

VEGETARIAN DIETS

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INTRODUCTION

A rapidly rising world population presents an increasingly grave threat to world food supplies. An adequate diet may be compounded in many ways, but the simplest dietary regimen known to man depends entirely, or in large part, on the plant kingdom. Such a program is generally referred to as "vegetarianism". In a broad sense this term may connote much more than abstinence from flesh foods. It is frequently associated with asceticism, philosophy, or other specific beliefs. Vegetarian diets have been significant in nurturing and sustaining man throughout the ages. In more recent history, vegetarianism has been practiced in many forms for a variety of reasons, including the more basic, such as economic, as well as the more lofty, such as philosophic or religious.

The purpose of this report is to summarize the concept of vegetarianism. First, some working definitions and a cursory review of the prevalence of vegetarian eating habits will be presented. Second, the risk which exists for those who fail to plan their vegetarian diets carefully will be reviewed. Third, the possible health benefits associated with vegetarian eating will be discussed. Finally, practical principles for counseling and diet planning will be listed.

HISTORY AND DEFINITIONS

History

The word "vegetarian" refers to a person whose diet is devoid of meat, fowl and fish. He may or may not eat eggs and/or dairy products (1). Vegans are those that totally abstain from all animal foods.

Vegetarianism has been practiced in different parts of the world

since time immemorial. Voluntary vegetarianism is not a new concept. The history of vegetarianism shows that a diet free of meat has been consumed by various religious and cultural groups for ethical reasons. On the other hand, the "new" vegetarians follow this type of diet for health, ethical and/or spiritual motives. The history of vegetarianism as reviewed by Hardinge and Crooks (2) and by Majumdar (3) will be discussed below. The Biblical Scriptures indicated that the human diet first consisted of fruits, seeds and nuts. Later this diet was modified to include the "herb" or vegetables. A second modification, which took place after the deluge which destroyed all vegetation, permitted one to have flesh food provided it was from clean animals of which more than one pair existed. Jews and Mohammedans follow this distinction to a lesser or greater extent.

Persons following the oriental religions such as Hinduism, Brahmanism, Buddhism, and Jainism believe in the transmigration of souls. Hence, preservation of animal life becomes an important aspect of their life. According to Vedas, the holy book of India, a fleshless diet is recommended but no sin is attached to nonconformity.

The Egyptians, nicknamed "eaters of bread", grew cereals from predynastic times. The intestinal content of mummies show that their diet was composed of plant foods. Persians of ancient origin were flesh eaters but the magi, the religious head, avoided meat. Unless necessary, Mohammedans are nonvegetarians. Yet they abstain from "unclean" meats like pig.

History records that during times of prosperity and security, eating meat and drinking wine became the rule. Frugality and simplicity of life styles were associated with diets of plant foods. Pythagorus, Plutarch, Porphyry and Pliny warned that such indulgences as meat and wine would eventually lead a nation to its downfall. Pythagorus, in the sixth century B.C.,

strongly expressed his views for a meatless diet. He is considered to be a founder of the vegetarian movement which started in Greece and proceeded toward Rome. The movement was well supported and led by Empedocles (490-430 B.C.), a Greek philosopher and statesman. Religious and moral convictions, rational arguments and a belief of transmigration of souls led people to practice vegetarianism during that period.

By the turn of the 18th century, vegetarian diets were consumed by many people. Among them was Benjamin Franklin (1706-1790), the American statesman. William Stake (1740-1790) served as a human subject in the first recorded experimental study and lived on bread and water. Twice he developed scurvy, the second time proved fatal.

In 1809, a vegetarian movement started in Manchester, England. During this period, members of the Bible Christian Church headed by William Cowherd took an oath not to consume alcoholic drinks or flesh foods. In 1811, William Lambe, a British physician, wrote The Return to Nature, which started modern vegetarianism. Vegetarianism crept into America when 41 members of the Bible Christian Church headed by the Reverend William Metcalfe travelled to the United States. A number of vegetarian sanatoriums were established in the U.S. by the middle of the 19th century. In recent years many restaurants which cater to the needs of vegetarians have opened in prominent U.S. cities.

Economists believe that production of animal foods is not an efficient use of agricultural land. Plant food is said to be of great importance during times when the world's population is growing in geometric proportions. Today scientists all over the world are attempting to develop ways of improving both quality and quantity of plant foods to meet the requirements of the growing population at large.

Definitions

During the course of history, many individualistic vegetarian regimes with diverse dietary patterns developed. Definitions evolved based on the types of foods avoided. Thus, lacto-ovo vegetarians consume dairy foods, eggs and plant foods; lacto vegetarians consume dairy products in addition to plant foods; fruitarians permit only raw or dried fruits and nuts, honey and olive oil in their diet. Characteristically, vegans are those who eliminate all animal foods from their diet. Pesco-and pollo-vegetarians are those that allow fish and poultry, respectively and may or may not prescribe dairy foods and eggs.

The older vegetarian groups with religious and ethnic orientations in the U.S. are Seventh-Day Adventists, Trappist Monks and the followers of Hinduism (2). The Trappist Monks, consume whole wheat bread, cereals and usually some milk with vegetables and fruits and exclude meat from their diet. A lacto-ovo vegetarian type of diet is officially recommended for Seventh-Day Adventists, but the exclusion of meat is entirely voluntary. Followers of Hinduism consume a fleshless diet because of their belief in transmigration of souls.

The recent past has identified many new adherents of vegetarianism (5). These "new" vegetarians, have adopted plant diets as the basis for good health, but are differentiated according to their extensiveness of food avoidances, or affiliations with groups advocating vegetarian diets. The "new" vegetarians are classified as either "circumscribed" or "far reaching". Circumscribed vegetarians avoid three or fewer classes of animal foods out of five possible classes (meat, poultry, fish and sea foods, eggs and dairy foods). Far reaching vegetarians avoid four or all five classes of animal food.

"New" vegetarians are also classified as "joiners" or "loners" (5,6). Joiners or group-affiliated subjects adopt rigid dietary practices and

emphasize macrobiotics raw foods, yoga or health foods. Loners are those who have antislaughter and other idiosyncratic convictions and thus avoid meat.

Various other reasons for following vegetarianism have been attributed to the "new" vegetarians (7). These include health, ecological, metaphysical, economic and political concerns. However, a common school of thought seemingly prevailing in all "new" vegetarians is the belief that a meatless diet can purify bodies and souls. An attempt is being made to develop vegetarianism so that it evolves as a new religion and a better lifestyle, as well.

Many "new" vegetarians have joined one of the new cults now existing (7). Each cult has its own importance, reasoning and a distinctive style. Taboos prevail in each sect and hence it is important to describe how they affect the social living. Most sects associate with some form of supernatural force which guides the group along to psychic tranquility. The macrobiotic movement is a good example. George Ohsawa, founder of this movement, defined macrobiotics as "the path of longevity and peace of mind through belief in Zen and adoption of rigid dietary practices". This movement followed the ancient Oriental system of "Yin" and "Yang" through a ten dietary stage regimen starting from an omnivorous diet to a vegetarian diet and gradually progressing to an ultimate diet of only brown rice.

Other vegetarian groups have been described by Erhard (8). The Messiah Crusade, better known as the "One World Family Commune", is a religious sect that attempts to create a healthy body state by discouraging consumption of meat, eggs and dairy products. (8). Yoga followers believe that meat is so near decomposition that its toxic burden on the body might result in uremia. It is also against their most basic philosophy of reincarnation.

However, Yoga followers are a diverse group ranging from fruitarians to lacto-ovo-vegetarians. The New Vrindavan International Society for Krishna Consciousness, originating in India, demands that its followers eat a meatless diet. Their "prasadam" or the spiritual food consists of fruits, vegetables, and milk. The Ehrests Mucusless Diet Healing System follows a diet that is largely composed of fruits. This group is very rigid about its vegetarian eating habit because of their belief that meat produces mucus which is a seat for many diseases. An extreme degree of vegetarianism has been the vegan diet. The basis for this diet is compassionate living, nonkilling and noninjuring. The American Vegan Society avoids killing animals for food to maintain one's physical, emotional, mental and spiritual well-being. Veganism is characteristically very severe and restricts the usage of animal derived wool, silk, leather, fur, pearl, soaps or cosmetics.

