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Differences in nutritional status between vegans, vegetarians and omnivores

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Well planned vegetarian diets effectively meet Recommended Dietary Allowances and are a 'healthy' alternative to meat eating. Lacto-ovo-vegetarian diets have similar nutrient composition to omnivore diets. Vegan diets may be low in vitamin B 12. The fat content of the vegan diet is significantly lower and the polyunsaturated:saturated fatty acid ratio higher than in the omnivore diet. The fibre content of the vegan diet is about twice that of the lacto-ovo-vegetarian diet which is about three times that of the omnivore diet. Protein and essential amino acid content of the vegan diet is adequate. Protein intake of vegans is lower than that in omnivores. Blood lipoprotein changes due to intervention with a lacto-ovo-vegetarian diet are favourable regarding coronary artery disease risk. Infants and children have special needs. Full discussion of the effect of vegetarianism on child growth is beyond the scope of this report. Several dietary guidelines are given; choosing a wide variety of foods is recommended.

Introduction

With the increasing attention being given to health promoting lifestyles in today's age, there is a corresponding rise in interest in vegetarianism. There are varying degrees of vegetarianism, depending on the extent to which animal products are avoided. Veganism adopted by vegans is the most extreme or pure form of vegetarianism where all animal products are excluded. Less strict forms exist, for example, lacto-ovo-vegetarian, where there is selective exclusion of meat, fish and poultry but with the retention of eggs and dairy products. A similar form but not excluding fish is called lacto-ovo-pisco-vegetarianism Varying forms of modified, semi-vegetarianism may also be practiced in the community.

Certain diseases, such as obesity, non insulin dependent diabetes mellitus and coronary artery disease have been observed to occur less in vegetarians than in omnivores (those who eat meat). This may reflect upon the nutritional status of vegetarians, but it may also reflect upon other factors that can often be associated with the adoption of a vegetarian pattern of eating: not smoking, regular exercise, avoidance of alcohol and caffeine, low fat intake, vitamin and mineral supplementation, increased dietary fibre, periodic fasting and other health promoting activities[1]. Therefore, it must be remembered, when assessing differences in nutritional status between vegans, other vegetarians and omnivores, that dietary intake may be only one contributing factor, with the associated health related attitudes and practices also having a significant impact.

Methods of Assessing Nutritional Status

Nutritional status may be viewed by looking at dietary intake, analysis of body composition, biochemical test results or a combination of all three. Analysis of dietary intake can be done based on dietary records kept by individuals or on a dietary history obtained by interview or questionnaire. Another method is by chemical analysis of samples using the duplicate portion sampling technique. Dietary analysis should also include information pertaining to bioavailability of nutrients. The simplest methods of estimating body composition are indirect assessments using the anthropometric parameters of height, weight, skin-fold thickness and circumference measurements. Measuring these parameters in children not only provides assessment of current nutritional status but also over time provides information on their growth status.

Dietary Status

It appears that both vegan and lacto-ovo-vegetarian diets are generally able to supply adequate amounts of all the essential nutrients for the body's maintenance of homeostasis, including energy, protein, mineral elements and vitamins. Several studies support this[2-6]. There is, however, some suggestion that absolutely strict vegans may have lower than recommended levels of intakes of vitamin B12[5,7-11]. This vitamin is unique in that it is only found in animal products (it is produced by microorganisms in the stomachs of ruminants) and hence it would not be expected to be found in a diet that totally excluded all animal products. However, many vegans are not lacking in vitamin B12. It has been hypothesised that microorganism contamination of food prepared under less than totally sterile conditions allows for the inclusion of vitamin B12 in the dietary intake of strict vegans. This theory introduces an unknown variable when it comes to assessing the dietary vitamin B12 status.

There are different ways of studying dietary intake. One method employed by Hardinge[12], over thirty-five

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years ago is a comparative study of 86 lacto-ovo-vegetarians, 26 pure vegetarians and 88 non-vegetarian adults, adolescents and pregnant women. All subjects were of average or above average social and economic levels and in good health. All had voluntarily maintained their respective diets for a minimum of five years preceding the study.

Results of this study showed that although the dietary intake of nutrients varied widely among individuals, the average intake of all groups, with the exception of the adolescent pure vegetarian, approximated or exceeded the amounts recommended by the National Research Council. Only two adolescent pure vegetarians were able to be found for the study; they were both healthy despite having a protein intake slightly below the National Research Council recommendations.

Another way of studying dietary intake, using the duplicate portion sampling technique, was employed by a group of Swedish researchers at the University of Lund, Lund, Sweden[4,5]. They performed two similar studies. One compared copies of four 24-hour diets of 6 middle-aged vegans with similar dietary collections of a normal mixed Swedish diet using the duplicate portion sampling technique and nutrient composition determination by chemical analysis. The second study was performed along identical lines but instead of sampling vegan diets, sampled diets of 6 middle-aged lacto-ovo-vegetarians and similarly compared them with a normal mixed Swedish diet. As the methods of the two separate studies were identical the authors make direct comparisons between them. They compare the lacto-ovo-vegetarian group from one study, the vegan group from the other study and the control normal Swedish mixed diet groups.

