asked to organize a course for such controllers working for Arabsat, a multinational organization controlling similar satellites. If MCF has been able to achieve smooth and flawless operations for all these years, it is only due to the personal involvement of everyone of the staff members who takes pride in his or her job with an excellent team spirit.

MCF has been responsible for several innovations such as the survival of INSAT-1B through the eclipse season in spite of the loss of both the onboard batteries, use of attitude control thruster firings for orbit adjustment, detailed on-orbit measurement of antenna footprint, etc. MCF has also taken the lead in indigenization programmes as well as technology transfer to the industry.

### Into the future

INSAT system is still in the stage of growth in terms of introduction of newer payloads and newer services. Correspondingly, the augmentation of the facilities at MCF will go on for the next few years. For example, presently, new earth stations are being built for testing Ku-band (11/14 GHz) communication payload and Mobile Satellite Service (MSS) payload. In the next three years a launch of INSAT is planned every year. There will also be experimental missions carried on the test flights of GSLV. Each launch calls for calibrating, checking and revalidating the performance of every subsystem to ensure fail-safe operation. The launch seasons are so hectic that the MCF personnel have very little time for other activities. However, the routine operations tend to be less glamorous, but provide useful feedback to the designers. ISRO is one of the few organizations in which the satellite design and operations are carried out under the same umbrella. This is sure to pay rich dividends in the long term.

# Vegetarianism: A nutritional appraisal

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*Vegetarianism in India is perhaps 3000 years old. What is the extent of flesh consumption at present? How do vegetarian diets stand up to scrutiny in the light of modern nutritional knowledge? What of the future? These are the questions addressed in this paper.*

NOWHERE in the world except in India is the concept of vegetarianism really commonplace, or accepted without explanation. Nor is this surprising, since the vegetarian ethos was propounded here by the Vedic Indians as early as about 1000 BC. There are many today who are a product of total vegetarian eating for as long as hundred generations, and survive, reproduce and live full and satisfying lives, both physically and mentally. So it has been done, and can be done. There is room, however, to review the current trends in the use of animal foods, and the practice of vegetarianism, in relation to the knowledge of scientific nutrition that has been unravelled over the last century or so.

### Proportions and causes

Census figures of 1971 record the proportions of vegetarians that exist in the various states of India. Among the high-vegetarian-population states (expressed as percentages of the population) are Gujarat 69, Rajasthan 60, Punjab–Haryana 54 and Uttar Pradesh 50. At medium levels come Madhya Pradesh 45, Karnataka 34, Maharashtra 30 and Bihar 24, while the low-vegetarian-population states are Tamil Nadu 21, Andhra Pradesh 16, Assam 15, and Kerala, Orissa and West Bengal 6 each. The overall figure for vegetarianism in the whole country in 1971 was 28%.

What is the nature of this vegetarianism? Reliable dietary data have been collected for the years 1979–81 by the National Nutrition Monitoring Bureau, Hyderabad, in 10 states spread all over India[1]. In the rural areas of these 10 states, the consumption figures for fish and other flesh foods (including eggs)[1] are shown in Table 1. Everywhere, fish intake is much higher than that of meat, the averages for each of these for the 10 states being about 10 g of fish and just 3 g of meat a day. Since vegetarians form about one-quarter of the popula-

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**Table 1.** Nonvegetarian food intakes Rural dwellers (g/consumption unit/day)

| Region | Fish | Other flesh foods | Total |
|---|---|---|---|
| North | | | |
| Uttar Pradesh | 3 | 2 | 5 |
| Madhya Pradesh | 0 | 0 | 0 |
| South | | | |
| Kerala | 37 | 1 | 38 |
| Tamil Nadu | 3 | 8 | 11 |
| Karnataka | 1 | 2 | 3 |
| Andhra Pradesh | 15 | 7 | 22 |
| East | | | |
| West Bengal | 17 | 4 | 21 |
| Orissa | 12 | 5 | 17 |
| West | | | |
| Maharashtra | 11 | 3 | 14 |
| Gujarat | 1 | 0 5 | 1.5 |
| Mean, about | 10 | 3 | 13 |
| Weighted mean for nonvegetarians, about | 13 | 4 | 17 |