Thus vegetarianism is a broad term which encompasses varied dietary patterns. There is good documentation about the traditional vegetarians. At the same time, little is known about the new vegetarians. The recent upsurge in the number of vegetarians suggests that there is a need to learn more about vegetarians and their dietary patterns.

RISKS OF VEGETARIAN DIETS

In general, whenever a diet is restricted in food sources, the probability of its meeting all the nutrient requirements for an individual decreases. Vegetarian diets have characteristic deficiencies in them, but when carefully planned and skillfully implemented, they can supply sufficient calories, optimal ratios of essential amino acids and adequate sources of calcium, iron, riboflavin and most vitamins (9). In this section, the risks faced by persons consuming vegetarian diets will be discussed in detail.

The major risks of vegetarian diets are deficiency diseases especially during times of life such as infancy and during rapid period of growth during adolescence (10). Vegans are more susceptible to nutrient deficiencies than other classes of vegetarians (11). The vegan diet differs strikingly from the less restricted vegetarian diets and does not tend to meet the recommendations (RDA) set by the Food and Nutrition Board of the National Research Council (12) for food energy, total protein, zinc, iodine and vitamin B₁₂.

Dietary and growth studies

Various investigators have studied the growth and development of children who consumed vegetarian diets. Fulton et al, (13) determined the average daily dietary intake of food energy, protein, three minerals and six vitamins of 48 preschool children (2-5 years old) living in a pure vegetarian commune in Tennessee. Their all plant dietary was supplemented by addition of 6.25 mcg of the vitamin B₁₂ to each 8 oz. of soy milk and addition of yeast (which contained 2 mcg vitamin B₁₂/tbsp) as a flavoring agent to many foods. Mean intakes for all age groups exceeded the allowances for all nutrients with the exception of food energy, calcium, phosphorus, and iron. However, intakes of vitamin A, riboflavin and niacin probably were below two-thirds of the allowance for some children. The mean percentages of the RDA for calcium consumed was less than 50 for all groups of these children. This was attributed to the fact that no dairy products were consumed and all of the calcium obtained was from vegetable sources. The researchers stated that the low calcium intake of these preschoolers, coupled with the high-phytate diet, suggested a need for further investigation. Phosphorus intakes were not as low as calcium intakes because of the amounts of phosphorus in legumes and grains. Mean iron intake of the 2- and 3-year-old girls was 93% of the RDA, but all

other groups exceeded the RDA for iron. In addition to dietary sources, iron also was available to 35 of the children through food cooked in iron cookware and to 12 children from vitamin and mineral supplements. Mean intakes of vitamin B₁₂ were adequate when compared to the RDA, but there was great variability in levels of intake of individual children. One child received no vitamin B₁₂ during the 3-day period studied. Mean heights and weights of the 2-year-old children met or exceeded the Health and Nutrition Examination Survey (HANES) (14) values, but mean heights and weights of 3- to 5-year-old children were below the HANES findings.

Dwyer et al. (15) examined 119 vegetarian preschool children in the Boston area to observe the effect of vegetarian diets in the early part of life. Among the 119 subjects, 49% followed a macrobiotic dietary pattern, 24% were members of various yogic groups, 10% were followers of the Seventh-Day Adventist faith, and 17% were not affiliated with any group. More of the Children's measurements were below the Harvard 50th percentiles for length and weight after 6 months than expected. (16). Vegetarian children were leaner as determined by skinfold measurements after 6 months of age. A⁺ association of vegetarian diets with smallness, lightness, and leanness was more pronounced among the older, nonbreast-fed and macrobiotic children.

Shull et al. (17) observed the growth velocities of vegetarian preschool children in the Boston area and compared them to norms established from the Harvard Growth Study. The children were classified as either macrobiotics or nonmacrobiotics. Growth velocities of vegetarian children under 2 years of age were depressed. A greater percentage of vegetarians had low weight and length measurements than did the nonvegetarian controls (Table 1). Low caloric density of weaning foods in many vegetarian diets resulted in poor growth velocities during the weaning transition. The investigators stated that perma-

Table 1

Weight and length measurements of 72 vegetarians and 34 control preschool compared to age and sex-appropriate Harvard standards (15).

	25%	25% - 75%	75%
Weight			
Vegetarians (N=72)	31	24	17
Controls (N=34)	5	17	12
Length			
Vegetarians (N=72)	33	23	16
Controls (N=34)	15	13	6

nent consequences of growth retardation depends on its timing and severity. Malnutrition or disease may cause a retardation in the second phase of growth (6-18 months). At this stage, if the diet is not adequate, the infant loses his acquired immunity. In the final phase of preschool children's growth (18 months to 5 years), catch up growth is possible. But because of low velocity of growth and long duration of insult there may be a failure to overcome a previous retardation and a smaller size may result. Vegetarian children may experience more illnesses than nonvegetarian children, which are reflected in their growth pattern.

Vitamin D and vegetarians

Most macrobiotics children are on borderline vitamin D malnutrition. A study of dietary intake of 52 preschool children from the Boston area seen

from 1974 to 1976 demonstrated that macrobiotic vegetarian diets provided marginal amounts of vitamin D, calcium, and phosphorus. These amounts were less than those of other vegetarian diets (18). During this period it was noticed that vitamin D supplements were seldom given. Some subjects even showed roentgenographic evidence of rickets. Vitamin D deficiency rickets a rare disease in America, occurs in those children who subsist on vegetarian diets that provide little or no animal foods. It is more pronounced in those who live in northerly latitudes where exposure to sunlight is very minimal. Vegetarian children on macrobiotic diets obtain only small amounts of vitamin D from their diets. In general, health histories of children on these vegan diets were more likely to include signs of rickets than those on less restricted vegetarian diets. Dwyer and others, (19) in a more recent study with 39 preschool children from the Boston area, indicated that the mean intake of vitamin D in macrobiotics was one-eighth of the RDA. Macrobiotic children had lower intakes of vitamin D than those of the other groups of vegetarians studied.

Protein

The primary sources of dietary protein in most vegetarian diets is plants.(20). In most of the third world countries, dietary protein is supplied predominantly from plant sources. The nutritive value of the plant protein is low because of amino acid deficiencies or imbalances. Consequently, the dietary protein is inadequate. Many approaches have been used to increase the quality and quantity of protein in plant foods. These include amino acid fortification, use of protein mixtures (protein supplementation and complementation), and genetic alteration of food crops. This need has been emphasized in vegetarian diets to meet the protein requirements of the body.

In terms of composition, the most perfect dietary protein for man is human protein (21), but most animal proteins also are high in biological value. Proteins differ in their composition of essential amino acids present in them (22). Animal proteins (eggs, meat, milk and cheese) are generally high in leucine, isoleucine lysine, threonine and valine. The proteins of legumes, whole grains, nuts, and vegetables contain those amino acids but at much lower levels.

Plant proteins are usually low in a particular essential amino acid (21). Wheat protein is deficient in lysine and maize in tryptophan. However, the mixing of plant proteins gives a biological value as good as some animal proteins. This can be illustrated by the fact that if wheat protein with a protein score of 53 when mixed with soy flour having a protein score of 73, in the ratio 7:3 gives rise to a flour mixture with a protein score of 72. The chemical scores of rye, oats, and rice are as high as 80, 79, and 72% respectively.

Hardinge et al. (22) stated that nonvegetarians in their California study obtained more than two-thirds of their total protein from animal foods. About half of this was obtained from meats and the rest from milk, cheese and eggs. The lacto-ovovegetarians, on the other hand, derived approximately half of their total protein from milk, cheese, and eggs. A diet high in cereals is usually low in lysine. However, liberal use of grain products did not result in lysine deficiency in the pure vegetarians. The intake of total sulphur-containing amino acids (S-AA) of all the three dietary groups, the lactovegetarians, pure vegetarians, and nonvegetarians, was almost identical. The pure vegetarians had relatively less, but not an inadequate intake, of methionine. No evidence of protein deficiency was found in any of the three groups and each group met or surpassed the RDA for protein.

Marsh et al. (23) studied the metabolic response of adolescent girls to a lacto-ovovegetarian diet. The intake of essential amino acids far exceeded the minimal requirement for women for every amino acid. Ellis et al. (10) reported no association between body weight and protein intake of 26 vegans. All the subjects met the RDA requirements for protein.

