ADEQUACY OF VEGETARIAN DIETS FOR OPTIMAL NUTRITION OF MOTHER AND CHILD

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A large proportion of the population of India subsists on vegetarian diets - partly as a result of religious persuasion and tradition, and partly as a result of economic compulsion. Even among large sections of non-vegetarians in the country, meat is taken only occasionally, and not a regular feature of the daily diet. Under the circumstances, it is important to know, in the light of modern knowledge on nutritional requirements, if vegetarian diets are adequate for the promotion of optimal growth, development and overall good health.

We may broadly recognize three categories of "vegetarian diets": (*a*) "vegan diets" which exclude the consumption of all foods of animal origin except breast milk; these diets do not include cow, buffalo or other mammalian milk; (*b*) "lacto-vegetarian diets" which include besides breast milk, other mammalian milks as well; and (*c*) "lacto-ovo vegetarian diets" which include eggs in addition to mammalian milk.

Cow or buffalo milk has always been a traditionally valued dietary item in Indian dietaries: and even strictly vegetarian diets in India invariably include mammalian milk. "Vegan diets" in which mammalian milk (other than breast milk) are excluded, are not in vogue in India. For the purpose of our present discussion we will, therefore, be considering the nutritional adequacy of "lacto vegetarian diets", habitually consumed in the country.

Nutritional Adequacy of Vegetarian Diets

On the basis of extensive experimental, clinical and epidemiological studies, estimates of daily requirements of different essential nutrients needed for normal growth, development and maintenance are now available. Recommended Dietary Allowances (RDA) based on such estimates have been drawn up by officially designated Scientific Agencies of different countries. The Indian Council of Medical Research, taking note of all available contemporary scientific evidence, had thus set out RDA for Indians(1). RDA for Indians as contained in the latest Report of the ICMR have been indicated in *Table I*.

A simple way of ascertaining the nutritional adequacy of a diet is to find out if it provides all the essential nutrients at the "recommended levels". The latest publication on the "Nutritive Values of Indian Foods"(2) from the National Institute of

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TABLE I–*Recommended Dietary Allowances for Indians*

Group	Particulars	Body wt	Net energy	Protein	Fat	Cal-cium	Iron	Vit. A.μg/dl		Thia-min	Ribo-flavin	Nico-tinic acid	Pyri-doxin	Ascor-bic acid	Folic acid	Vit. B_{12}
								Reti-nol	β-caro-tene							
		kg	Kcal/d	g/d	g/d	mg/d	mg/d			mg/d	mg/d	mg/d	mg/d	mg/d	μg/d	μg/d
Man	Sedentary work	60	2425	60	20	400	28	600	2400	1.2	1.4	16	2.0	40	100	1
Woman	Sedentary work	50	1875	50	20	400	30	600	2400	0.9	1.1	12	2.0	40	100	1
	Pregnant woman	50	+300	+15	30	1000	38	600	2400	+0.2	+0.2	+2	2.5	40	400	1
	Lactation															
	0-6 months		+550	+25						+0.3	+0.3	+4				
					45	1000	30	950	3800				2.5	80	150	1.5
	6-12 months	50	+400	+18						+0.2	+0.2	+3				
Infants	0-6 months	5.4	108/kg	2.05/kg		500				55μg/kg	65μg/kg	710μg/kg	0.1			
														25	25	0.2
	6-12 months	8.6	98/kg	1.65 kg				350	1200	50μg/kg	60μg/kg	650μg/kg	0.4			
Children	1-3 years	12.2	1240	22			12	400		0.6	0.7	8			30	
	4-6 years	19.0	1690	30	25	400	18	400	1600	0.9	1.0	11	0.9	40	40	0.2-1.0
	7-9 years	26.9	1950	41			26	600	2400	1.0	1.2	13	1.6		60	

Source: Nutrient requirements and recommended dietary allowances for Indians, ICMR 1989.

Nutrition, sets out the composition of "low-cost balanced diets" for various physiological categories and the corresponding levels of essential nutrients that such diets actually supply. The "low-cost balanced diet" so recommended is a "lacto-vegetarian diet" which does *not* include meat. A typical low-cost balanced diet recommended for a sedentary man and its nutrient composition are indicated in *Tables II & III*. It will be noted that even this least expensive lacto-vegetarian diet fully meets the Recommended Dietary Allowances.

The message that stands out from these data is that even with low-cost balanced diets which low-income groups can afford and which are, composed entirely of vegetable foods and milk, essential nutrient requirements can be adequately met. This is in line with the conclusion of the American Dietetic Association that "well-planned vegetarian diets are consistent with good nutritional status"(3).

