

VEGETARIANISM

by

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**THIS BOOK  
CONTAINS  
NUMEROUS PAGES  
WITH DIAGRAMS  
THAT ARE CROOKED  
COMPARED TO THE  
REST OF THE  
INFORMATION ON  
THE PAGE.**

**THIS IS AS  
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## INTRODUCTION

A "vegetarian" is a person who avoids the consumption of food from animal sources such as meat, poultry and fish; his diet may or may not be supplemented with eggs, milk, cheese and other dairy products. For centuries, vegetarian diets have been followed for various reasons - religious, cultural, ethnic, health and economic (1).

Due to economic necessity and availability of little or no animal products, large populations of the world have lived for many years on diets considered near vegetarian. Today, there is an abundance, as well as a variety, of food supplies in the United States, but there is a growing interest among younger Americans in vegetarianism as part of "health" and "natural" foods movements (2). The word vegetable is derived from the word "vegetus" which means "whole, sound, fresh, lively," a definition which explains why so many follow this dietary ritual (3).

It is more difficult for a vegetarian to plan a nutritionally adequate diet than a non-vegetarian as the food choices are limited. However, a strict vegetarian can consume a nutritionally adequate diet if he has a good knowledge of food composition and of the nutrients he needs. If vegetarian diets are not well planned, certain deficiencies may occur (3).

The purpose of this paper is to review (a) types of vegetarian diets, (b) nutritional adequacy of vegetarian diets, (c) nutritional status of vegetarians, (d) vegetarianism and health, (e) meat analogs, (f) planning a vegetarian diet and (g) educating vegetarians.

#### CLASSIFICATION OF VEGETARIANS

Vegetarians may be classified as those who avoid red meat only (beef, pork and lamb) but eat poultry and fish; lacto-ovo-vegetarians who avoid flesh foods but consume milk, cheese and eggs (4); lacto vegetarians who consume a vegetable diet supplemented with milk and cheese (5); and strict or pure vegetarians or vegans who avoid all foods of animal origin (4).

Erhard (6) has discussed a number of popular cults or communes that practice vegetarianism. Many of these groups have adopted religions of the orient and have a strong belief that some supernatural force guides them to psychic tranquility.

#### Ehret's mucusless diet healing system

This cult was founded by Arnold Ehret in the 1920's and is one that does not have an oriental religion as its basis. Ehret believed that he was cured from diabetes by the consumption of a fruit diet. The followers of this cult live on a vegetarian diet that is made up largely of fruit which produces very little mucus; they believe meat produces mucus which forms a breeding media for disease. Ehret believed

fasting was a natural remedy for headaches and dizziness which were caused by an accumulation of mucus (6).

### Messiah's cult

The commune of Messiah's cult was originated by Allen Noonan. The followers of this cult are vegetarians. Noonan believed that food could balance the positive and negative (Yin/Yang) aspects of life; it helps individuals to attain a healthy body and state of mind to react sensibly to life.

Noonan considers the followers of this cult as one family; his plan provides food, clothing, shelter, recreation and transport for all his followers. This cult consists of fifty adults and twenty children who live in Berkeley. They own a natural food center which is operated by all the members of this One World family. Their diet consists mainly of fruits, nuts, grains, seeds, sprouts, vegetables and some breads. Meats, eggs and dairy products are discouraged. The followers of this cult believe that one's body can be healed by eating the right kinds of foods and fasting. The Messiahs fast one day a week to clean out their systems (6).

### Yoga groups

The term "yoga" is often associated with relaxation and certain types of exercise. Yoga is related to religion, vegetarianism, reincarnation, meditation and spiritualism. Yoga is a Hindu philosophy which in recent years has been followed by many westerners. This philosophy is based on "oneness."

It provides a harmony of body, mind and spirit. Some of the breathing exercises for hyperventilation are used as an alternative to drugs. Yoga followers believe that because meat is near decomposition, it can produce toxic effects in the body, which lead to uremia. They also avoid consumption of meat because they believe in reincarnation. Their diet generally consists of fruits, raw vegetables and fermented dairy products. The yogis believe that all external progress is a result of the development of the inner self, which can be accomplished by a vegetarian diet (6).

#### Sufi groups

Sufi is a vegetarian based cult which originated in the mid-east; it is a part of Islam. Sufi is based on a blend of religious teachings, mainly of the Zoroastrian Magi. The dietary patterns of the sufis are very close to those of the yogis (6).

#### Zen Macrobiotic diets

Zen Macrobiotics are a group that follows a religion with strong dietary goals. Their dietary regimen was proposed by George Ohsawa, a Japanese born in 1893. A physician told him that he was suffering from a disease which was incurable. He went on a diet which consisted of only brown rice. After which he regained his health. The terms Yin and Yang are symbolic, associated with the Zen Macrobiotic dietary patterns. For instance, good and evil, for and against, up and down, man

and nature are mutually dependent opposites, so are the terms Yin and Yang. In man, Yin symbolizes love, truth and calmness and Yang, its dependent opposite, represents righteousness and activity. Every individual has both characteristics. Yin is thought of as female and receptive while Yang is male and aggressive. In nature, Yin symbolizes spring and softness, while Yang represents autumn and hardness. Yin and Yang is a diet which blends and harmonizes change in one's ethical behavior (6).