Abdulla et al. (11) in a recent study of middle aged vegans in Sweden found that the intake of essential amino acids exceeded the RDA set by the Food and Nutrition Board in the United States in all the 6 subjects. However, the mean protein intake (47g for men and 37g for women) was considered below international recommendations (57g) when its plant origin was taken into account. When protein intake was related to urinary excretion of nitrogen, positive nitrogen balances were recorded. Hence, an adequate amount of protein was consumed. None of the subjects studied presented clinical or biochemical indications of protein deficiency.

According to Shinwell and Gorodischer (24), 25 infants on totally vegetarians diets who were admitted to a hospital in Israel showed evidence of protein-calorie malnutrition. Three of the infants were dead on arrival and five more died within a few hours of admittance. All of the infants showed severe malnutrition without edema (marasmus) or with protein deficiency and edema (kwashiorkor). Persistent attempts were made to find suitable dietary modifications that would conform to the vegan philosophy. The authors stated that these attempts failed and still remain a challenge to pediatricians and nutritionists.

Majumdar (3) reported that in a vegetarian diet, there is limited choice of good protein. Because of the lack of amino acids in all plant foods, vegetable proteins are considered "second class" proteins. Vegetable food is less concentrated because of the high moisture content. Hence a larger quantity

of plant foods than animal foods have to be consumed for the same food value. Majumder pointed out that combinations of several food types, such as milk, cheese (lactoalbumin), soybean products (glycinin), Brazil nuts (excelsin), and enriched corn and wheat (glutenin) would provide vegetarians a completely adequate protein supply. This is however, not possible in a population existing at subsistence level. Thus a nutritionally balanced vegetarian diet is not only impractical at times but also has several economic and ecological implications.

Although protein has been highlighted for malnutrition, the problem is often compounded by a total calorie deficit (10). Even when an adequate amount of protein is provided, the symptoms of protein deficiency may still appear if the diet does not provide enough calories. In such a condition some of the protein is utilized for energy.

Vitamin B₁₂ deficiency among vegetarians

Most studies done on vitamin B₁₂ status in vegetarians infer that this vitamin could be deficient in the diet of vegetarians, especially vegans, unless great care is taken in diet planning (25-28). Vitamin B₁₂ has been of particular interest in vegetarian diets because of its availability only in foods of animal origin. Ellis et al. (10) found that the mean serum B₁₂ level of 26 vegans was much lower than that of control subjects. Infants on strict vegetarian diets are specially at risk.

Severe vitamin B₁₂ deficiency symptoms were observed by Higginbottom et al. (29) in an infant of six months who was exclusively breastfed by a very strict vegetarian mother. Biochemical abnormalities included methylmalonic aciduria, cystathionuria, glycinuria, methyl citric aciduria, 3-hydroxypropionic aciduria and formic aciduria. The infant had severe megaloblastic anemia, was in a state of coma and showed hyperpigmentation of the extremities. The

authors (29) suggested that this severe form of deficiency was a consequence of inadequate intake of vitamin B₁₂, for the infant was exclusively breastfed by a strict vegetarian mother who manifested methylmalonic aciduria.

Severe nutritional deficiencies developed in four infants (5 to 13 months) admitted to a hospital from a vegan community in Israel who consumed a diet that was totally vegetarian and did not include eggs, milk, artificially processed foods, or vitamins (25). Profound vitamin B₁₂ deficiency was noticed in these infants who had received breast milk until the age of 3 months. The infants responded well to treatment which included almond milk and soya milk fortified with vitamin B₁₂ (Fig 1). On discharge the mothers were advised to give the infants a daily vitamin B₁₂ supplement, but they did not follow this on a regular basis.

Weighton et al. (26) examined an exclusively breastfed infant of a vegetarian mother. They noticed neurological deterioration at about 3 months of age which progressed to a comatose premoribund state by 9 months. Investigation revealed nutritional vitamin B₁₂ deficiency in the mother and very severe megaloblastic anemia in the infant. The infant responded very well to a vitamin B₁₂ supplement. Clinical and hematological improvement was obvious, but neurological recovery was not satisfactory. The investigators concluded that dietary vitamin B₁₂ deficiency was the only cause of the infants deterioration.

Jathar and Deshmukh (30) studied the plasma and erythrocyte vitamin B₁₂ levels in pregnant Indian women who were consuming very little food of animal origin and compared them with nonpregnant women consuming a similar diet. A distinct fall in hemoglobin, packed cell volume, plasma vitamin B₁₂ and albumin levels was observed in the pregnant women. Jathar and Deshmukh implied that the need for vitamin B₁₂ increases during pregnancy.

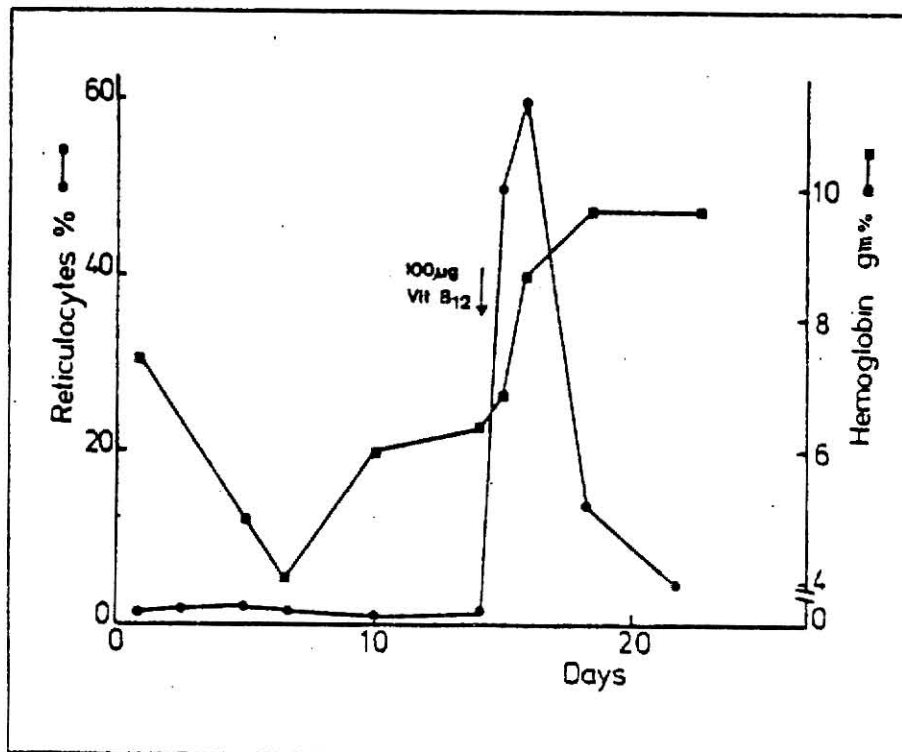


Fig.1 Hemoglobin and reticulocyte response to vitamin B₁₂ administration to 4 infants (25)

The vitamin B₁₂ deficient subjects in the various studies reviewed (25-27) responded well to vitamin B₁₂ supplements and dietary modifications. Weighton et al. (26) recommended that all strict vegetarians especially women in the child-bearing age group, take vitamin B₁₂ supplements. Other authors emphasized the importance of educating strict vegetarians about the deficiency of vitamin B₁₂ in their diets and the importance of vitamin B₁₂ supplements (29).

Iron

Most iron from foods is absorbed in the small intestine as either heme or nonheme iron (12). Heme iron which is derived solely from animal food sources is more bioavailable than nonheme iron. Approximately 40% of the total iron in animal tissue is heme and the remaining 60% is nonheme.

Anderson et al. (31) reported that breads and cereals provided 32%, vegetables 25%, dry legumes and nuts 18% and fruit 17% of the iron intake of 9 vegan and 47 lacto-ovovegetarian women. The study indicated that 22% of the 56 women were at moderate risk judged by hemoglobin level. Eight percent were at high and 6% were at moderate risk judged by serum transferrin. There was no significant difference in hemoglobin, hematocrit, serum iron, total iron binding capacity or serum transferrin between the 20% of the sample who took iron supplements regularly and the 80% not taking any supplements. Agarwal (32) pointed out that rural and pregnant women in India who were on vegetarian diets had very low intakes of iron.

