

Coluthur Gopalan (1918–2019)

Time goes by fast. Indeed, it seems like yesterday that we reviewed the life of Coluthur Gopalan, then 95 years old, in *Current Science*, under the journal's series on 'Living legends in Indian Science'¹. Six years later today we are sadly penning his requiem. Gopalan, born on 29 November 1918, passed away at the age of 101 on 2 October 2019.

Gopalan was an internationally acclaimed nutrition scientist – a visionary, an institution builder, a powerful communicator, an administrator, and above all a person with great concern for human suffering. The last explains his decision to shun a lucrative career in medicine and opt for research in nutrition. In those days, nutrition deficiency diseases like kwashiorkor and marasmus (protein calorie malnutrition), blindness due to vitamin A deficiency, beriberi (vitamin B1 deficiency), pellagra (Niacin deficiency), scurvy (vitamin C deficiency) and rickets (vitamin D deficiency) took a heavy toll of human life and caused immense suffering among the poor. Today these florid nutrition deficiency diseases are history, but high rates of under-nutrition, with a growing burden of over-nutrition (obesity) and associated degenerative diseases – diabetes, cardiovascular diseases, etc. – continue to haunt developing countries like India, and contribute to the burden of diseases and premature mortality².

At the age of 10, Gopalan moved from a local school to the then famous Madras Christian College High School. Kuruvila Jacob, a legendary figure in the field of education recognized the young student's brilliance and motivated him to aim high. Medical education at Madras Medical College peppered with participation in public meetings against the British Raj, and turbulence of the Second World War followed. After an MD degree from the Madras Medical College in 1943, Gopalan became the first Indian to be selected for the prestigious Nuffield Foundation Scholarship for further studies in England. In two and half years he completed research and returned with PhD and D Sc degrees in nutrition. Contrary to the expectations of family and friends, this brilliant young doctor chose to take up a job at the Nutrition Research Laboratory (NRL) and launch a career in research. NRL was started by a British doctor

Robert McCarrison in a jam factory in Coonoor. Gopalan joined as deputy director. In 1950, Prime Minister Jawaharlal Nehru visited NRL and proposed the scheme of mid-day meal. Gopalan planned it, but it was aborted at the state level. Much later, it was revived with great fanfare.

NRL was shifted to Hyderabad in the late 1950s. Gopalan became its Director in 1962. During its Golden Jubilee in



1969, NRL was rechristened as the National Institute of Nutrition (NIN). The visionary that he was, Gopalan realized the complexity and dimensions of nutrition research and planned three working streams. The main laboratory with state-of-the-art equipment for basic research, nutrition wards in three local hospitals for collaborative work in clinical nutrition, and a field unit for public health nutrition. NIN has a fine library which was open for 24 hours in those days. As nutrition research is done on laboratory animals, NIN also has a good laboratory animal's facility which was and is still used by other institutions as well. Gopalan's predecessor director, Patwardhan was a brilliant biochemist and worked at the bench. Gopalan's passion for basic research, despite a medical background, was no less. He believed in the importance of basic research, and opened new vistas in hypothesis-based research supported by facts and evidence. This resulted in questioning of some of the entrenched notions of the aetiology of deficiency disorders.

The existing hypothesis that kwashiorkor was due to dietary protein deficiency

requiring high protein supplements and marasmus due to calorie deficiency was challenged based on observations on Indian diets. Both were manifestations of energy protein deficiency. Kwashiorkor was a more terminal manifestation when adaptation to deficient food intake, leading to severe emaciation (marasmus), broke down. This meant that improved home diets with a combination of cereals and pulses could be used for treating these conditions rather than expensive protein supplements.

Pellagra is attributed to the deficiency of the vitamin niacin (nicotinic acid). It was traditionally known to be more common in maize eaters. Maize is deficient in the essential amino acid tryptophan, the precursor of niacin. Additionally, in maize nicotinic acid is in bound form making it less available. Contrary to this notion, in India, pellagra was prevalent among people whose diet was predominantly sorghum-based. Sorghum used to be given as wages in kind to farm workers. Both maize and sorghum have high content of the amino acid leucine, leading to imbalance between leucine and isoleucine. Treatment with niacin could treat this disease. Pellagra has almost disappeared since the green revolution and the availability of rice in public distribution system. Today, however, millets like sorghum are gaining importance, but they are part of a mixed diet.

Research at NIN showed that burning feet syndrome was due to pantothenic acid deficiency and phrynodema (a skin lesion) is due to essential fatty acid deficiency.