The data in *Tables II & III*, however, pertain to a sedentary man. Nutritional requirements of the mother during pregnancy and lactation, and of infants and children during their crucial phases of growth and development are more exacting than those of a sedentary man. Can lacto-vegetarian diets adequately meet the requirements of these vulnerable groups as well?

The major questions which we will be addressing in this communication are: can vegetarian diets fully meet the nutritional needs of the mother during her pregnancy and lactation, and, of the infant and child during their crucial phase of growth and development? Can children reared on vegatarian diets achieve full expression of their innate genetic potential for growth and development or, are they likely to be at a disadvantage in this regard, as compared to children on non-vegetarian diets?

TABLE II– *Low Cost Balanced Diet (Sedentary Man)*

Cereals	460
Pulses	40
Leafy vegetables	50
Other vegetables	60
Roots & tubers	50
Milk	150
Oil & fat	40
Sugar & Jaggery	30

Source: Reference 2.

Nutritive Value of Vegetable Foods

The major food items of a vegetarian diet are generally, cereals and millets (staple), legumes and pulses, nuts, edible oils derived from vegetable sources, vegetables (green leafy, other vegetables and tubers), and fruits. A lacto-vegetarian diet includes, besides

TABLE III– *Nutrient Composition of Low-cost Balanced Diet*

Nutrient	Actual content	RDA
Calories (Kcal)	2738	2425
Protein (g)	67	60
Calcium (mg)	782	400
Iron (mg)	62	28
Vitamin A (μg)	715	600
Riboflavin (mg)	1.1	1.4
Thiamine (mg)	2.4	1.2
Vitamin C (mg)	74.8	40
Niacin (mg)	15.6	16
Total fat (g)	67	20

Source: Reference 2.

the above, milk (breast milk and mammalian milk). We may start this discussion with a brief review of the overall nutritive value of these vegetable foods, with respect to "proximate principles" - namely carbohydrates, proteins and fats; and micronutrients namely vitamins and minerals.

Proximate Principles

Carbohydrates: Cereals and millets are rich sources of complex carbohydrates; and along with pulses and vegetables they also provide dietary fibre - the physiological importance of which has been recognized in recent years. Cereals, nuts, vegetable fat (oils) and tubers are good sources of energy. That vegetarian diets can provide the energy needs of the body is hardly disputed.

Fats: The fatty acid composition of vegetable oils, with the possible exception of coconut oil, may be considered wholesome, and indeed nutritionally superior to that of animal fats. Vegetarian diets can thus fully meet the nutritional needs with respect to fats and essential fatty acid requirement, even more satisfactorily than animal fats.

Proteins: Cereals are generally poor in the essential amino-acid lysine and cereal proteins unlike proteins from meat, milk and eggs are, therefore, "incomplete" from the nutritional point of view. However, lysine deficiency in cereals can be easily offset by the inclusion of pulses and legumes which are rich in lysine. Traditional vegetarian diets do include pulses, dhal and legumes in varying proportions. The protein efficiency-ratio (PER) of cereal-legume diets compares favorably with the PER of animal foods. There are also numerous reports to show that established cases of severe protein-calorie malnutrition (Kwashiorkor) can be successfully treated with diets providing vegetable proteins(4). The protein-nutritive values of vegetarian diets will be further enhanced when some quantities of milk are also a part of these diets (as is the case with lacto-vegetarian diets). The protein-nutritive value of a lacto-vegetarian diet is thus assured.

Micronutrients: Vegetables, especially green leafy vegetables and fruits are rich sources of carotenoids (including B carotene) which are precursors of vitamin A. They are also good sources of folic acid (an essential element for growth and hemopoiesis), vitamin C, iron, and calcium. With a judicious combination of cereals, pulses, vegetables and fruits, and milk it should be possible to ensure a diet of good nutritive value which would fully meet all essential nutrient requirements.

Limitations of a Purely Vegetarian Diet (Vegan Diet) and How They Can be Overcome:

Vegetarian diets, however, do have some limitations and now we will briefly discuss how they can be overcome. In a 'vegan' diet, some essential nutrients are lacking. The essential nutrients that cannot be supplied by a totally vegetarian (vegan) diet devoid of all milk including breast milk, have been indicated in column 1 of *Table IV*. In column 2 of the same Table, the manner in which these deficiencies can be overcome has been indicated.