Several other studies conducted on vegetarians have indicated that iron is likely to be deficient in meatless diets. (4, 24, 33, 34). Ganapathy and Dhanda (35) studied young adult Punjabi students accustomed to a lacto-

ovovegetarian diet who maintained their food intake and habits while studying in the USA. Their diet was inadequate in iron and several other nutrients. In Brown and Bergan's study of the "new" vegetarians, only one woman met the allowance for iron and eleven out of twenty-one consumed less than 60% of the allowance. These vegetarians consumed plant foods and some animal foods, including fish, cheese and poultry, all of which are poorer sources of iron than red meats. Marsh et al. (36) reported that approximately half of the lacto-ovovegetarian women participating in their study consumed less than 60% of the allowance for iron. The dietary intake of iron did not appear to be a serious problem in lacto-ovovegetarian men.

Gopaldas and Capoor (37) in a nutritional study on 274 apparently healthy Gujarati vegetarian boys in India noticed that mean hemoglobin levels nearly equalled the WHO recommended values. None of the subjects manifested any clinical sign of nutritional anemia. This was explained by the dietary intake of iron that far exceeded the RDA. Dwyer et al. (19) commented that mean iron intakes of vegetarians approximated the RDA in their study that involved 39 preschool children consuming different types of vegetarian diets.

Plant products provided 92% of total dietary iron for 56 Seventh-Day Adventist (SDA) Canadian women studied by Anderson et al. (38). More than 85% of these vegetarians ate meat, poultry or fish less once a month. The mean daily amount of iron available for absorption was found to be 81% of both FAO and WHO standards. The iron density of SDA vegetarian diets was higher than that for the general population in the Nutrition Canada Survey. The authors related the iron status to dietary fiber intake and reported that SDA vegetarians of this study had a significantly higher dietary fiber intake than nonvegetarians. However, results in the study suggested that any adverse effects of fiber on iron availability were not sufficient to produce sub-

optimal iron status in long-term vegetarians. It was speculated that long-term vegetarians had adapted to their vegetarian diet by increased absorption of dietary iron.

A varied and well-balanced diet meets the iron needs of the human body (39). Little amounts from many places add up significantly. Other nutrients from a mixed diet such as the copper in green leaves, protein in soybeans, and vitamin C and citric acid in citrus fruit facilitate iron absorption. Use of cast iron cookware is recommended for an iron deficient vegetarian.

Zinc deficiency in vegetarians

Another nutrient of concern in a vegetarian diet is zinc. Harland and Peterson (33) observed low zinc levels in blood and urine of men in a Trappist monastery, who were on a lacto-ovovegetarian diet. Freeland et al. (40) examined the zinc content of 74 vegetarian foods and stated that legumes, seeds, nuts, whole grains, hard cheeses and some nutritional supplements were excellent sources of zinc. Vegetables, fruits and their products are poorer sources of zinc. Small amounts of zinc are present in milk and milk products, including rennetless cheese.

Although many foods have adequate zinc in them, a high fiber content may limit its availability. Freeland et al. (41) reported that 79 vegetarians, who avoided animal products in their diets, consumed low amounts of zinc and high amounts of crude fiber. They observed that lacto-ovovegetarians ate twice the amount of crude fiber as compared to nonvegetarians and vegans consumed 4 times as much.

The zinc content of salivary sediment was significantly lower in the vegetarians studied by Freeland et al. (41) than in nonvegetarians.

There was an inverse relationship observed between the zinc content in the saliva and the amount of crude fiber in the diet. Characteristically, zinc in hair was less in vegetarians than in nonvegetarians. An increase in crude fiber coupled with decreased values of zinc in saliva and hair seemed to indicate that vegetarians, particularly women, have less than normal zinc status.

Anderson et al. (38) studied 56 Seventh-Day Adventist (SDA) Canadian women who had followed vegetarian diets for more than 15 years. The SDA vegetarians had a significantly higher dietary fiber intake than non-vegetarians. However, in contrast to the Freeland et al. study (40), the zinc status of these long-term vegetarian women appeared adequate despite their low intake of readily absorbed zinc from flesh foods. They concluded that this group of vegetarians might have adapted to their vegetarian diet by increased absorption of dietary zinc.

Zinc requirements are generally increased during pregnancy. Hence, pregnant vegetarian women may be at a greater risk of developing poor zinc status than pregnant nonvegetarian women. Based on this hypothesis, King et al. (42) studied the zinc status of 12 pregnant lacto-ovovegetarian women, 6 pregnant nonvegetarian women and 5 nonpregnant lacto-ovovegetarian women. Dietary, plasma and urinary zinc levels did not differ significantly between the pregnant vegetarians and nonvegetarians. Consumption of a lacto-ovovegetarian diet did not appear to alter zinc status in this group of vegetarian women. One of the reasons attributed to this finding is that there was no significant difference in any dietary constituent measured in the two groups. The investigators found that zinc status of lacto-ovovegetarians is not at risk when diets contain less than 9.0 g crude fiber. In their study, the consumption of crude fiber by vegetarians was 8.9 g as opposed to 4.8 g by nonvegetarians.

The parameters of zinc status were affected by pregnancy more than by the lacto-ovovegetarian dietary intake.

The effect of a lacto-ovovegetarian diet on plasma zinc tolerance tests and plasma and saliva zinc concentration was measured in 12 nonvegetarian women (43). Zinc in salivary sediment significantly decreased from initial values of 128 to final values of 94 mg/g. The increased plasma response to zinc load and decrease in salivary sediment zinc after a vegetarian diet indicated that diet can adversely affect zinc status.

Phylate: zinc molar ratio, minerals and fiber contents of regular lacto-ovovegetarian and soya meat-substitute hospital diets were estimated by Ellis et al. (44). They found that the phylate: zinc molar ratio, minerals and fiber contents of the soya meat-substitute diet were significantly higher than those of the lacto-ovovegetarian diet.

Other vitamins and minerals in vegetarian diets

Mason et al. (45) measured the food intakes of 36 nonvegetarians and 42 vegetarian women on lacto-ovovegetarian diets. While intakes of phosphorus, iron, sodium, and potassium were similar for the two groups, vegetarians consumed more thiamin and less niacin. Vitamin A, riboflavin and ascorbic acid did not differ significantly. Vegetarians consumed 100% or more of the recommended allowance for ascorbic acid.

Agarwal (32) indicated that the mean intakes of retinol and ascorbic acid in lacto vegetarian women in India were below the recommendations of the Indian Council for Medical Research (ICMR) and of the U.S. National Research Council. Ascorbic acid intake was adequate only among the urban pregnant women, because they consumed greater amounts of citrus fruits.

Nutrients which may be of marginal content in strictly vegetarian diets are calcium, iron, riboflavin, vitamin B₁₂ (34). Riboflavin has been

identified as a problem in those diets that exclude milk and its products. Abdulla et al. (11) observed adequate intakes of potassium, magnesium, iron, sodium and copper in a Swedish vegan diet. Iodine and selenium were low in the vegan diet while it was rich in folic acid. Ganapathy and Dhanda (46) obtained similiar findings about selenium in their study.

Gibson et al. (47) compared the copper, manganese and selenium status of 36 post menopausal vegetarians, of which 8 were vegans and 28 were lacto-ovovegetarians, with that of a group of post-menopausal omnivores. Their study indicated that copper and selenium status of vegetarians was comparable to that of nonvegetarians, despite their high intake of dietary fiber. Manganese intake of vegetarians exceeded the intake of some of the controls.

BENEFITS ASSOCIATED WITH VEGETARIAN DIETS

This section will emphasize possible benefits of vegetarians and the potential for decreased risks associated with vegetarian eating. Vegetarians seem to exhibit fewer health associated problems such as obesity, constipation, coronary heart disease, diverticular disease of the colon, kidney stones, diabetes mellitus, high blood pressure and colon and breast cancer.

Coronary heart disease

Phillips et al. (48) in a 6-year study examined 24,044 Californian Seventh-Day Adventists who were consuming a lacto-ovovegetarian diet. The diet reduced the risk of coronary heart disease considerably. The risk of fatal coronary heart disease among nonvegetarian Seventh-Day Adventists between 35 to 64 years old was three times more than for their vegetarian counterparts. The investigators suggested a strong correlation between the vegetarian diet and the decreased incidence of coronary heart disease.