Results showed that the nutrient composition of the lacto-ovo-vegetarian diet was certainly adequate. In fact it was closer in agreement with Swedish recommended dietary allowances than the normal Swedish diet. Thus, the lacto-ovo-vegetarian diet contained 35% of the energy as fat and was rich in polyunsaturated fatty acids, especially linoleic, which resulted in a polyunsaturated: saturated fatty acid ratio of 0.6. The lacto-ovo-vegetarian diet had a cholesterol concentration only half that of a normal diet. Protein content and amino acid composition were well above recommendations. Dietary fibre was three times higher in the lacto-ovo-vegetarian diet than in the mixed diet. In the Hardinge studies of vegetarians[13], the dietary fibre intake of the lacto-ovo-vegetarians was nearly twice that of the non vegetarians and a little less than half that of the pure vegetarians. Referring back to the Swedish study, the essential minerals and trace elements of the lacto-ovo-vegetarian diets satisfied current requirements. The daily intake of vitamin B12 in this group, however, was only 1.4μg which is below Swedish recommendations. The intake of folates was high, 300 to 400μg daily.

In the vegan diet 30% of energy originated from fat, and linoleic acid was the dominant fatty acid. The vegan diet contained less dietary protein than the mixed Swedish diet but did not, however, fall below requirements. The essential amino acid intake of the vegans exceeded recommendations. Dietary fibre was five times higher in the vegan diet than in the mixed diet and nearly twice that in the lacto-ovo-vegetarian diet. Mineral elements in the vegan diet approximated or exceeded levels in the mixed diet except for iodine and selenium which were much lower. Folic acid intakes were high in the vegan diet but vitamin B12 intake was only 0.3 to 0.4μg daily compared to 3.0 to 4.0μg daily in the normal Swedish diet and 1.4μg daily in the lacto-ovo-vegetarian diet.

Anthropometric Assessments

In adults, anthropometric assessment of nutritional status shows no differences in status (height or weight) between lacto-ovo-vegetarians and omnivores[12,14]. In the vegan group, however, according to the Hardinge study[12], both men and women have a mean weight 20 pounds lower than their respective lacto-ovo-vegetarian or non vegetarian counterparts, despite the fact that the energy intakes of the three groups appears to be approximately the same.

The differences in child growth in vegetarian and non vegetarian populations has been studied[15-20]. Infants and children have special needs and the effect of vegetarianism on growth is a topic on its own. Full discussion of results of studies on this topic fall beyond the scope of this report. In brief, it seems the more extreme forms of vegetarianism are associated with retarded growth or other nutritional status problems. There are studies associating infant malnutrition with cult vegetarian diets; some even calling it a form of child abuse[21-23].

Biochemical Assessments

Biochemical data can elucidate differences that reflect, a) lowered levels of a particular nutrient in the body, suggesting a possible deficiency state or b) changes in other chemicals in the body which are either favourable or unfavourable to good health. Usually, such favourability or unfavourability to good health is suggested by studies supporting correlations between incidence of a disease state with certain levels of chemical in the body. A prime example of the latter is the relationship between blood lipids and coronary artery disease. It is because of this relationship that studies of blood lipid status in different dietary populations are of such paramount importance to modern Western society, aiding the formulation of dietary guidelines for the community that will hopefully lower the prevalence of coronary artery disease.

Blood Lipid Status.

Nearly thirty years ago differences in blood cholesterol between vegetarians and omnivores was clearly documented[24]. Hardinge and co-workers studied the dietary intake and cholesterol levels of 86 lacto-ovo-vegetarians, 26 vegans and 88 omnivores. The total fat and fatty acid intake of the three groups was analysed and compared. The results revealed that:

a) significant negative correlation exists between the serum cholesterol level in the older age groups and the total unsaturated fatty acids [linoleic (cis-cis-9,12-Octadecadienoic) acid, a polyunsaturated fatty acid and oleic (cis-9-Octadecenoic) acid, a mono-unsaturated fatty acid] content of the diet;
b) significant positive correlations exist between the percent of animal fat [hexadecanoic fatty acids] and serum cholesterol levels in the older age groups;
c) highly significant inverse relationships exist between the ratio of polyunsaturated: saturated fatty acids and serum cholesterol in the older age groups;

d) in the younger age groups studied (adolescents and pregnant women), despite differences in fat and fatty acid intakes in their respective groups, the serum cholesterol levels did not differ significantly between vegetarians and omnivores. The pure vegetarians in both sexes had the lowest serum cholesterol levels, highest intakes of plant fat and highest dietary polyunsaturated: saturated fatty acid ratios, though their total fat intake was not a great deal less than that of the other two groups.

The Hardinge study was based on people who had already adopted their diets and, probably, their own dietary related lifestyle. (Hardinge's study doesn't take into account any variables such as smoking, physical activity or other health related behaviour.)