tion, the daily averages for nonvegetarians as a whole are 13 g of fish and 4 g of meat, a total of 17 g per head per day. In other words, in India, the nonvegetarian item by and large represents just one more vegetable, only a small part of the total food. Larger amounts of fish are eaten in coastal states like Kerala (37 g), and West Bengal, Andhra Pradesh and Orissa (17–12 g)[1]. In Goa and the Andaman Islands, data from other surveys conducted around the same time show that per capita fish consumption is as high as 100 g a day, with practically no meat at all[2].

Two factors are involved in vegetarianism. One is the ethical or religious belief, to which have recently been added economic and environmental concerns. The other is income, because meat and, slightly less so, fish are expensive items of food. Table 2 shows intakes of nonvegetarian foods for various income groups in Kerala, Tamil Nadu and Gujarat[1]. In Kerala, 94% of the population are nonvegetarians: fish eating is widely prevalent, and income is not a very major determinant. In Tamil Nadu, religious belief and the income effect are both depressants of nonvegetarian intake, but the reason seems to vary at different levels. Upper income groups are vegetarians through belief, lower ones through income scarcity. More meat than fish is eaten at all levels, a distinct and somewhat surprising reversal of the general rule for a coastal state. Gujarat too has a long sea coast, but the large populations of Jains and Vaishnavites are responsible for very low consumption of both fish and meat at all income levels[1].

Simply the fact of living in cities seems to influence the nature of food intakes in several respects[3]. The dietary data in Table 3, showing the consumption of nonvegetarian food in Trivandrum, Madras and Ahmedabad, the capitals of the three states that have just been discussed, illustrate in exaggerated form the rural deductions just made[3]. In Trivandrum, high-income groups take both fish and meat, other groups mainly fish. In Madras, again the distinct preference among upper-income groups for meat over fish is apparent even when both can be afforded; is not, fish is consumed. Quantities are low in Madras upper-income groups because of ethical vegetarianism. In Ahmedabad, there is far more nonvegetarian food consumed than the average 1.5 g/day in rural Gujarat (Table 1). Again, meat is preferred over fish, reflecting the choice of the cosmopolitan (and perhaps not always Gujarati) upper-income groups of that city.

**Table 2.** Nonvegetarian intakes Rural dwellers (g/consumption unit/day)

| Region (population group) | Fish | Other flesh foods | Total |
|---|---|---|---|
| Kerala | | | |
| High-income | 45 | 9 | 54 |
| Middle-income | 47 | 1 | 48 |
| Low-income | 33 | 0 | 33 |
| Tamil Nadu | | | |
| High-income | 3 | 8 | 11 |
| Middle-income | 4 | 9 | 13 |
| Low-income | 1 | 7 | 8 |
| *Gujarat* | | | |
| High-income | 0 | 0 | 0 |
| Middle-income | 2 | 0 | 2 |
| Low-income | 1 | 0 | 1 |

**Table 3.** Nonvegetarian intakes, Urban dwellers (g/consumption unit/day)

| Region (population group) | Fish | Other flesh foods | Total |
|---|---|---|---|
| Trivandrum | | | |
| High-income | 36 | 30 | 66 |
| Middle-income | 47 | 3 | 50 |
| Low-income | 41 | 0 | 41 |
| Madras | | | |
| High-income | 4 | 15 | 19 |
| Middle-income | 14 | 13 | 27 |
| Low-income | 17 | 8 | 25 |
| Ahmedabad | | | |
| High-income | 4 | 19 | 23 |
| Middle-income | 1 | 5 | 6 |
| Low-income | 2 | 10 | 12 |