Table 1 shows the ten different Zen Macrobiotic dietary regimens. According to Zen Macrobiotic followers, the higher levels of diets have curative properties and are spiritually purifying (6). The lowest regimen which includes 10% cereals, 30% cooked vegetables, 10% soup, 30% animal products, 15% salads and fruits and 5% desserts. Diet 7 is the highest level which is made up of 100% cereal. Persons following Zen Macrobiotic food choices run a great risk of serious nutritional deficiencies, especially with the highest level of diet. Cases of scurvy, anemia, hypoproteinemia, hypocalcemia, emaciation due to starvation, loss of kidney function due to restricted fluid intake and other forms of malnutrition have been reported; some cases have resulted in death (7,8).

The Council on Foods and Nutrition of the American Medical Association stated that the diets of Zen Macrobiotic followers are so rigid that they cannot be nutritionally adequate. Zen Macrobiotic followers believe their diets provide mental

Table 1  
Macrobiotic dietary regimen (6).

No.	Cereals (%)	Cooked vegs (%)	Soup (%)	Animal (%)	Fruit salads (%)	Dessert (%)	Drinking liquid
7	100						sparingly
6	90	10					"
5	80	20					"
4	70	20	10				"
3	60	30	10				"
2	50	30	10	10			"
1	40	30	10	20			"
1	30	30	10	20	10		"
2	20	30	10	25	10	5	"
3	10	30	10	30	15	5	"

and spiritual as well as physical satisfaction. However, if such diets have adverse effects and cause ill-health, ultimately leading to death, they should be eliminated totally (9).

#### Vegan groups

The vegan belief of avoiding killing and exploiting animals is a way of keeping one's desires under control and maintaining physical, emotional, mental and spiritual well-being. Furthermore, vegans avoid the use of animal products such as wool, silk, leather, fur, pearls, soap and cosmetics containing animal oils or fats and brushes made of hair. They discourage the use of vaccines made from animal extracts or drugs which have been tested on animals (6).

Vegans in the United Kingdom (10) and in the United States (6) are total vegetarians who do not consume foods of animal origin for ethical reasons. Their dietary pattern is based on compassion for the living. They eat food which is not processed and consume it in its raw, natural form. The vegan diet includes only vegetables, fruits and berries, nuts and seeds, sprouts, legumes, whole grains or cereals, dairy substitutes, cold press oils, distilled or spring water and fruits and vegetable juices. Vegans usually avoid salt, spices and condiments, alcohol, tea, coffee, soft drinks, tobacco and vitamins.

Another restrictive pattern of some vegans may be to exclude all grains and cereal products from their diets. Such

inadequate diets may cause health problems and put such persons in a higher health risk category than their counterparts who consume a more nutritionally adequate diet which includes unrefined grains, legumes, nuts and nut-like seeds, a variety of vegetables, especially green, leafy varieties and fruits. After weaning, vegan infants are often fed Soya-Tahini milk and almond milk. These formulas have proven inadequate as judged by failure of growth of vegan children. Many vegan mothers are aware of the nutritional inadequacy of a strict vegan diet and will accept nutritional advice. Some recognize the value of fortified soy formulas (6). ✓

#### NUTRITIONAL ADEQUACY

Numerous publications have shown the prevalence of nutritional diseases in underdeveloped areas of the world. These diseases, however, are not the result of a vegetarian dietary pattern, but are caused by shortage of food or a diet consisting of foods rich in carbohydrates such as cornmeal, cassava root, tapioca or white rice with practically no milk, eggs, leafy vegetables, legumes or fruits. Lack of suitable post-weaning foods is hazardous to young children, especially if they are born to the vegan mother. Parasitic infestations often aggravate the symptoms of nutritional diseases in underdeveloped areas (2).

Literature on vegetarian and near vegetarian diets has been reviewed by Hardinge and Crooks (11). They concluded that vegetarians have widely differing dietary patterns. A



plant diet which is well planned and supplemented with milk, eggs and cheese can meet the nutritional requirements for all age groups.) It has been shown that the use of pure vegetarian diets which contained adequate calories obtained from unrefined grains, legumes, nuts and nut-like seed, a variety of vegetables and an abundance of fruits produced no detectable deficiency signs.)

Inadequate vegetarian diets include: (a) vegan diets which are deficient in vitamin B<sub>12</sub>; (b) vegetarian diets which are unbalanced, and provide mainly a large number of calories, especially starchy foods, but are low in other nutrients; (c) refined cereals, for example corn meal or white rice, which are consumed as the main diet; (d) the consumption of insufficient calories so that the body has to draw on its own protein and other nutrients for maintenance requirements (2).

// The Food and Nutrition Board of the National Research Council has emphasized that even pure vegetarians can be well nourished if they select their diets carefully so as to provide sufficient calories, a good balance of essential amino acids and adequate sources of calcium, riboflavin, iron, vitamin A, vitamin D, and vitamin B<sub>12</sub><sup>1)</sup> (12).<sup>some</sup> The risk of deficiencies can be greatly reduced if one chooses a large variety of foods and avoids the use of a single staple food, for example, corn. An adequate intake of most vitamins, minerals and other nutrients can be obtained by the consumption of legumes, fortified soybean milk formulas, whole-grain

products, nuts and seeds, and dark green, leafy vegetables. Legumes are a good source of protein, and in addition, provide B vitamins and iron. Whole grains are a good source of carbohydrates and protein, as well as thiamin, iron and trace minerals. Nuts and seeds contain B vitamins and iron; they are also a concentrated source of fat in vegetarian diets which tend to be low in fat. An adequate supply of calcium and riboflavin may be obtained from dark-green, leafy vegetables, by individuals who avoid the consumption of dairy products (13).

