of electrons and their antiparticles, positrons, while others will split into pairs of muons, a kind of heavy electron.

Particle Magic with Antimatter (PANDA)

According to the theoretical concept, every particle of 'normal' matter has its corresponding antiparticle. In the PANDA experiment, a particle will meet its antiparticle and annihilate each other in a burst of free energy from which other new particles can arise. These new particles will provide us with deeper insights into the mysterious strong force. Through PANDA scientists want to study the different combination of quarks and gluons, their properties, force and understanding how matter gets its mass.

Atomic, Plasma Physics and Applications (APPA)

APPA will range from the investigation of fundamental processes in atoms and macroscopic effects in materials or tissues to engineering and medical applications. Research at FAIR will open a gateway to treat many diseases like cancer and atrial fibrillation. Carefully targeted beams of ions or protons that travel at 98% of the speed of light can be used very effectively to kill difficult-to-reach tumour cells while leaving surrounding healthy tissue unharmed. These extremely fast protons could not only destroy tumours but also simultaneously be used to image them via proton radiography. As a result, therapy and diagnostics could be combined into 'theranostics'.

Materials research

The experiments designed in FAIR will address protective issues related to the Moon and Mars missions and help in the investigation of the radiation damage induced by cosmic rays. The experiments will also enable materials scientists to find out more about the effect of the radiation emitted by naturally occurring uranium on minerals subjected to high pressure and temperature of the Earth's interior

Atomic physics

Equipped with high-precision spectroscopy and high-powered lasers, experiments will be performed to validate the fundamental theories such as quantum electrodynamics (QED) and Einstein's special theory of relativity under extreme conditions like uranium nucleus with a single electron. Atomic physicists will also use FAIR experiments to solve whether matter and antimatter behave in the same way by generating anti-hydrogen and anti-helium and find out how they differ from 'conventional' hydrogen and helium.

Plasma physics

High Energy Density Matter (HEDM) is a class of energetic materials, particularly fuel, with a high ratio of potential chemical energy output to density. The availability of high-energy, high-intensity ion beams would enable the investigation of HEDM in regimes of temperature, density and pressure which is not accessible so far. At FAIR, researchers will create especially dense plasmas like those are present inside stars.

Participating countries

The FAIR GmbH, an international company under German law was founded followed by a dedicated contract that was signed on 4 October 2010, for the realisation of FAIR. The shareholders of FAIR are from Finland, France, Germany, India, Poland, Romania, Russia, Slovenia and Sweden. Though the United Kingdom is an Associated and the Czech Republic is still an Aspirant partner in FAIR.

Association of India with FAIR India is the third largest collaborating country committed to contributing to building the advanced accelerator and detector systems for this highly advanced new-generation accelerator facility. The Department of Science and Technology (DST) and the Department of Atomic Energy (DAE) (with DST acting as the nodal agency in executing the project) are funding the project jointly. Most of India's participation will be in-kind, both in accelerator and in detectors.

India's participation involved manufacturing of different important components of FAIR experiments like a power converter, vacuum chamber, beam stopper, superconducting magnets, gas electron multiplier (GEM) foil, etc.

Initial exploratory works have been completed for the shielded power cable to be used to connect the magnets to the power converters. A small-size power cable made by an Indian industry has been tested successfully by the FAIR team.

On the experimental front, three proposals from NUSTAR and one from CBM have been selected as a possible start point as the detector in-kind items from India. The systems for the NUSTAR experiments are (a) building of a part of the spectrometer for the DESPEC/HISPEC experiment; (b) design and building of neutron detectors for DESPEC; and (c) building of the ion trap for the MATS experiment at NUSTAR. In CBM, many groups have been working on building the muon detection system using a specialised detector technology known as GEM. A set of GEM chambers have already been built and tested with X-rays and proton beams. The efficiency and rate handling capability match the requirement of CBM.

The participation in FAIR will provide an opportunity for Indian labs and industries to become a part of the world-class existing or projected inhouse facilities and learning of new technology.