## The complexions of regional diets

So far we have focused on the nonvegetarian part of Indian diets. Lets us now look at the rest of the diets, shown in Table 4 for the rural areas of four states situated in the north (Uttar Pradesh), south (Tamil Nadu), east (West Bengal) and west (Gujarat) of the country[1]. In all these diets, nonvegetarian items form only a very small part: rural Indian food everywhere in the country

is essentially vegetarian. The quantities of cereals and pulses consumed in all states are fairly similar, though the cereal used will differ, and to a lesser degree the pulse. Uttar Pradesh would have mostly wheat, Tamil Nadu and West Bengal mostly rice, and Gujarat rice, wheat and bajra. Intakes of roots and tubers, and of vegetables, are low in Tamil Nadu and Gujarat, and high in West Bengal. Consumption of milk and its products is low in West Bengal and exceptionally high in Gujarat. The levels of calories, proteins and fats calculated from the above dietary components[1] are shown at the end of the table, but these are better considered a little later, along with the quantities of other minor nutrients derived from these diets.

These nutrient intakes[1] are shown in Table 5, along with the 1989 recommended daily intakes for each nutrient laid down by the Indian Council of Medical Research[4]. In the new norms, the weights of an Indian reference man and woman have been set higher (at 60 and 50 kg, respectively) than the current averages in order that the levels of nutrients recommended become targets to be reached by the better-built citizens of tomorrow. This may make some of the actuals appear more deficient than they really are for the smaller people. Generally speaking, calories, proteins and fats are fairly well met even in average Indian rural diets. Calcium and iron are apparently adequate, though iron represents a special case, which will be discussed later. Vitamin A intakes are really low, and are reasonably satisfactory only in Bengal, thanks to the high consumption of green leafy vegetables, a cheap and excellent source of this vitamin. Other nutrient requirements are more or less met. It would appear that, generally speaking, Indian-style cereal-based diets, though containing very little nonvegetarian foods, are nutritionally fairly satisfactory, and can be made even more so with greater buying power and some dietary knowledge and alteration. Let us now look into our foods and cooking practices in greater detail.

**Table 4.** Average regional rural diets (g/consumption unit/day)

| | Uttar Pradesh | Tamil Nadu | West Bengal | Gujarat |
|---|---|---|---|---|
| Cereals | 497 | 518 | 572 | 438 |
| Pulses | 47 | 35 | 23 | 32 |
| Roots/tubers | 79 | 39 | 93 | 46 |
| Vegetables | 140 | 106 | 235 | 96 |
| Milk and its products | 75 | 82 | 39 | 199 |
| Fats/oils | 4 | 11 | 8 | 21 |
| Sugar/Jaggery | 7 | 17 | 11 | 33 |
| Animal foods | 5 | 11 | 21 | 2 |
| Calculated nutrients | | | | |
| Calories | 2115 | 2196 | 2580 | 2333 |
| Protein, g | 70 | 54 | 63 | 67 |
| Fat, g | 25 | 36 | 32 | 51 |

## Indian food practices

Many traditional Indian habits have come down to us from very ancient times, and are based on the food materials actually available, on deductive observations in the past of their effects on health, and on the overall Indian food ethos. These practices have much to

**Table 5** Nutrients present in Indian rural diets

| | Uttar Pradesh | Tamil Nadu | West Bengal | Gujarat | ICMR recommendation |
|---|---|---|---|---|---|
| Calories | 2115 | 2196 | 2580 | 2333 | 2700 |
| Proteins, g | 70 | 54 | 63 | 67 | 60 |
| Fat, visible plus invisible, g | 25 | 36 | 32 | 51 | 20[d] |
| Calcium, mg | 426 | 609 | 493 | 546 | 400 |
| Iron, mg | 29 | 26 | 33 | 25 | 28 (women 30) |
| Vitamin A, mcg | 207 | 211 | 495 | 264 | 600 (lactation 950) |
| Vitamin C, mg | 41 | 39 | 91 | 35 | 40 (lactation 80) |
| B vitamins | | | | | |
| Thiamine, mg | 2 1 | 0 9 | 1 1 | 1 9 | 1 35 |
| Riboflavin, mg | 1 2 | 0 8 | 0 8 | 1 2 | 1 62 |
| Nicotinic acid, mg | 21 6 | 12.1 | 17 9 | 14 1 | 17 60 |
| Pyridoxine, mg | — | — | — | — | 2 0[a] |
| Folate, mcg | — | — | — | — | 100[b] (pregnancy 400) |
| $B_{12}$ | — | — | — | — | 1.0[c] (lactation 1 5) |