### Protein ✓

According to Venkat Rao et al. (14) both the quality and quantity of protein are of central concern in all diets. The protein quality of plant foods is genetically lower than that of animal foods. The amounts and utilization of eight of the twenty essential amino acids in a protein are the determining factors of protein quality. Animal foods contain protein which provide all of the eight essential amino acids in nearly optimum amounts for use in body metabolism and thus are designated high quality proteins.

Complementary protein foods. Proteins in cereal grain are lower in quality than meat proteins because they are deficient or relatively low in lysine and other essential amino acids. Legumes such as dried beans and peas contain ample lysine, but are relatively low in methionine, so their protein is of

marginal quality. The balance in amino acid supply is improved when cereal and legume proteins are consumed together. Methionine is provided by the cereal grains and lysine and threonine by legumes, and the result is a mixture of proteins which is of better quality than that provided by either product alone. The world wide practice of combining cereals and legumes in diets of man and rations of farm animals provides evidence of the supplementary effect of one plant food on the other. If appropriate plant proteins are mixed, one can get combinations of proteins of almost the same high nutritional value as animal protein (14).

Vegetarians should combine several different foods to meet their daily need for protein. Figure 1 shows the combinations of a variety of foods which produce a more complete protein than single foods. A completely adequate protein supply can be obtained entirely from vegetable sources if the supply of amino acids is carefully considered in the planning stages (2,12,15).

✕ Millions of people in Asia, Africa and South America depend on edible leguminous seeds and cereals as an important source of protein in their daily diet. The common leguminous seeds consumed in different parts of the world may be broadly groups as (a) beans, (b) peas, (c) grams.

In view of the acute shortage in production of animal proteins and prevalence of malnutrition in the countries mentioned above, legumes have become important as a supplementary

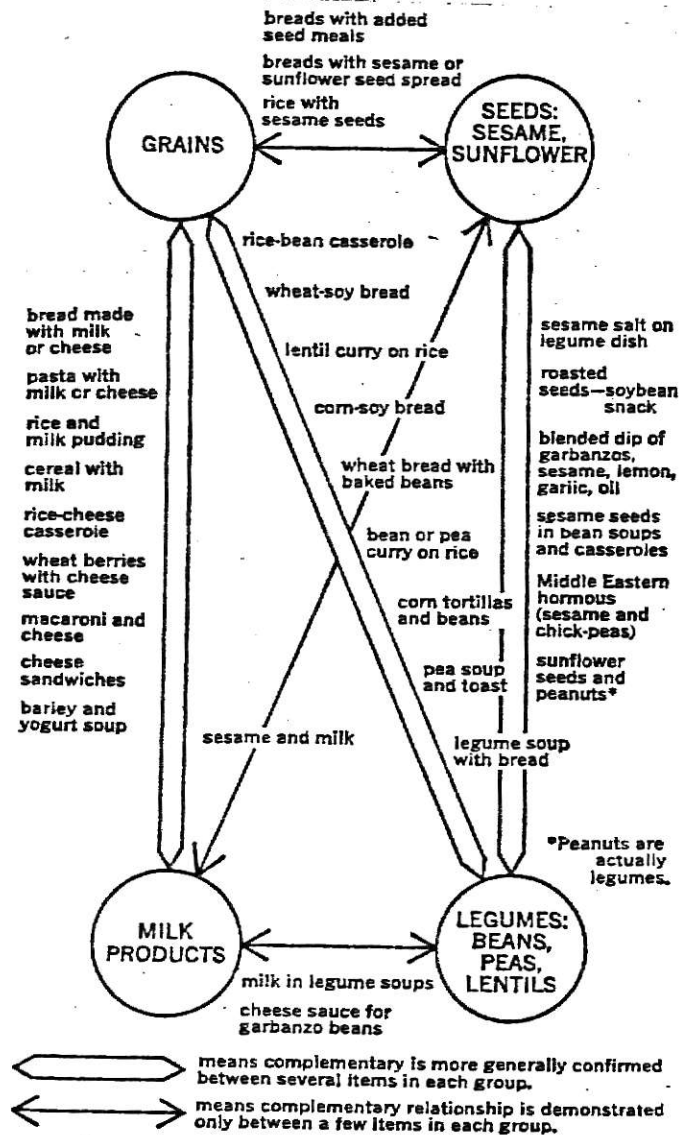


Fig. 1 Summary of complementary protein relationships (15).

protein food. Protein malnutrition in children can be treated and prevented by the utilization of legume and oil seed meals as shown by recent investigations carried out by several groups of workers (1).

In India the term "pulse" is used commonly for edible legumes. According to Venkat Rao et al. (14), India produces the largest amount of legumes in the world; the average consumption of legumes per capita is 61 gm per day.

Experiments with rats. Venkat Rao et al. (14) discussed the supplementation studies of several groups of workers. Chick peas, when incorporated into a rat diet at the 15% level, greatly improved the quality of a poor Indian rice diet. When a low protein rice-tapioca rat diet was supplemented with chick peas at the 27% level, 4% extra protein was provided. That diet combination promoted a significantly greater gain in body weight than that observed with the control rice-tapioca diet. In a later study, when a low protein maize-tapioca diet was supplemented with chick peas to provide 15% extra protein, good growth was promoted in rats. It was found that poor diets based on rice or a mixture of maize and tapioca flours could be supplemented effectively with processed protein foods made from a blend of chick peas, low fat groundnut flour and coconut meal.