Simons et al. (49) explained that vegetarian diets affect the amount of cholesterol in the body. In their study, Seventh-Day Adventists following a vegetarian diet, had significantly lower plasma cholesterol and triglycerides than nonvegetarians. The dietary intake of cholesterol and the percent absorption of cholesterol were lower in vegetarian than nonvegetarians. Burslem et al. (50) noted that after an overnight fast, blood was taken from 58 vegetarian men and women. Mean lipoprotein cholesterol intake was less than 10 mg daily. Apolipoprotein A-1 (Apo A-1) and apo B values were lower while high density lipoprotein (HDL) cholesterol: Apo A-1 ratios seemed to be higher in vegetarians than in normolipemic free living nonvegetarians. The vegetarian's very low density lipoproteins (VLDL) and low density lipoproteins (LDL) decreased while both amount and composition of HDL were increased. The changes in LDL values, HDL cholesterol : LDL cholesterol ratios and HDL cholesterol : Apo A-1 ratios would each place vegetarians in a low risk category for the development of atherosclerosis. The study of Burr et al. (51) also indicated that vegetarians have a low total serum cholesterol and a high HDL percentage.

Vegetarians have low average plasma lipid values (52, 53). Possible mechanisms were studied and was concluded that vegetarian diets are associated with low levels of low density lipoprotein and increased levels of high density lipoprotein. This places their counterparts, the nonvegetarians, at a higher risk for coronary heart diseases. A vegan type of diet may be one of the choice in the treatment of ischemic heart disease, angina pectoris and certain hyperlipidemias. The study done by Sainani et al. (54) indicated that the group who totally abstained from onion and garlic had significantly higher levels of serum cholesterol, triglycerides, beta lipoproteins and phospholipids. Even those consuming small amounts of garlic and/or onion were

better protected as compared to subjects with total abstinence.

Blood pressure

There is a significant increase in systolic and diastolic blood pressure associated with meat eating (55). Sacks et al. (56) studied 21 strict vegetarians who were fed their usual vegetarian diet for a 2 week control period, followed by 4 weeks during which 250 g beef was added to the daily vegetarian diet and then by 2 weeks of the vegetarian diet. Plasma HDL cholesterol did not change whereas plasma total cholesterol increased significantly (19%) by the end of the meat eating period. Systolic blood pressure increased significantly (3%) during the meat eating period. This study suggested an adverse effect of intake of beef on plasma lipids and blood pressure.

Armstrong et al. (57) stated that dietary amount of sodium does not explain the blood pressure difference between vegetarians and nonvegetarians. However, their study showed a positive correlation between systolic and diastolic blood pressure and plasma cholesterol values, which were lower in vegetarians than in nonvegetarians.

Obesity

Various studies indicated that weights of vegetarians usually are closer to desirable weights than are weights in the omnivore population (11, 17, 24). Vegans may reach the point of emaciation and growth may be affected. However, this is the exception rather than the rule. Vegetarians as a group, especially vegans, have lower weights for their heights than nonvegetarians (58). Dwyer et al. (59) observed a higher incidence of lower percentile subscapular skinfold thickness and arm muscle circumference than the standard

in groups of children of macrobiotics and other vegetarian types. Generally, vegetarian children 12-35 months, were likely to have low skinfold thickness and those on macrobiotic diets were likely to be short and light. However, vegetarianism is said to offer no protection against obesity (58).

Diabetes Mellitus

Diabetes mellitus, like obesity, is thought to be rare in vegetarian populations eating most of their carbohydrate in the form of starches containing large amounts of fiber (60). Epidemiological studies indicated that the incidence of adult-onset, non ketosis-prone diabetes mellitus was reduced among persons existing on vegetarian diets. Control for insulin-dependent diabetes is achieved by diets high in complex carbohydrates and low in added disaccharides (61). Jackson et al. (62) noted that vegetarians ate twice as much legume seeds, almost 3 times as much vegetable oil, more fruits and vegetables and ate the same amount of sugar as their nonvegetarian counterparts. A glucose screening test done on 12 out of 107 vegetarian subjects indicated a diabetic condition. The authors emphasized that vegetarians and the general population were very similar in mean blood glucose concentration and in the incidence of hyperglycemia. Thus vegetarianism practiced by these subjects did not protect them from diabetes mellitus.

Constipation

There is good evidence that vegetarians suffer less from constipation. It is postulated that higher intakes of foods rich in dietary fiber such as whole grains, fruits, vegetables and various kinds of seeds, which increase fecal bulk, decrease constipation in vegetarians (60).

Diverticular disease of the colon

Mendeloff (60) studied a rural population in Africa which ate very large amounts of vegetable products with 50 g dietary fiber per day. This group was free not only from diverticuloses but also from appendicitis, polyps of the colon, cancer and hiatus hernia. Mendeloff explained that carcinogens or cocarcinogens arising in the colon or traveling through the small intestine into the colon are diluted in the large amount of stool water associated with higher fiber diets and the entire fecal content is expelled more rapidly and provides less contact time. Ease of passing stools decrease the strain and hence decrease the frequency of hiatus hernia. Gear (63) observed a lower incidence of diverticular disease in vegetarians and related it to higher dietary fiber intake.

Incidence of cancer

Epidemiological studies have demonstrated a correlation between risk of cancer of breast and colon and diets high in meats, fat and refined carbohydrate (64). Vegetarians living in western countries have lower incidence rates for some forms of cancer. Vegetarian diets appear to alter the metabolism of hormones (65,66). Goldin et al. (65) indicated that vegetarian women excrete 2 to 3 times more estrogens in feces than do omnivorous women. A greater amount of biliary estrogens escapes reabsorption and is excreted and this difference in estrogen metabolism in vegetarians is believed to be the cause of the lower incidence of breast cancer.

Eating a fiber-rich diet or adding cellulose to the diet lowers serum cholesterol (67). A high fiber diet increases the excretion of bile acids in the feces. The bacteria in the colon degrade bile to form precursors

of carcinogens. These noxious compounds remain in contact with colonic mucosa for a longer time in a more concentrated form when a fiber deficient diet is consumed. Diets containing fiber result in large, soft stools that traverse the intestine rapidly. This mechanism explains the prevention of both benign and malignant tumors of the colon and rectum.

Renal stones

Robertson et al (68) stated that among men in their study, recurrent idiopathic stone formers ate more animal protein than did normal subjects. A high intake of animal protein significantly increased the urinary excretion of calcium, oxalate and uric acid which are considered to be 3 of the 6 main urinary risk factors for calcium stone formation. The overall relative probability of forming stones was increased by a diet high in animal protein. This study also indicated that vegetarians' diets were associated with a low excretion of calcium, oxalate, uric acid and a low relative probability of forming stones.

Osteoporosis

Some reports such as that of Marsh et al. (36) indicated that bone loss of lacto-ovovegetarians after the age of sixty is less than that of omnivores. Allen et al. (69), suggested that high protein intakes increase calcium requirements. In their experiment, urinary calcium increased rapidly in proportion to increase of protein intake. A decrease in the reabsorption of calcium by the kidney seems to be the most likely cause of the protein-induced hypercalciuria. Consumption of high calcium diets did not prevent the negative calcium balance and probable bone loss resulting from consumption of high protein diets. Hence a vegetarian diet may be beneficial in terms of

protection and defence of bone and bone mineral loss respectively, especially in the later years of a woman's life.

Other benefits

Certain other benefits have been associated with vegetarian diets. Finegold et al. (70) stated that the Seventh-Day Adventists group in their study had fewer anaerobic microbial flora than non-Adventists who were not vegetarians. Dwyer (71) found that children of vegetarian parents had high I.Q.'s and have mental ages over a year beyond their chronologic ages. However, more thorough research is necessary to substantiate this study.

COUNSELING AND DIET PLANNING

This section offers some guiding principles that may be helpful in giving dietary advice to or counselling vegetarians. Also some food guides are presented, that may be useful in careful selection of foods so that well balanced and nutritionally adequate vegetarian diets can be planned and implemented.

In an attempt to examine the nutrition knowledge of vegetarians and non vegetarians, Freeland-Graves et al. (72) conducted a study in Austin, Texas, which indicated that vegetarians scored significantly higher on a nutrition knowledge test than did their non-vegetarian counterparts. The vegetarian sample consisted of lacto-ovovegetarians, lacto vegetarians, pescovegetarians and vegans. The majority of the subjects understood the concept of a good quality protein but only 3 to 8 % of the vegetarians and non vegetarians were able to name an example of a limiting amino acid in either grains or legumes. Only one-fifth of them knew what mutual supplementation of plant protein was. More than half the subjects did not know that milk is a complete protein. One-fourth of the vegetarians and one-

third of the nonvegetarians considered fruits to be foods containing complete proteins. Most vegetarian subjects performed very poorly in naming specific food sources of iron, vitamin B₁₂ and zinc, all of which are thought to be marginal in vegetarian diets.