[a]Wheat and bajra: rich; rice: poor.
[b]Liver and eggs: rich, cereals, green vegetables, banana, orange: moderate.
[c]Mostly from animal foods and bacterial activity (see text)
[d]Visible fat only

commend them. Everywhere in India cereals and pulses are eaten together: rice with sambhar, chapati with dal, and combination cooked foods like the idli, dosai, dhokla, pesarattu, khichdi and holige. There is an important protein complementation effect involved[4,5]. Cereal proteins carry good levels of the two essential amino acids cystine and methionine, and pulse proteins that of the amino acid lysine. When both are taken together, these amino acids complement each other, raising the total protein eaten to one of higher quality. If percentage marks are given, eggs, meat and fish proteins would score about 80 and milk about 72. A cereal–dal combination would score about 65, though each protein in itself would score only 50–55. Add to this some milk or curd, and there is not much to choose in protein quality between vegetarian and nonvegetarian diets taken as a whole. A second point about Indian-style diets is that they are rich in dietary fibre[5]. This is a recent term which means all complex carbohydrates that are not broken up by the digestive enzymes and are, therefore, not absorbed, thus passing into the stools. Today, many diseases of the lower colon, like cancer and constipation, are being linked with an insufficiency of dietary fibre, and hence of long intervals between evacuations. Indian diets rich in cereals and vegetables do well on this count. So do they in terms of fat[6]. Rice and wheat carry about 2–4% of invisible fat each, and consumption of the usual 500 g of cereal a day would give 10–20 g of fat right away. Indian diets have been computed to contain a total of as much as 25 g of such invisible fat a day on an average[6]. Fermented foods have much to commend them. The digestibility of both carbohydrates and proteins in foods like idli and dhokla is very high, since these entities have been broken down during fermentation[7,8]. Any iron that is present becomes ionized and, therefore, available to the body. Curds carry microflora developed during fermentation, which serve to replenish those in the lower intestine and are helpful in digestion and in warding off infection.

Today the virtues of liquid unsaturated vegetable oils are being publicized in the western countries. India has had a long tradition of the use of such oils in daily cooking. Ghee has had a place of veneration that current nutritional science does not tend to endorse[9].

Raw foods are valued because they are one way of ensuring a good supply of a nutrient like vitamin C, which is quickly destroyed by air, light and heat. Western salads of raw vegetables and fruits are meant for this purpose, and in India we have long cherished our raw chutnies, pacchadis, raitas and kocchumbers made up of ground green ingredients. In fact, cooking without fire was a distinct Vedic category of food preparation[10–12] and included items like pickles of lime and mango with spices and salt, or sugar-preserved items in which nutrients are well conserved for year-round use. Sprouting of mung, chana and ragi is a well-established Indian practice, and often the products are eaten raw, which further conserves vitamins. Vitamin C and several B vitamins are nearly doubled on sprouting and iron is released from bound forms[7,8,13]. An age-old practice thus finds modern nutritional vindication.

Indian historical injunctions regarding hygiene have a thoroughly contemporary connotation. One was obliged to wash hands and the mouth before and after eating, eat from disposable plates to avoid cross-infection, and not to sip water from a glass but pour it in. Leftover food was not to be eaten, which in pre-refrigerator days made sound sense. There were two kinds of foods in the Aryan ethos[12]. *Kaccha* foods were everyday foods, eaten daily, like rice and dal; these boiled foods were to be cooked and eaten only within the kitchen by the family members. *Pucca* foods could be taken outside, and also shared; these were usually fried foods, which, as we know today, have a much longer keeping quality, and are not prone to infection. Sociological theorizing was in this instance a basis for sound nutritional practice.