Amino acid supplementation of proteins. Edible legume proteins are deficient in the sulfur-containing amino acids and

tryptophan but they are rich sources of lysine and threonine. The nutritive value of legume proteins is known to improve significantly when they are supplemented with methionine, the sulfur containing amino acid. For instance, if Alaska field peas are supplemented with methionine, their nutritive value is increased almost to that of casein. The value of the protein in split-pea, lentil and pigeon-pea was improved to a marked extent with the addition of tryptophan, threonine and methionine (14).

Biological value of proteins for human beings. Both the quantity and quality (biological value) of protein are of concern in vegetarian diets. The biological value of proteins depends upon the amount and ratio of the essential amino acids which are supplied in food. The essential amino acids for adults are isoleucine, phenylalanine, threonine, valine, leucine, tryptophan, methionine and lysine; children also require histidine (16). When determining the biological value, nitrogen in the food as well as urinary and fecal nitrogen are assessed so that nitrogen balance can be determined. The retention of protein is measured in relation to protein absorption, when sufficient amounts of essential amino acids are present to meet the needs for growth, more protein will be retained. Fecal nitrogen is the nitrogen which has been unabsorbed as well as nitrogen from sloughed off cells. A protein which has a biological value of 70 or more (70% of absorbed nitrogen is retained) has the capacity for supporting growth ~~and~~

and wear and tear of body tissue, provided caloric intake is adequate (16,17). A negative nitrogen balance may result when any essential amino acid is ingested in an amount inadequate to meet the body's need (18). Swenseid and Dunn (19) reported that nitrogen equilibrium can be acquired with a minimum amount of essential amino acids, representing .6 gm of nitrogen. The remaining amino acids which are essential for the body can be synthesized by the body. Nitrogen balance can be achieved by persons who consume complete vegetable diets containing a wide variety of vegetables (20).

The percentage of protein in lacto-ovo-vegetarian diets is surprisingly similar to that in diets of omnivores (21). Non-vegetarians obtain two-thirds of their total protein from animal sources, one-half from meats and the remainder from milk, cheese and eggs.

Symptoms of acute protein malnutrition in man are as follows: falling hair, lassitude, depletion of plasma proteins, abnormal enlargement due to edema, ascites, and negative nitrogen balance. Clinical protein deficiency has not been reported in American adults who follow the vegan philosophy and dietary patterns except for those who are on a Zen Macrobiotic regimen whose vegetable intake is highly restricted. Vegetarians, especially young children and pregnant mothers should include milk and cheese in their diets. One cup of milk, whole or skim, provides 9 gm of protein and 1 ounce of cheddar cheese provides 7 gm of protein (22).

Toxic factors in raw legumes. Growth inhibitors which are present in several raw legumes, affect the nutritive value of their proteins. However, these growth inhibitors can be inactivated by methods such as optimal heat processing and leaching in cold or warm water. The toxic factors which are inactivated by heat processing under controlled conditions are trypsin inhibitors, goiterogenic agents and saponins. The toxic elements which are leached out in water include cynogenic glucosides and other toxic factors present in legumes of the Larythrus family (14). The protein efficiency ratios of optimally heated processed legume proteins range from 1.5 to 2.0 depending on the variety and species of legumes (14).

### Vitamins

Vegetables and fruits, nuts and seeds, and legumes and cereals have good supplies of vitamins. The vitamin content of vegetarian diets depends on maturity and variety of the plant, season of harvest, storage conditions and methods of cooking (21). The eating of raw vegetables and fruits ensures an adequate intake of nutrients such as vitamin C and folic acid, which are destroyed by some cooking methods.

Vitamin A. Vitamin A occurs chiefly in the form of its provitamin, carotene, which is present in green, leafy and deep yellow vegetables, as well as fruits, and is therefore unlikely to be deficient in the vegetarian diet (21). Carrots, broccoli, kale and dandelion greens are excellent sources of



carotene. Little vitamin A activity is lost under normal conditions of processing of vegetables due to its high degree of stability (17).

Vitamin D. Vitamin D cannot be obtained from any plant source, but individuals can synthesize vitamin D from its precursor, 7-dehydrocholesterol, in the presence of ultra-violet light. Adults usually do not require a dietary source of this vitamin since they have large stores in their liver, regardless of whether they are an omnivore or a vegetarian (21). Vitamin D in amounts much greater than the RDA of 400 IU daily has been claimed to build strong bones but the RDA is adequate for most infants and children and provides a margin of safety even when children are not exposed to sunlight (13). Deficiencies possibly could develop in children weaned on a vegan diet if they are not exposed enough to sunlight (21).

Vitamin C. Fruits and vegetables are a fairly good source of vitamin C and a vegetarian has no problem meeting his needs for this vitamin. Beverages made and processed from rose hips are known to contain substantially more vitamin C than citrus fruit drinks (23). Vitamin C may be destroyed by heat and therefore omnivores have more of a problem meeting their vitamin C needs than do vegetarians who eat a large percentage of their fruits and vegetables in the raw form (21).