Sanders(5) had carried out a longitudinal study of the growth and development of children born of vegan mothers and reared on a vegan diet. All these children had been bread-fed for at least the first six months of life. "The majority of these children grew and developed normally but they did tend to be smaller in stature and lighter in weight than standards for the general populations. Most parents were aware of the need to

TABLE IV– *Essential Nutrients Lacking in a Totally Vegetarian (Vegan) Diet, Devoid of all Mammalian Milk*

Missing Nutrients	Food items that could correct the deficiencies
Retinol (vitamin A)	Carotenoids - B carotene (precursor of vitamin A) abundantly available in vegetable foods
Vitamin B_{12}	Available in mammalin milk
Vitamin D	Available in mammalian milk; Available through exposure to sunlight
Carnitine & (needed by infants) taurine	Available in breast milk
Some long-chain fatty acids	Available in breast milk (needed by infants)

supplement these diets with vitamins B_{12}". The author concluded that "provided sufficient care is taken, a vegan diet supports normal growth and development".

While theoretically it should thus be possible to rear children on vegan diets devoid of mammalin milk, provided due precautions are taken to supplement the diet with vitamin B-12, we do not recommend such strictly vegetarian diet (mammalian milk free) for infants and children as a general rule. As was pointed out earlier, traditional Indian vegetarian diets do not preclude the inclusion of mammalian milk; infact milk has always been a traditionally valued item. In the matter of infant and child feeding, it will be safer to opt for lacto-vegetarian rather than for vegan diets. It will be noted from *Table IV* that all essential nutrients missing in a vegan diet can be adequately provided by a lacto-vegetarian diet. Carotenoids specially B carotene, abundantly available in vegetables (especially dark green leafy vegetables) and fruits, which can be converted into vitamin A in the body can fully meet vitamin A requirements. Indeed, recent studies indicate that carotenoids possess metabolic properties which mark them out as even superior to vitamin A in some respects. Vitamin B_{12} and vitamin D can be provided by mammalian milk.

The inclusion of breast-milk and mammalian milk can thus serve to completely offset the marginal nutrient deficiencies of strictly vegetarian (vegan) diets. Subjects reared on, or subsisting on lacto-vegetarian diets will, therefore, be at no nutritional disadvantage compared to those on non-vegetarian diets.

Other Shortcomings of Vegetarian Diets

There are a few other shortcomings of predominantly vegetarian diets that need consideration.

(1) Low-Calorie Density of Predominantly Cereal-Based Dietaries

Diets which are predominantly cereal-based have low calorie density. Infants and young children (unlike adults) may find it difficult to consume such diets in quantities adequate to meet their full energy needs. This (the bulk factor) is a major disadvantage of purely vegetarian diets in the matter of feeding of infants and young children. It is also, by now, generally agreed that the

major factor leading to PEM (protein-energy malnutrition) in poor children largely subsisting on cereal based diets is their low overall energy intake; protein deficiency is incidental to such energy inadequacy.

The three major approaches towards overcoming the low calorie density of cereal based dietaries are:

1. Inclusion of some fat in the diet; two teaspoonfuls of vegetable oil can supply about 70 calories and 4 teaspoonfuls 140 calories. This will not only increase overall calorie density of the diet but also increase its palatability.

2. Increasing the frequency of feeds so that it will not be necessary to stuff in all the needed calories in just 2 or 3 feeds.

3. Reducing the viscosity of cooked cereal diets by the use of such traditional methods as malting which could contribute to significant reduction in bulk and increase in calorie density. The classical studies of Desikachar(6) and Tara Gopaldas(7,8) have shown how the viscosity of cereal based foods meant for infant and child feeding, can be greatly reduced through the incorporation of ARF (amylase rick-food) that can be prepared in village house-holds by poor mothers using traditional methods without expensive inputs.

Lacto vegetarian diets which are not entirely cereal based but which include besides legumes and vegetables, fat and milk, should pose no problems with respect to infant and child feeding.

Tayter *et al.*(9) had compared the anthropometric measurements and nutrient intakes of "omnivore children" (non-vegetarian) with those of children of the same age who consumed lacto-ovo-vegetarian diets. Mean heights for both groups of boys (non-vegetarians and vegetarians) were above the 50th percentile values; mean weights were above the 50th percentile for non-vegetarian boys and above the 30th percentile for vegetarians. On the basis of the weight-for-length index (WLI), while 17% of non-vegetarian boys were considered obese, none of the vegetarian boys fell in the obese category; however, in the case of girls vegetarian diets were apparently not as protective against obesity as in the case of boys. The authors argue that differences in activity levels may explain these differences. The authors conclude that "a lacto-ovo-vegetarian pattern of eating seems to be as supportive of growth as an omnivore diet in preadolescent children and compares favorably for most nutrients". It would appear that while vegetarian diets promot linear growth (height increment) just as well as non-vegetarian diets, they are less likely to promote obesity. This must be considered an advantage.