Based on the results of the above study, Freeland-Graves et al. (72) suggested the following guidelines for developing education materials for the nutritional counseling vegetarians.

1. Basic concepts of protein nutrition, including limiting amino acids and mutual supplementation of plant proteins with practical examples.
2. Identification of high quality proteins.
3. General information of nutrient composition of foods.
4. Application of the Four Food Groups, with their respective nutrients to the vegetarian diets.
5. Relative bioavailability of animal and vegetable sources of nutrients.
6. A listing and explanation of commonly-held nutrition misconceptions.

Many present day vegetarians are seeking dietary assistance (73). Nutritional professionals, whether in an institution, private practice, or public health, must be prepared to provide both practical and effective counseling to this evergrowing number of people. A sound knowledge of vegetarian nutrition and dietary practices is thus essential for the nutrition counselor. A typical questionnaire as developed by Mann(73) for nutritional counseling of vegetarians should include the following items.

1. Does the client actually consider him/herself a vegetarian? If so, what types of dietary restrictions and practices are involved?
2. What are the client's reasons for following his/her personal dietary regimen?
3. How long has your client been a vegetarian? and have there been any

breaks in the dietary practice?

4. Why has the client come to you for dietary counseling? What has been the client's past experience with nutritionists and other health care providers?
5. Are other members of the health care team aware that the client is a vegetarian? Are they familiar with vegetarian diets?

More counseling techniques need to be developed in order to successfully combat the vagaries of a vegetarian diet. The effective nutrition counselor must highlight the deficiencies of a vegetarian diet and educate clients as to how best they can attain a complete diet.

Planning of Vegetarian diets

Nutrition authorities differ substantially regarding their evaluation of the adequacy of vegetarian diets (9). However, it is perfectly possible to construct a vegetarian diet that provides all essential nutrients to the body. Planning of a vegetarian diet is not difficult. It involves the application of the basic concepts of nutrition along with a relatively few but important dietary modifications.

There are several recognized types of vegetarian diets. This report will include suggestions for planning diets for two very important classes of vegetarians,-- the lacto-ovovegetarian and the vegan. These two types of diets represent the two extremities of the broad term vegetarianism. As mentioned earlier, a lacto-ovovegetarian diet includes milk and milk products, eggs and plant food sources, while the vegan diet is characteristically meatless and is comprised of only plant food sources.

Of most concern is the vegan diet because of its exclusion of egg and milk and its products. Abdulla et al. (11) stated that the vegan diet

is nutritionally adequate for all most all age groups. It is adequate for infants when given with breast milk or fortified soy milk. Shull et al. (17) recommended that infants be breast fed for at least the first six months of life and that solid foods not be introduced until four months of age.

When a diet becomes more restrictive in food sources, the probability of its meeting all the nutrient requirements for an individual decreases but with careful planning one could offset this shortcoming (11). The key to successful vegetarian diets is to include a variety of plant foods and also those foods rich in calcium, riboflavin, iron, zinc and vitamin A.

Nutrient considerations for planning a vegetarian diet

An adequate diet is one that provides an individual with proper amounts of all nutrients essential for physiological well being. Such is the criterion used for planning a vegetarian diet. With careful selection of foods it is possible to plan well balanced, nutritionally adequate vegetarian diets that meet the needs of most people.

Read and Thomas (74) determined the degree of food supplement use among a group of vegetarians because of the public's belief that use of supplements is essential for nutritional adequacy--especially among vegetarians. Sufficient evidence that vegetarian diets, especially of the lacto ovo type are adequate if properly planned, had led the investigators to believe that supplementation was unnecessary. Their study indicated that vegetarians from the sampled population were heavy users of food supplements. The range of supplement level for specific nutrients used was anywhere between 100% to 15,000% of the RDA. Among all the nutrient supplements, vitamin C was consumed most frequently followed by the B-complex vitamins, vitamin E, vitamin A and calcium. Less frequently used supplements were yeast, sea salt, vitamin

B₁₂, alfalfa tablets, lecithin, vitamin D, zinc, iron and dolomite. Those who had high nutrition knowledge test scores used food supplements as much as those who had low scores. The fact that the most common reason given for supplementation was "to make up for what is not in food" indicates a lack of understanding about nutrient adequacy in general. The authors emphasized that the counseling and educational efforts of dietitians should stress the importance of nutrient adequacy.

Protein and its complementarity

Nine essential dietary amino acids have been identified to be important for growth, maintenance and repair of body tissue(75). Those dietary proteins that carry these essential amino acids in the amounts needed for these physiological functions are considered to be complete proteins, high quality proteins or proteins of high biological value. The proteins in milk, milk products and flesh foods are considered complete. On the contrary, plant proteins contain inadequate amounts of at least one essential amino acid (75). These proteins are referred to as incomplete or of intermediate biological value. Plant sources usually are inadequate in lysine, methionine and tryptophan as compared to a standard reference protein. Grain crops are essentially low in lysine and high in methionine. Legumes, with the exception of groundnuts are high in lysine and low in methionine and tryptophan whereas nuts and seeds are deficient in lysine. However, a combination of these foods (grains, legumes and seeds) provides a vegetarian with the required amounts of each of the essential amino acids. This is commonly referred to as protein complementation. Such complementation is effective when all amino acids are provided at the same meal. A good diet of whole foods supplies adequate protein to the body (39). Many whole foods that are not usually associated

with protein are bread, beans and many vegetables. These foods are capable of meeting most of the protein needs of the body completely when mixed together in adequate quantities.

Contreras et al. (76) reported that a corn and beans mixture in the ratio of 70:30 was desirable for an improvement in animal performance and weight gain. Leguminous seeds contribute greatly to the daily protein consumed by people living in the poorer countries (77). Proteins of pulses and proteins of cereals have a complementary effect. This results in an improved protein quality and the effect is maximal when the protein ratio of cereal protein and pulse protein is 1:1. Grains are generally low in lysine and high in methionine and vice versa for legumes (39). Any two members of these two food families will complement each other. Food group planning will help to provide high quality dietary protein. For example, the milk and eggs group could supply half the protein and the rest of it could be derived from plant foods. For an all-plant diet, or the vegan diet, a diet whose protein comes from grains, legumes and dark leafy green vegetables in the ratio of 12:7:1 (60%, 35%, 5%), respectively, has an optimum amino acid pattern which meets human needs.

In a study of preschool children Roxas et al. (78) observed the advantage of substitution of high protein (10.4%) rice for average protein rice. Significant increases in height and weight were observed in the experimental group compared to the control group. Shah et al. (79) compared leaf protein concentrate (LPC) fortified dishes with isoproteinous and isocaloric amounts of milk for the supplementation of normal diets of children of a local slum in Pakistan. The data collected on increases in height and weight and on red blood cell and hemoglobin status of children confirmed that the LPC-fortified dishes were comparable to milk as a supplement to provide protein, minerals,

and vitamins to nutritionally inadequate local diets.

Casey and Wrigley (80) stated that seed products are the most important world dietary source of both protein and energy. On a global scale, cereal and legume seeds are the main sources of protein. Cereals and legumes contribute to two-thirds of man's protein intake. The authors stressed the need to use plant breeding techniques to improve both the quantity and quality of seed protein.

Three basic combinations of foods provide vegetarians the appropriate amounts of essential amino acids (10) (Figure 2). They are

- a) Grains (cereals, rice, pasta) and legumes.
(beans, peas, lentil, peanuts)
- b) Grains and milk products (milk, cheese, yoghurt)
- c) Seeds (sesame, sunflower) and legumes.

Vegetarians are urged to utilize such combinations in their diets for effective protein complementation.