Vitamin B<sub>12</sub>. Vitamin B<sub>12</sub> is found only in foods of animal origin, and therefore, is of special concern to a strict

vegetarian. It is important for strict vegetarians to consume foods fortified with vitamin B<sub>12</sub>, such as soybean milk, or a vitamin B<sub>12</sub> supplement (4). An adult who has consumed animal proteins throughout his life will have adequate stores of vitamin B<sub>12</sub> in his liver; this amount is sufficient for 3 to 5 years (4). However, individuals who exclude all animal products, including milk, cheese and eggs, for several years are at a high risk of vitamin B<sub>12</sub> deficiency. One who follows the vegan cult and dietary pattern may be unaware of his vitamin B<sub>12</sub> deficiency until the spinal cord starts degenerating, since this diet contains adequate amounts of folic acid which mask the signs of vitamin B<sub>12</sub> deficiency. The degenerative changes of the spinal cord have been reported so often that it is termed as "vegan back." Other symptoms include nutritional and pernicious anemias, poor appetite, growth failure, soreness of tongue, menstrual irregularity, paresthesia, loss of position and vibratory sense, optic neuritis, pallor, nervous system diseases and brain degeneration (6,24). If the symptoms are detected early enough, vitamin B<sub>12</sub> can be administered in the form of fortified soy milk formulas or a supplement. Physicians strongly recommend that vegetarians and fructarians take a vitamin B<sub>12</sub> supplement even though the body stores enough of this vitamin to last for several years. It is difficult to convince vegans to follow this suggestion, for they find it hard to believe that there is no plant source of vitamin B<sub>12</sub> (6).

Numerous studies have shown that vegetarians have a lower intake of vitamin B<sub>12</sub> than non-vegetarians. In one study it was concluded that the mean serum vitamin B<sub>12</sub> level in non-vegetarians was almost three times the mean level observed in lacto-vegetarians (24).

According to Ellis and Montigrippo (25), a prolonged deficiency of vitamin B<sub>12</sub> and folic acid will result in megaloblastic anemia. Vegans have high serum folate levels because of their high intake of fruits and vegetables (26,21). High serum folate levels mask the megaloblastic anemia which is a result of the low serum vitamin B<sub>12</sub> level (25). It is dangerous to treat megaloblastic anemia due to vitamin B<sub>12</sub> deficiency with administration of folic acid. Folacin may cure the anemia, but the neurological disease continues to develop (17,25).

### Minerals

Strict vegetarians should be able to obtain enough calcium, iron and zinc if they consistently make choices from a wide variety of foods. Many vegetarians in the United States eat more vegetables, fruits, whole grain cereals, wheat germ and bran than non-vegetarians. These foods are excellent sources of vitamins, minerals and fiber and their use should be encouraged (4).

Calcium. A lacto-ovo-vegetarian would obtain most of the Adult Recommended Dietary Allowance (RDA) for calcium from two

servings of milk and cheese, but a strict vegetarian would need regular servings of cooked greens, dried beans, certain seeds and certain nuts such as almonds to obtain the same amount of calcium. Green leafy vegetables, on a weight basis, supply as much calcium as milk. A large serving (about 1 cup - 200 gm) of such greens as collards, kale, turnip greens and mustard greens provide as much calcium as one cup of milk. Soybean milk and soy formulas also are satisfactory sources of calcium (2,4).

/ Iron. Many beans, seeds, nuts, green leafy vegetables, dried fruits and grain products are fair sources of iron. Although iron in meats seems to be better absorbed than iron in plant foods, studies of vegetarians have shown no greater incidence of iron deficiency anemia among strict vegetarians than among non-vegetarians (26,27).

The bran of whole grain cereals contains phytates, the esters of phytic acid, the presence of which may decrease the absorption of iron from these foods. Grains also contain phytates (enzymes) which may actually prevent insoluble iron phytate from forming in the digestive tract. The importance of phytates in human absorption of iron so far has been almost impossible to assess (28).

Zinc. Whole grain products are good sources of zinc. However, phytates in the whole grains may interfere with zinc absorption (4). It has been demonstrated by Reinhold, that

zinc can be released from its binding with phytate by leavening whole wheat bread with yeast (4). It seems that phytate in the whole grains interferes with zinc absorption only in certain parts of the world where 95 to 100 percent extraction of the whole grain is used to make an unleavened bread, which constitutes the major part of the diet. If leavened whole bread is consumed as part of a varied diet, it probably does not interfere with zinc absorption (4).

The nutritive value of white enriched bread and flour is not the same as that of whole wheat bread and flour because the milling process removes more nutrients than the iron, thiamin, riboflavin and niacin which are replaced in enriched flour and bread. Whole grain breads and cereals are much better sources of trace minerals than white breads. The nutritive value of wheat germ is quite good and its use should be encouraged. However, mistaken ideas about any "magical" or "miraculous" effects of wheat germ should be corrected (4).

#### NUTRITIONAL STATUS OF VEGETARIANS

Several nutritional studies on vegetarians show that vegetarians from different populations of the universe have maintained excellent health. Results of these studies indicate that diets can be nutritionally adequate if they are properly selected from the plant kingdom. ✕

In 1954 Hardinge and Stare (27) reported on the nutrient intake and the nutritional status of vegetarians. Their study involved 200 adult subjects in three dietary groups of

which 88 were non-vegetarians, 86 were lacto-ovo-vegetarians and 26 were total vegetarians. Based on physical examination and laboratory analysis of these subjects, they found no evidence of deficiency. The nutrient intake of each group was equal to or exceeded the NRC-RDA, except that the total vegetarians were low in vitamin B<sub>12</sub>. The adult men on the pure vegetarian diet had an average protein intake of 83 gm, those on the lacto-ovo-vegetarian diet 98 gm and those on the non-vegetarian diet, 125 gm. The average protein intakes in women were 61 gm, 82 gm and 94 gm, respectively.