(2) *Iron Deficiency in Vegetarian Diets*

The risk of iron-deficiency is greater with purely vegetarian diets as compared to non-vegetarian diets. Heme iron from cellular animal tissue is highly bio-available. Vegetarians, however, have to rely largely on non-heme iron which is relatively less well absorbed than heme iron, the absorption, being susceptible to the influence of other factors in the diet. While vitamin C can enhance absorption, phytates and phosphates, commonly found in cereal grains, can play an inhibitory role. Oxalates in green leafy vegetables can also exert inhibitory effects. Some forms of dietary fibre can also inhibit iron absorption. It is, therefore, important that vegetarian dietaries include foods rich in ascorbic acid which enhance the bio-availability of iron. As was pointed out earlier deficiency of vitamin B_{12} in purely

vegetarian diets can be prevented by inclusion of milk. Fortunately, leafy vegetables are rich sources of folic acid.

The Demands of Pregnancy

Women subsisting on vegetarian diets, especially during pregnancy should include a liberal intake of green leafy vegetables which supply besides carotene, vitamin C, folic acid, iron and calcium. Vitamin A, folic acid and vitamin B_{12} needs of the mother during pregnancy can be adequately met through ensuring daily adequate intake of green leafy vegetables and milk. However, it will be prudent to supplement the diet with iron and folate tablets at least during the last trimester of pregnancy.

In order to meet the increasing demands of pregnancy, ICMR's latest RDA report(1) suggests an additional intake of about 300 k calories for the pregnant woman over and above the levels recommended for her non-pregnant counterpart. It may be practically difficult to provide these additional calories to a pregnant woman through a diet which is predominantly cereal based; such a diet could become bulky and cause abdominal discomfort. It may, therefore, be necessary to significantly increase the fat intake in the diets of pregnant women on vegetarian diets. The practice in vogue in Punjab where pregnant women traditionally consume "panjiri" a preparation of wheat flour, fat and sugar that could easily provide an additional 300-400 calories daily is much to be recommended. It is necessary to ensure adequate energy-nutrition to the mother in pregnancy especially in the context of high incidence of low birth weight deliveries in the country.

Meat–Not an Essential Item

In any discussion on the nutritional adequacy of vegetarian diets, note has to be taken of the recent emerging views on the inadvisability of excessive meat intakes. Infact there is nothing in modern nutrition science to suggest that meat intake is obligatory in order to ensure optimal nutrition. Daily protein intakes in European and American dietaries now exceed 100 g, much of the protein being derived from animal sources. Since excess nitrogen cannot be retained in the body and has necessarily to be excreted, this order of protein intake is wasteful. Excessive consumption of meat implies unnecessary wasteful cycling through animals of food grains which can be *directly consumed* by humans. In the present context of hunger afflicting large masses of people in developing countries, excessive meat intake of the order prevailing in Europe and North America can be considered anti-social, inhumane, and wasteful.

Apart from these considerations, purely from the scientific point of view and the point of view of human health, the arguments against excessive meat intake and in favor of a balanced diet largely based on vegetable foods are the following:

1. A recent WHO report(10) points out: "As recently as the 1970s, protein deficiency was widely thought to be the fundamental cause of global malnutrition. Acting on this assumption, considerable efforts were made to increase people's, intakes of "quality" protein from animal sources.

"Progressively it was recognized that even in totally vegetarian diets containing a diversity of foods, plant sources, tended to complement one another in amino-acid supply. Although the total amount of protein in the diet may need to be higher in vegetarian diets to provide an adequate intake of all the amino acids, the usual concentrations of proteins in these diets are sufficient. If the energy needs of the child or adult are met by these diets, then so are the

amino acid needs(11).

2. Sirtori *et al.*(11) showed that when vegetable proteins (soya protein) was substituted for animal protein there was a 14% decrease in plasma cholesterol after 2 weeks and a 21% decrease after 3 weeks with the overall level and type of dietary lipid intake remaining constant.

3. The WHO report also claims: "Evidence indicates that a diet low in total and saturated fat, high in plant foods, especially green and yellow vegetables and citrus fruits, is consistent with a low risk of many of the major cancers of the world today".

"Although the mechanisms underlying these effects are not fully understood, such diets are usually high in starches and fibre as well as in several vitamins and minerals including B carotene(11).

In this communication, we have tried to examine the nutritional adequacy of vegetarian diets purely from the *scientific* point of view. We are not concerned here with vegetarianism as a cult but as a possible salutary dietary practice, consistent with good health and nutrition, and in keeping with the traditions of Indian people, their economic resources and cultural dietary practices.

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