Iron

Rich sources of iron in plant foods include legumes, whole or enriched grains and nuts or seeds. However, several factors in the diet are believed to influence the absorption of iron. Phytic acid, oxalic acid, large amounts of plant fiber, phosvitin in egg yolks and tannic acid in tea decrease iron absorption while it is increased when flesh foods or foods containing ascorbic acid are included (75). Vegetarians should consume one food rich in iron in addition to one that is high in ascorbic acid at each meal for better absorption. (31). Sources of ascorbic acid include citrus fruits and their juices, tomatoes, broccoli, strawberries, green or red sweet pepper, dark green leafy vegetables and potatoes when cooked along with their skins.

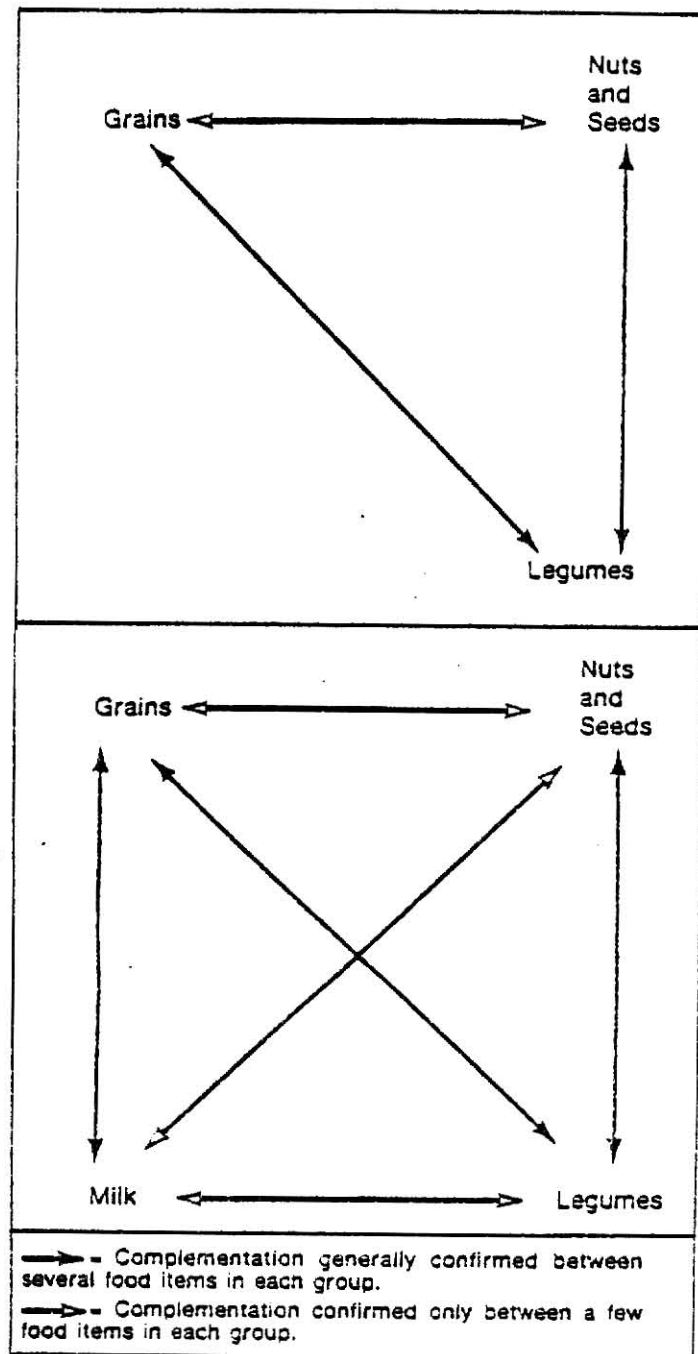


Fig.2 Complementary protein relationships (10)

Zinc

Vegetarians are prone to dietary zinc deficiency (75). Dietary sources of zinc for vegetarians include legumes, whole grains and nuts (table 2). These foods are high in phytic acid content and dietary fiber which tend to decrease zinc absorption (41). The phytate level in whole wheat flour can be reduced by yeast fermentation, a reaction that generally takes place in most yeast leavened breads (75).

Calcium

Milk, milk products and calcium-fortified soy milk are the richest most reliable and practical sources of dietary calcium (75). Vegan diets that exclude milk tend to be deficient in calcium. A vegan consumes calcium from plant sources which have low calcium bioavailability because of the presence of oxalic acid and dietary fiber. Hence calcium also must be provided to a vegan as calcium fortified soy milk, calcium precipitated tofu, certain nuts and seeds, legumes and dark leafy vegetables low in oxalic acid (Table 3). Calcium supplementation is necessary for children and pregnant or lactating women.

Vitamin B₁₂

Vitamin B₁₂ is an essential nutrient that is absent in plant foods (25). A long term vegan diet faces a major vitamin B₁₂ deficiency. Sources of B₁₂ for vegans are vitamin B₁₂ fortified foods such as soy milk, cereals and meat analogs (75). A lacto-ovovegetarian diet provides B₁₂ from eggs and milk.

Table 2
Zinc content of Common Foods (81).

Food	mg/ 100 gm (edible portion)
Beef, separable lean, cooked, dry heat	5.8
Beans, common, mature, dry	2.8
Beans, Lima	2.8
Breads	
Rye	1.6
White	0.6
Whole wheat	1.8
Chick peas or garbanzos	2.7
Corn, field, whole grain, white or yellow	2.1
Corn, sweet, yellow	0.5
Corn meal, white or yellow, bolted(nearly whole grain)	1.8
Cowpeas (black eyed), mature	2.9
Granola	2.1
Lentils, mature	3.1
Oatmeal (rolled oats)	3.4
Oat cereal, puffed, ready to eat	3.0
Peanuts, raw	2.9
Peanuts butter	2.9
Peanuts, roasted	3.0
Peas	3.2
Popcorn	4.1

Table 3. Calcium Content of Plant Foods (75)

Food	Serving Size	(mg/ serving size) Calcium
Vegetables *		
Broccoli	1c	136
Collards	1c	220
Kale	1c	206
Mustard greens	1c	193
Turnip greens	1c	267
Legumes *		
Lima beans	1c	55
Navy beans	1c	95
Blackeyed peas	1c	43
Great northern beans	1c	90
Nuts(shelled, whole)		
Almonds	$\frac{1}{2}$ c	166
Filberts	$\frac{1}{2}$ c	146
Seeds		
Sesame	$\frac{1}{2}$ c	83
Sunflower	$\frac{1}{2}$ c	87

* Cooked

Riboflavin

If milk is excluded in a diet, riboflavin becomes a nutrient of concern (34). For a vegan, riboflavin is procured from foods such as grains, avocados, broccoli and dark green leafy vegetables (75). Several servings of these foods per day should be included to insure riboflavin adequacy.

Vitamin D

Vitamin D is an important nutrient that is not available in plant sources (18). However, vitamin D can be synthesized in the body when the skin is exposed to sunlight. Because this is not a very regular source of vitamin D and depends on the place where the person lives, vitamin D should be included in the diet through fortification of cows milk or soy milk. Vegan children and pregnant and lactating women should take vitamin D supplements.

Menu Planning

Nutritionally adequate meal patterns can be developed for vegetarians by using food groups (82). A vegetarian is well assured of a balanced diet by combining various food items into one of the major food groups and by making choices from these groups on a day to day basis. Generally the best approach for combining food items into one major group is by grouping the foods of comparable nutritive value. The following food groups are thus designed to contain the major nutrients (75).

Group I Cereals and whole grains which provide proteins, fiber, iron, magnesium, zinc, niacin, pyridoxine (B_6) riboflavin and thiamin.

Group II Legumes and meat substitutes that provide protein, calcium, iron, magnesium, phosphorus, zinc, thiamine, niacin and ascorbic acid if the legume is sprouted. Nuts and seeds provide protein, calcium, iron, magnesium,

phosphorus, zinc, niacin, riboflavin and thiamine.

Group III Milk and milk products which provide protein, calcium, phosphorus, vitamins A, B₆, B₁₂, D (if products are fortified) and riboflavin. Egg white provides protein and riboflavin, while egg yolk provides protein, cholesterol, vitamins A, B₆, B₁₂, riboflavin and thiamin.

Group IV Fruits and vegetables provide fiber, calcium, iron, magnesium, potassium, vitamin A, ascorbic acid, folic acid and riboflavin.

Group V Oil provides vitamins A, D and K.

Differences exist in the nutrient content of specific foods within each group and hence exceptions are expected in this grouping system. To illustrate in the fruit-vegetable group, vitamin A is found mainly in the dark green, leafy and deep orange vegetables and ascorbic acid is found basically in food such as citrus fruits, strawberries and broccoli.