Various workers have studied the supplementary value of adding legumes to children's diets based on cereal or a blend of maize and tapioca flour. Venkat Rao et al. (14) reported that nutritional status of Indian children fed a diet based on cereals and legumes was inferior to that of children fed a mixed diet containing animal foods. They said, on the other hand, that Baptist and Demel reported that children in an age range of 1 to 6 years fed an entirely vegetarian diet containing a variety of plant proteins from three cereals (rice, ragi and wheat), four legumes (lentil, green gram, black gram and pigeon pea), coconut and several vegetables had a growth rate similar to that of a control group of children receiving the same diet plus one-half ounce of skim milk powder every day (14).

In the different populations of the world where malnutrition is prevalent, it is associated with insufficient intake

of protein. This problem, however, is often compounded by total caloric deficiency. Even though a diet provides an adequate amount of protein, if it does not provide sufficient calories, symptoms of protein deficiency may still appear. With caloric restriction, some of the protein is utilized for energy (11,16,17). In the United States, the average caloric intake is approximately 3,200 Kcal/day with a total of 97 gm of protein of which 31 gm comes from plant sources. In contrast, in India, the average caloric intake is approximately 2,050 Kcal/day with a total of 57 gm of protein of which plant sources provide 51 gm (14).

Register and Sonnenberg (2) pointed out that in the past vegetable proteins were regarded as inferior to animal proteins and that vegetable proteins were designated as second class compared to animal proteins which were regarded as first class. However, this distinction has now been phased out. Certainly some proteins, if fed as the sole source of protein are of relatively low value for promoting growth, but many field trials have shown that a suitable mixture of proteins of vegetable origin enable children to grow as well as children provided with milk and other animal proteins (14).

Bressani and Behar (28) stated that animal protein should not be differentiated from vegetable protein from the nutritional aspect. The most important factor determining the biological value of a protein is the relative concentration of the amino acids, in particular the essential ones, regardless

of the source. Vegetable proteins cannot be distinguished nutritionally from those of animal origin, if the different vegetable proteins are selected judiciously.

Early studies on supplementary value of wheat proteins to other proteins were carried out at Loma Linda University (2). Foods that are relatively high in lysine were tested as supplements of wheat. It was found that there was an excellent supplementary action as judged by rat growth when 70% of the protein in the diet was from wheat and the remaining 30% from milk, yeast, nuts, soybeans and other legumes.

Sanchez et al. (29) fed a group of rats a week's hospital vegetarian diet containing milk and eggs. Another group of rats received the same diet in which the plant protein was replaced by meat. There was no significant difference in the average growth rate of the two groups. The average growth of animals on the vegetarian diets was 37 gm per week and that on the meat diet was 39 gm per week.

Hardinge and Crooks (11) analyzed and compared the essential amino acids, as well as cystine and tyrosine, of lacto-ovo-vegetarians and non-vegetarians. The intake of all three groups ranged from more than twice to many times the minimum essential amino acid requirements (Table 2).

In developing countries, the concept of judicious combinations of foods to supply good quality protein has aroused great interest in single plant sources which might be used to supplement the staple rice or rice-wheat diets. Venkat Rao



Table 2

Essential amino acids in diets of adult male vegetarians and non-vegetarians (11).

Amino acid	Non-vegetarian	Lacto-ovo-vegetarian	Pure vegetarian	Recommendation*
Isoleucine (gm)	6.6	5.4	4.0	1.4
Leucine (gm)	10.1	8.2	6.0	2.2
Lysine (gm)	8.3	5.4	3.7	1.6
Phenylalanine + tyrosine (gm)	10.4	8.8	7.0	2.2
Methionine + cystine (gm)	4.3	3.2	2.7	2.2
Threonine (gm)	5.0	3.8	2.9	1.0
Tryptophan (gm)	1.5	1.2	1.1	0.5
Valine (gm)	7.1	5.6	4.3	1.6
Protein intake (gm)	121.3	97.2	81.5	65.0

\*Recommendation is twice the minimum.

et al. (14) summarized the conclusions of a number of studies. Peanut protein, which is rich in lysine and valine, supplements wheat, oat, corn, rice and coconut proteins. Soybean proteins supplement those of wheat, corn and rye. Cereal proteins are remarkably supplemented by proteins of legumes and leafy vegetables. A mixture of soy and sesame proteins has a high nutritive value compared to milk proteins. One advantage of all these plant foods is that they do not contain cholesterol or saturated animal fat.

Hardinge and Stare (27) reported that vegetarian and near vegetarian diets usually consisted of cooked cereals and bread, legumes, nuts and large quantities of fruits and vegetables. The use of refined and commercially prepared foods was kept to a minimum. Few desserts were eaten. A reasonably chosen plant diet supplemented with a fair amount of dairy products, with or without eggs, apparently was adequate for every nutritional requirement of all age groups.

Keys (30) reported an average daily consumption of 5.7 gm of ordinary beans per capita for middle-aged farmers in Japan, as compared to 7.5 gm per capita in the United States. However, in Japan, a total of 69.4 gm leguminous seeds were consumed daily in the form of tofu, miso and other processed forms. The Japanese diet may contribute to a low serum cholesterol level which is a characteristic of this population because leguminous seeds appear to have a cholesterol-depressing effect.