Most of the public health programmes in nutrition like the mid-day meal programme in schools, anaemia prophylaxis programme (iron-folic acid supplementation to pregnant women), prevention of blindness due to vitamin A deficiency (massive dose of vitamin A) were started under Gopalan's research initiatives. Remarkably, Gopalan had the courage of conviction to challenge programmes developed under his guidance when he felt that they were not relevant. Thus, in more recent years, he did not support the massive dose vitamin A programme. But the common wisdom is to continue it at least in areas where the problem of clinical signs and symptoms of vitamin A

deficiency – night blindness and Bitot spots persist. Indian diets are deficient in vitamin A despite there being plenty of vitamin A precursor β -carotene in plant foods. Gopalan was a strong advocate of farm-based rather than pharmacy-based approach to combating nutritional deficiencies. This concept, now called bio-fortification, is becoming more popular, with many edible plant species now bred with higher levels of micronutrients. The importance of dietary diversity in combating malnutrition cannot be overemphasized and Gopalan was one of the first to recognize this.

At one time breast feeding was not promoted and worst, in India the colostrums (first three days milk) discarded. Gopalan's studies on the composition of breast milk of poor Indian mothers showing that it was similar to breast milk from European women paved the way for promoting breast feeding as an essential intervention for newborn and child health. Today, mothers are urged to start breast feeding within one hour of birth and continue for as long as possible.

National Nutrition Monitoring Bureau (NNMB), one of the best conceived programmes in India to continuously monitor diet and nutrition, was started by Gopalan initially in eight states and expanded later to ten. These surveys provided secular trends on dietary intakes and anthropometric data of men and women in urban and rural areas of these ten states over three decades. These surveys have been discontinued now, but there is a great need to collect this type of data at a national level.

Nutritive value of Indian foods is the brain child of Gopalan and tribute to hard work of the scientists of the analytical division of NIN. A revised and updated version has recently been published as Indian Food Composition Tables.

Till now the recommended dietary allowances (RDA) for different nutrients for Indians are based on the work done under Gopalan at NIN and published by ICMR. They are being periodically revised as there have been substantial changes in the economic, social and cultural environment in India, affecting

physical activity and nutritive requirements.

Food and drug toxicology division at NIN was initiated recognizing that these have an important influence on nutrition. An important contribution was finding a link between consumption of *Lathyrus sativus* (Kesari dal) and neurotoxicity. Gopalan led the team which demonstrated the neurotoxicity of lathyrus toxin in animals and led to the banning of consumption of this legume. Today, however, many scientists want the ban on this pulse to go as it is no longer consumed as the staple food, is rich in protein and methods for removing the toxin-BOAA are available.

The link between consumption of aflatoxin and liver cancer was shown by NIN under Gopalan's guidance; yet another contribution was showing the link between fluoride content of water and skeletal fluorosis.

In 1974 Gopalan left NIN and became the Director General of the Indian Council of Medical Research – a position he held till his retirement in 1979. His vision as a health scientist who thought beyond nutrition is seen from the fact that he set up three new institutions of public health importance under ICMR – the National Institute for Malaria Research in New Delhi, the Vector Control Research Centre in Puducherry and the Leprosy Research Institute in Agra, each addressing important health problems of the country.

In 1979, Gopalan setup one more institution, the Nutrition Foundation of India in New Delhi, which is devoted to research in areas of public health nutrition leading to formulation of policies.

Realizing the importance of and need for frequent scientific interaction and dialogue between nutrition scientists, Gopalan initiated the Nutrition Society of India (NSI) in 1966. It meets every year. The Asian Congress of Nutrition held every four years is an opportunity for Asian scientists to meet and discuss region-specific nutritional problems. The first Congress was held in Hyderabad, India under his leadership in 1970.

It is hard to imagine a scientist who could have made more contributions

through original research in the field of nutrition and beyond. Many global and national schemes to tackle macro and micronutrient deficiencies owe their origin to this one man. At a time when facilities in research institutions were often basic, Gopalan contributed through his vision, his powers of observation, his ability to ask the right questions and scientific rigour in everything he did. Most of all, he loved India and wanted to leave it a better place than he found it. We will indeed miss him.

Gopalan was honoured with the Fellowship of Royal Society (London) in 1987 and the *Padma Bhushan* in 2003. Some of the other fellowships received include: Honorary Fellow of the London School of Hygiene and Tropical Medicine and fellowship of most Indian science academies. Gopalan has received numerous national and international awards including the Living legend award of the International Union of Nutrition Sciences 1989, and more recently the first ever Living legend award of the Federation of Asian Sciences in 2019.

In the passing of Gopalan, India and the developing countries have lost a dynamic and inspiring leader, in the field of nutrition.

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2. India state level disease burden initiative malnutrition collaborators. The burden of child and maternal malnutrition and trends in its indicators in the states of India: The Global Burden of Disease Study 1990–2017, www.thelancet.com/child-adolescent; Published online, 18 September 2019.

MAHTAB S. BAMJI^{1,*}
KAMALA KRISHNASWAMY²
SOUMYA SWAMINATHAN³

¹INSA Emeritus Scientist,
Dangoria Charitable Trust,
Hyderabad 500 020, India
²Formerly National Institute of Nutrition,
Hyderabad 500 007, India
³World Health Organization,
Geneva 1211
*e-mail: msbamji@gmail.com