Hence, emphasis is laid on selection of the widest possible variety of foods from every group. It is also important to select foods that are nutrient dense. Foods that provide many nutrients within a limited calorie allowance are said to be nutrient dense. Care should be taken to include the necessary number of servings of each food group to make sure that the intakes of amino acids, calcium, iron, zinc, riboflavin and vitamin B₁₂ and D are adequate.

Food guides for lacto-ovovegetarian diets and for vegan diets

Food guides have been developed for two classes of vegetarians,--lacto-ovovegetarians (Table 4) and vegans (Table 5). These guides are designed to provide food choices to an individual and at the same time assure adequate nutrient intakes for most people. However, one has to consider that some vegetarians may not meet the energy requirements because of the high bulk

Table 4. Food guide for Lacto-ovo diets (75)

Food Group	Minimum Number of Servings Daily										Standard Serving
	1-3 yr Both Sexes	4-6 yr Both Sexes	7-9 yr Both Sexes	10-12 yr Both Sexes	13-17 yr M	13-17 yr F	18-19 yr M	18-19 yr F	20+ yr M	20+ yr F	
I. Cereals, whole grains, breads	3	3-4	4	5	7	5	9	5	8	6	1 slice whole-grain or enriched bread or $\frac{3}{4}$ c cooked cereal or 1 oz dry cereal
II. Legumes, meat analogs, textured vegetable protein (TVP)	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	$1\frac{1}{2}$	1	1	$\frac{3}{4}$	1 c cooked legume or 2-3 oz meat analog or 20-30 g TVP
Nuts, seeds	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$\frac{3}{4}$	2	1	1	1	$1\frac{1}{2}$ oz or $\frac{3}{4}$ T
III. Milk, Milk products	2-3	2-3	3	4	4	4	2-3	2-3	$1\frac{1}{2}$	$1\frac{1}{2}$	1 c milk*
Eggs	1	1	1	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1 medium egg
IV. Fruits, vegetables	2-3	3-4	4	5	5	5	6	5	6	5	$\frac{1}{2}$ c juice or 1 medium piece or 1 c raw or $\frac{1}{2}$ c cooked
V. Oils	$\frac{1}{3}$ -1	$\frac{2}{3}$ -1	$\frac{2}{3}$ -1	1	1	1	1	1	1	1	1 T

*Common portions of dairy foods and their milk equivalents in calcium:

1-in cube cheddar-type cheese = $\frac{1}{2}$ c milk $\frac{1}{2}$ c yogurt = $\frac{1}{2}$ c milk $\frac{1}{2}$ c cottage cheese = $\frac{1}{4}$ c milk

2 T cream cheese = 1 T milk

 $\frac{1}{2}$ c ice cream or ice milk = $\frac{1}{2}$ c milk

Table 5. Food guide for adult vegan diets (75)

Food Group	Minimum Number of Servings Daily*	Estimated Protein (g) Per Serving†
I. Bread	4	2
Whole grains	3-5	4
II. Legumes	2	10
Nuts or seeds	1	5
IV. Fruits	1-4	-
Vegetables	4	2
V. Oils	1	-

* A serving = 1 slice whole-grain or enriched bread; 1 c cooked cereal or whole grains; 1 c cooked legumes; 3 T nuts or seeds; $\frac{1}{2}$ c fruit juice; $\frac{1}{2}$ c cooked or 1 c raw vegetables; and 1 T oil.

† Vegan protein balance formula; 60% of protein from grains; 35% of protein from legumes; 5% of protein from leafy, green vegetables (D. Calloway, Professor of Nutrition, University of California, Berkeley).

content of their diet (75). Increased intakes of whole grains and cereals are recommended in such a situation. Children and pregnant women can follow these standard food guides with some variations. For children, foods that cause discomfort such as nuts, seeds, wheat germ and granola-type cereals may be avoided. Inclusion of a variety of unprocessed foods and fortified soy milk will benefit this age group.

For the pregnant woman who is a lacto-ovovegetarian increasing the minimum number of servings of legumes to two and milk to four is advisable. For a vegan pregnant woman, the addition of 4 cups of calcium-B₁₂ fortified soy milk each day is highly recommended. In both cases, iron supplementation is necessary. Therapeutic diets also can be planned for these classes of vegetarians by using the above indicated food guides.

SUMMARY

The word "vegetarian" refers to a person whose diet is devoid of meat, fowl and fish. The diet may or may not include eggs and/or dairy products.

Vegetarianism in a broad sense connotes much more than abstinence from flesh food. It is frequently associated with asceticism, philosophy, or other specific beliefs. Vegetarianism has been practiced for a variety of reasons, including religious, ethical, economic, political, health and concern for environment and world food supply. Different definitions of vegetarianism have evolved based on the foods avoided. for example, lacto-ovovegetarians consume dairy foods, eggs and plant foods; while vegans eliminate all animal foods from their diets.

Vegetarian diets have characteristic nutrient deficiencies, but when carefully planned and skillfully implemented they can supply sufficient calories, an optimal ratio of essential amino acids and adequate sources of calcium, iron, riboflavin and most other vitamins. Of most concern in a vegetarian diet is the insufficient adequacy of protein, vitamin B₁₂, vitamin D and calcium. The nutritive value of plant protein is low due to amino acid deficiencies or imbalance. Protein complementarity is hence recommended. Combinations of grains and legumes is one good example of protein complementarity. Most vegetarians, except for vegans, do not have problems meeting the vitamin requirements. Since vitamin B₁₂ is found in animal products it is important for vegans to consume foods fortified with vitamin B₁₂ supplements. Calcium and vitamin D fortified foods also are recommended for vegans.

Many vegetarian diets offer possible benefits and the potential

risks of obesity, constipation, coronary heart disease, diverticular disease of the colon, kidney stones, diabetes mellitus, high blood pressure and colon and breast cancer. Vegetarian diets are usually high in plant fiber, which may be protective against hyperlipidemias and ischemic heart disease.

Planning a vegetarian diet is not difficult. It involves the application of the basic concepts of nutrition along with a relatively few but important dietary modifications. Different food guides are available to plan a nutritionally adequate vegetarian diet. Effective counseling imparts the knowledge necessary to help the vegetarian plan a more complete diet.

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VEGETARIAN DIETS

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AN ABSTRACT OF A MASTER'S REPORT

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The word "vegetarian" refers to a person whose diet is devoid of meat, fowl and fish. The diet may or may not include eggs and/or dairy products.

Vegetarianism in a broad sense connotes much more than abstinence from flesh food. It is frequently associated with asceticism, philosophy, or other specific beliefs. Vegetarianism has been practiced for a variety of reasons, including religious, ethical, economic, political, health and concern for environment and world food supply. Different definitions of vegetarianism have evolved based on the foods avoided. For example, lacto-ovo vegetarians consume dairy foods, eggs and plant foods; while vegans eliminate all animal foods from their diets.

Vegetarian diets have characteristic nutrient deficiencies, but when carefully planned and skillfully implemented they can supply sufficient calories, an optimal ratio of essential amino acids and adequate sources of calcium, iron, riboflavin and most other vitamins. Of most concern in a vegetarian diet is the insufficient adequacy of protein, vitamin B₁₂, vitamin D and calcium. The nutritive value of plant protein is low due to amino acid deficiencies or imbalance. Protein complementarity is hence recommended. Combinations of grains and legumes is one good example of protein complementarity. Most vegetarians, except for vegans, do not have problems meeting the vitamin requirements. Since vitamin B₁₂ is found only in animal products it is important for vegans to consume foods fortified with vitamin B₁₂ supplements. Calcium and vitamin D fortified foods also are recommended for vegans.

Many vegetarian diets offer possible benefits and the potential risks of obesity, constipation, coronary heart disease, diverticular disease of colon, kidney stones, diabetes mellitus, high blood pressure and colon

and breast cancer. Vegetarian diets are usually high in plant fiber, which may be protective against hyperlipidemias and ischemic heart disease.

Planning a vegetarian diet is not difficult. It involves the application of the basic concepts of nutrition along with a relatively few but important dietary modifications. Different food guides are available to plan a nutritionally adequate vegetarian diet. Effective counseling imparts the knowledge necessary to help the vegetarian plan a more complete diet.