## Animal foods in nutrient terms

Proteins of high quality were once considered the major virtue of animal foods. There is truth in this in terms of amino acid quality, but as we have seen, blending of proteins from cereals and pulses compensates fairy adequately. The quantity of protein in fresh meat and fish is 18%, whereas most dals carry between 20 and 23%. However, because of swelling and bulkiness, it is easier to consume say 100 g of meat than to eat the same weight of dal, and the gas-forming nature of most dals is also a drawback[8,13].

There is a bit of a mystery about iron. It has repeatedly been shown that from nonvegetarian diets, there is high absorption of any iron present in the food, whereas the same quantity of iron from a cereal-based diet is absorbed only to the extent[14] of about 3%. Also, from the same diet, a pregnant woman will absorb about 5% of the iron and a woman suckling a child[4] 7%. Some sort of feedback mechanism operates, and vegetarian diets do face a problem of low absorption. As a result, most Indians are slightly anaemic by western standards, and consumption of iron-fortified salt is being recommended even on a national basis. Studies in large groups have shown excellent and sustained improvement in blood iron levels after taking such salt[15].

Vitamin $B_{12}$ is an 'animal' vitamin, present in high amounts in liver and to lesser extents in meat. From purely vegetarian diets it is difficult to get enough of this vitamin to meat normal needs, and yet there is little evidence of deficiency in India by way of pernicious anaemia[7]. This has been attributed to several causes:

the higher absorption (70%) of the vitamin from food by vegetarians than by meat-eaters (16%), the presence of bacteria (which synthesize vitamin $B_{12}$) on the surfaces of green vegetables and in water supplies carrying decaying vegetable matter, and the poor hygienic practices prevalent in India[4]. The quantity of the vitamin needed daily is very small, only one mcg a day. Yet many vegetarians from India who migrate to England frequently develop signs of vitamin $B_{12}$ deficiency like pernicious anaemia; the type of bacteria populating their small intestines has been found to change, and the number of bacteria drops considerably, probably reducing $B_{12}$ synthesis in the small intestine markedly[16]. Also, a large number of antagonistic factors may come into play, like the use of more processed foods, an excess of vitamin C and copper, and excessive medication. Cholesterol is another product of animal metabolism, found in eggs and meat, and also in milk, butter and ghee. Consumption of these is low in India, but the high incidence of cardiovascular disease among Indians living in England, once tentatively attributed to oxidized cholesterol found in heated ghee freely used by Indians there, is now being linked[9,17] to the *trans* fatty acids present in ghee to the extent of about 4%. Fears regarding cholesterol consumption have sharply depressed intakes of butter (which is also a saturated fat) in advanced countries, perhaps without justification. Cholesterol in milk itself is at a low level and milk is not considered a major source.

## Global concerns

In India, in the recent years there has certainly been a trend towards a higher degree of nonvegetarianism among traditionally vegetarian families. Many factors are operative. Better purchasing power among the middle class is one of them, and the aping of the habits of the so-called upper class, the executive and the film star. To restless younger people, it represents part of a desire to break traditional shackles, especially when they travel abroad alone and undergo the travails of finding appetizing vegetarian food when on the move. Whatever it be, the phenomenal growth during the last two decades of the egg and chicken industry in India is a reflection of the spread of nonvegetarian eating habits among Indians.

The west, on the other hand, seems to be moving steadily towards vegetarianism. Both in Britain and the USA, some 7–10% of people, especially the younger generation, are believed to have become vegetarians. Many reasons are given for this. One is the humanitarian concern of *ahimsa*. A more important reason is the realization that the animal is an inefficient converter of feed materials into meat or milk. The same food grains which an animal is given could feed several human beings, and the production of a typical western non-vegetarian diet of say 3000 calories has actually used up many times that value in terms of feed calories. There is a growing realization of the fact that our earth is a single, finite spaceship in which the whole of humanity will sink or swim together: food must be found for everyone, and animal food is too energy-expensive to meet the need.

What of the future? One can only hazard a guess that a new genetic revolution in food plants is on its way, which may increase grain yields to an extent that can hardly be visualized. If grain production from the same agricultural land area goes up dramatically, and if the population of the world gets stabilized, the economic argument will lose strength. Whether the ethical or moral one will continue to prevail remains an open question.


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