## VEGETARIANISM AND HEALTH

Coronary heart disease and vegetarianism

During the first World War, the people of Denmark were forced to adopt a vegetarian diet. The Norwegians also eliminated meat from their diets during World War II. Nutritionists have concluded that in both cases there was a significant drop in heart disease (as well as a general improvement in health). Furthermore, when both nations returned to meat consumption, studies showed that the temporary health advantages apparently subsided. In both cases above, there was a decrease in saturated fats and cholesterol and an intake of dietary vegetable fiber (31).

V The decrease of coronary heart disease could be related to the decrease in consumption of animal products. Meat eaters may run a higher risk of atherosclerosis (a likely cause of heart disease) since their diet contains a significantly greater amount of saturated fats and cholesterol than that of vegetarians (32).

Lack of dietary fiber is another point worthy of examination. It has been implicated in some recent studies of dietary factors that affect incidence of coronary heart disease. Trowell (33,36) concluded that vegetable dietary fiber actually lowers the cholesterol level in the system and has anti-atherosclerotic effects. It is possible that a lack of dietary fiber is a greater risk than excess fat consumption in heart disease (35).

Trowell (34) hypothesized that the risk of coronary heart disease is inversely related to the amount of vegetable fiber regularly consumed. He found that a high fiber diet is protective against hyperlipidemias and ischemic heart disease. Trowell also found that dietary fiber decreased the reabsorption of bile salts and increased fecal excretion. Other studies on vegetable fiber have shown that it improves glucose tolerance (36) and shortens intestinal transit time (37).

Malhotra (35) studied paired railroad workers from two parts of India who had similar serum cholesterol levels, but widely differing risks of coronary heart disease. The group with the lower mortality rates from heart disease consumed a higher percent of vegetable fiber than the other group.

To confirm a correlation between high dietary fiber and low cholesterol levels, studies were done where the vegetable fiber was reduced or removed. A fiber-free diet induced the development of atheromas, as well as, gallstones and diverticular diseases in experimental animals. When the addition of vegetable fiber was introduced, the new diet was protective against these disorders (36).

#### Colonic disease and vegetarianism

In 1955, Hodgson and Johnson (37) showed that diets which were low in fiber induced structural changes in the colons of rabbits and rats.

In human studies (38), increasing the fiber content of diets relieved symptoms of painful diverticular diseases,

abdominal pain and right and left iliac fosa. Bowel symptoms such as constipation, incomplete emptying of the rectum, and tender rectum, as well as symptoms including nausea, heartburn and flatulence, were decreased or eliminated when fiber was added to the diet.

Dietary fiber is not the only suspected nutritional factor associated with colonic diseases. Meat fat and protein have been related to colon cancer (38). There is evidence that formation of malonaldehyde is related to colonic diseases. This substance is a product of per-oxidative fat metabolism in animal tissues when the diet is deficient in antioxidants. Malonaldehyde has been shown to produce cancer in mice (39).

Reddy et al. (40) examined the risk of cancer of the colon with respect to fecal microflora and bile acids. They found a higher amount of anaerobic bacteria in the intestinal tract when meat was consumed; this was seen by a microflora assay on fecal material.

Through previous research (40) there was evidence of diet dependent compounds that would be modified by intestinal tract bacteria producing carcinogenic substances. Several bile acids were found to be diet dependent compounds able to be converted into carcinogenic substances by anaerobic microflora in the intestinal tract. Some of the harmful bile acids are deoxycholic acid, bismor-5-cholenic and apocholic acid and these have been shown to induce carcinomas at the site of injection in rats.

## PLANNING A VEGETARIAN DIET ✓

It is fortunate that the planning of a vegetarian diet is not difficult. It is the application of the basic concepts of good nutrition with some important modifications. When planning a vegetarian diet, one of the most important considerations is to choose a variety of foods and cut down the use of refined products. Relying on a single source of food, usually a cereal grain or starchy root crop, could lead to malnutrition. Legumes, particularly soybeans are rich in protein, B-vitamins and iron. The basic 4 food groups can be used as a guide for planning vegetarian diets with a considerable change in the "meat group." With the exception of vitamin B<sub>12</sub>, which is absent in all plant sources, an individual's nutrient requirements can be met by plant diets (2).

There are several points to keep in mind when planning a vegetarian diet. It is important to include plant proteins from nuts, dry legumes, seeds and cereals in a vegetarian diet (3). Commercially prepared plant proteins are not essential, but they help to add variety to the menu. Grains are a good source of carbohydrates, protein, thiamine, iron and trace minerals. Nuts and other seeds contribute fat, protein, B-vitamins and iron. Non-fat or low fat milk products, such as cottage cheese, should be included in the diet to provide both protein and vitamin B<sub>12</sub>. However, the use of soybean milk fortified with vitamins and minerals in place of regular milk will provide calcium, riboflavin, protein and vitamin B<sub>12</sub>.

Dark green leafy vegetables are sources of calcium, riboflavin and carotene (precursors of vitamin A) (Table 3), and should be used liberally by total vegetarians. In the winter months, when exposure to sunlight is limited, infants may receive inadequate vitamin D unless this vitamin is provided as a supplement (2).

#### MEAT ANALOGS

There are a wide variety of meat substitutes available at the present time. These plant protein foods may be referred to as "meat analogs." A number of these products combine various proportions of legumes, nuts and cereals (2,7).