Jyoti Sharma is Senior Scientist and Sanjeev Kumar Varshney Head & Advisor, International Cooperation Division (ICD), Department of Science and Technology, Ministry of Science and Technology, Govt. of India. Correspondent Author: **Email:** jyotisharma.dst@gmail.com

← Continued from page 3

BLACK NITROGEN – A NEW ALLOTROPE OF NITROGEN

In the periodic table of elements, the chemical elements are arranged in 18 columns each containing elements with similar electronic configuration and properties. It has been known that carbon, oxygen and other light elements, when put under extremely high pressures, have structures similar to heavier elements in the same group of elements. But till now, nitrogen has been behaving anomalously. When highly compressed, nitrogen showed no structures similar to those exhibited under normal conditions by the heavier elements of this group – specifically, phosphorus, arsenic and antimony.

Recently, researchers of the University of Bayreuth in Germany have succeeded in creating a crystalline structure out of nitrogen, which, under normal conditions, occurs in black phosphorus and arsenic. The structure contains two-dimensional atomic layers and is therefore of great interest for high-tech electronics. The scientists have named it "black nitrogen" (Physical Review Letters, 18 June 2020 | DOI: 10.1103/PhysRevLett.124.216001).

Black nitrogen, which is new allotrope of nitrogen, is formed when nitrogen is placed in a diamond stamp cell between opposite diamonds and pressed together under extremely high pressures. It took truly extreme conditions to produce black nitrogen. The compression pressure was 1.4 million times the pressure of the Earth's atmosphere, and the temperature exceeded 4,000˚C. It is composed of two-dimensional layers in which nitrogen atoms are cross-linked in a uniform zigzag pattern similar to graphene, which shows great promise as a material for high-tech applications.

Biman Basu is a former editor of the Science Reporter, published by CSIR.
Email: bimanbasu@gmail.com

ANNULAR SOLAR ECLIPSE 21 JUNE 2020

ON 21 JUNE 2020, INDIA GOT THE opportunity to witness the rare celestial event of an Annular Solar Eclipse (ASE). In India, the line of annularity passed through four northern states, namely Rajasthan, Haryana, Uttarakhand and few places in Uttar Pradesh. The rest of the country witnessed the partial phases of the eclipse. Due to advisories issued on national lockdown imposed for COVID-19, no in-person camp was organised by Vigyan Prasar to observe the ASE.

However, in order to enable people to view this rare and important event. Vigyan Prasar organised a live streaming session of the ASE on its YouTube channel. In addition to YouTube, VP also telecast it live on India Science (OTT channel) and Facebook page of VIPNET clubs. The event was live from the station located on central line of annularity. The programme was organised in collaboration with Department of Science & Technology, Govt. of Haryana. For the live feed, a three-member team of Dr Arvind C. Ranade, Mr Vipin Singh Rawat and Mr Pawan Bhatiwere was present at Kurukshetra, Haryana. In addition to the station on central line of ASE, one team was set up at Vigyan Prasar's Noida office. In total we had set up at three locations:

1. Little Angel Model School, Pehowa Road, Kurukshetra, falling on central line of annularity for maximum phase of the eclipse
2. Brahmsarovar, Kurukshetra, Haryana and
3. Vigyan Prasar, Noida office

Members of two VIPNET clubs, Ignited Minds (Farrukhabad) and SKY Amateur Astronomers VIPNET club (Lucknow) were also present at Kurukshetra. To cover the partial phase, a team of scientists from Vigyan Prasar setup a station at Noida office.

The Annular Solar Eclipse lasted for more than three hours. The annularity or the ring of fire was observed for about 22 seconds from Kurukshetra and it was a mesmerising view. As the Moon covered approximately the 99.6 per cent of the Sun as the clock struck a minute past 12 hours IST (Pehowa, Haryana), the Baily's Beads and prominences were also observed which is usually seen during a Total Solar Eclipse. A few local residents also joined and experienced this spectacular phenomenon. It was ensured that everyone viewed the eclipse with full safety using the certified filters and by following all the norms of social distancing.

The live streaming session was moderated by Dr Nidhi Srivastava, Project Scientist from Vigyan Prasar. The team of experts from the fields of Education, Science & Technology joined the session as panelists and discussed various aspects of the eclipse. More than thirty thousand people observed the annular solar eclipse from their homes through our YouTube streaming.