Textured soy proteins are vegetable proteins which have aroused great interest among consumers, especially vegetarians. Textured protein products can be synthesized to any protein, carbohydrate or fat level desired. Proteins can be combined to produce a high quality protein with a desirable amino acid composition, therefore they have great potential and flexibility. Spun soy isolates should be fortified or used in combination with foods which are good sources of nutrients such as iron and B vitamins. This fortification or combination with vitamin and mineral rich foods is important since spun soy isolates are purified protein extractions (2).

Bressani et al. (41) compared protein quality of textured soy protein with meat and milk. They found that there was no difference in growth rate between dogs fed soy proteins and those fed meat. No adverse physiological effects were observed,

Table 3

Greens compared with milk as sources of nutrients (2).

Food*	Protein	Calcium	Riboflavin	Iron	Vitamin B <sub>12</sub>
	gm	mg	mg	mg	mcg
Milk	7.0	234	340	0.2	1.2
Soymilk	6.0	60	120	1.5	0.6
Broccoli	7.2	206	460	2.2	
Turnip greens	6.0	490	480	3.6	
Greens**	6.7	305	390	3.0	
Soybeans	19.6	120	260	5.0	

\*1 cup or 200 gm.

\*\*Greens included: broccoli, brussels sprouts, collards, dandelion greens, kale, mustard greens, spinach and turnip greens.



even when they were fed large amounts of soy protein. Moreover, there was essentially no difference in the nitrogen absorption and retention in children fed milk and soy protein diets. They concluded that soy protein is a high quality protein with about 80% of the protein quality of milk and that it can be digested adequately.

Textured proteins add variety to the diet and provide adequate and good quality protein (7). Meat substitutes or imitation meats do not contain cholesterol or saturated animal fats since they are synthesized from plant sources (2).

Human consumption of soybeans has increased due to their high protein, phosphorus, iron and calcium content. Today, the soybean is being commercially processed in the form of soybean bacon, yogurt and cookies for human consumption (23). As the world population increases and the world protein supply decreases, textured protein products will become of even greater importance and will be used to supplement and extend protein sources. Meat analogs and extenders may equal ten percent of domestic meat consumption by the year 1985 (2).

#### IMPLICATIONS FOR EDUCATORS

Nutrition educators must motivate and encourage vegetarians to eat a variety of foods. They must be willing to accept kinds and quantities of plant foods that can upgrade their diets while conforming to the restrictions that they have set for themselves. The nutritionist should help them to: (1) appreciate their nutritional needs, (2) understand how well

or how poorly their food choices are satisfying those needs and (3) make food selections that will improve their diets (42).

Vegetarians have many different needs which call for individual attention to work with them. Appealing to their way of life works much better than lecturing about the "Basic Four" (5). It is difficult for professionals to give them any kind of advice on their diets because they refuse to accept advice; they are afraid such advice may interfere with their way of life. When working with vegetarians, traditional approaches to nutrition may fail. When discussing diets with vegetarians, the most useful words are "moderation" and "variety"; usually they are willing to accept those terms. Nutrition educators can only present nutrition facts and leave the final decision of what to eat to the vegetarian (5).

#### SUMMARY

A vegetarian is one who avoids the consumption of food from animal sources such as meat, poultry and fish. They may be designated as lacto-ovo-vegetarians who avoid flesh food but consume dairy products and eggs, lacto-vegetarians who have a diet quite similar to lacto-ovo-vegetarians with the exclusion of eggs, and vegans or total vegetarians whose diet includes only cereals, legumes, seeds, vegetables and fruits.

There are several reasons for choosing a vegetarian diet. Ethics, religion, health and economics are significant factors in making the decision. A number of cults who have

strong religious beliefs practice vegetarianism; these include Ehret's mucusless diet healing system, Messiah's cult, yoga groups, sufi groups, Zen Macrobiotic regimens and vegan groups.

A vegetarian diet can be nutritionally adequate if carefully planned and if choices are made from a wide variety of foods. Proteins and amino acids are of central concern in a vegetarian diet. Vegetarians have to combine several different foods to meet their daily need for protein. Judicious selections of cereals and legumes can produce combinations of proteins with almost the same quality as animal protein. Trypsin and growth inhibitors in raw legumes can affect adversely the nutritive value of their proteins, but they can be inactivated by methods such as optimal heat processing and leaching in cold or warm water. There is usually no problem in getting vitamins and minerals into the vegetarian diet as they are present in great abundance in vegetables, fruits and whole grain cereals -- with the exception of vitamin B<sub>12</sub>. Vegan diets are deficient in vitamin B<sub>12</sub>, which is found only in animal products. It is important that vegans consume foods fortified with vitamin B<sub>12</sub> supplements.

Vegetarian diets are usually rather high in plant fiber. Vegetable dietary fiber may lower serum cholesterol; it also may have some anti-atherosclerotic effects. A high fiber diet may be protective against hyperlipidemias and ischemic heart disease. The absence of fiber may have detrimental effects on the colon.

There are a wide variety of meat substitutes available today; they are also referred to as meat analogs or textured proteins. A number of these products combine various proportions of legumes, nuts and cereals. The use of textured proteins will add variety to the diet, as well as provide adequate and good quality protein.

Vegetarians have many different needs which call for individual attention to work with them. Nutrition educators can only present nutrition facts and leave the final decision of what to eat to the vegetarian.

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VEGETARIANISM

by

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