A dietary intervention type study was done in Perth, Western Australia by Dr. Masarei and co-workers[25], where, in contrast to the Hardinge study, the type of diet to be studied, that of lacto-ovo-vegetarianism, was introduced for the sole purpose of the study in volunteers whose diets prior to the study were no different to average non vegetarians employed as a control group.

Hopefully this type of study would eliminate some of the bias factors such as certain health related behaviour patterns associated with self chosen vegetarianism. Also, being a more recent study (1984) than Hardinge's, more sophisticated laboratory techniques for biochemical analysis were employed to do more specific lipid tests. In particular, the focus was on the high density lipoprotein (HDL) cholesterol because some studies had shown this form of cholesterol to be associated with a more favourable outlook with respect to coronary artery disease. Using techniques such as immunochemical turbidometry and rocket electroimmunoassay, various subspecies of lipoprotein were analysed including: HDL 2-cholesterol, HDL 3-cholesterol, apoprotein-B, and Lp(a). Changes in low density lipoprotein (LDL) cholesterol, the major blood component of cholesterol were also assessed.

The results of Dr. Masarei's study, determined by principal component (factor) analysis followed by stepwise multiple regression analysis, affirm that the differences seen in the levels of various lipids and lipoproteins between non-vegetarians and those adopting a vegetarian lifestyle are in fact due to differences in diet. The study supports the view that the vegetarian diet is associated with lower rather than unchanged or higher HDL cholesterol levels, and confirms that the change is seen in the HDL 2-cholesterol subfraction, the one thought to be most strongly negatively associated with coronary risk. Although HDL cholesterol levels fell on the vegetarian diet, ratios of HDL cholesterol to total cholesterol or LDL cholesterol were unchanged, which is more consistent with the known lesser risk of coronary artery disease risk in vegetarians.

Another dietary intervention type study was done at the Department of Human Nutrition, Syracuse University, New York[26]. In this study, the increased ingestion of whole eggs and of ascorbic acid was studied. Eggs were chosen for investigation because of the controversy regarding the effects on blood lipid levels of the ingestion of this cholesterol-rich yet highly nutritious food. Ascorbic acid was chosen because of its involvement in cholesterol metabolism and because of conflicting reports regarding the effects of ascorbic acid supplementation on plasma cholesterol levels. There were four groups of 10 healthy volunteers. They all ate a usual diet plus either a) three whole eggs, b) 2g ascorbic acid, c) both three whole eggs plus 2g ascorbic acid or d) a placebo. This dietary protocol was chosen in favour of a more controlled diet in order to make the results of the study as relevant as possible to the average person consuming a free-choice diet. Even though this study doesn't make comparisons of a vegetarian diet per se, it does, however, have a bearing on this topic as lacto-ovo-vegetarian diets, as might be expected, usually include a higher intake of eggs than their omnivore counterparts. This was shown to be the case in Perth[25], where the egg intake increased significantly on the lacto-ovo-vegetarian diet.

The results of the Syracuse study showed that in the egg plus ascorbic acid group there were significant increases in total cholesterol and LDL cholesterol. There were no significant changes observed in the other groups. It is interesting to note that in Dr. Masarei's study total cholesterol fell significantly in the group as a whole on changing from the omnivore to the lacto-ovo-vegetarian diet despite the significant increase in egg consumption on the latter. The Syracuse study was obviously not controlled enough for results to be highly significant. At best, it suggests a possible synergistic relationship between the two dietary factors, ascorbic acid and whole eggs.

Lastly, in relation to blood lipid status in vegetarians and non vegetarians the fatty acid spectra of the blood lipids can be looked at. There were significant differences in the fatty acid content of blood lipids between vegetarians and non vegetarian groups in a matched pair study done at the Institute for Social Medicine, West Berlin, Germany[27]. Results of this study showed the fatty acid profiles reflected the dietary consumption of lipids, for all of the blood lipid fractions. Those fatty acids which are indicative of animal product consumption, for example palmitoleic, eicosapentaenoic and docosahexaenoic acids were considerably higher in the non vegetarian group while linoleic and alpha-linolenic acids, mostly of plant origin, were higher in the vegetarian group.

Essential Nutrient Status.

Biochemical assessment of essential nutrient status in the body has been carried out in several studies of vegetarian and non vegetarians. It is not surprising that vitamin B12, which is only found in animal products, has been found to be low in some cases where a pure or vegan vegetarian diet has been adhered to[8-11].

Vitamin D status may also be low in vegans but this has only been shown to be the case in special populations such as young children (whose requirements are higher), or dark skinned vegans who spend little time out of doors. The latter is illustrated in a study of vitamin D status in Ugandan Asian immigrants to Britain[28]. Of the group studied, the Hindu pure vegetarians had the lowest dietary intakes, least time spent out of doors and the lowest serum 25-hydroxy-cholecalciferol.

Iron status has been reported to be lower in vegetarians than in omnivores[10,29]. The American Dietetic Association points out that Western vegetarians generally have better iron status than those vegetarians in developing countries[1]. The reasons given are that the former have a relatively

high intake of iron from plant foods such as dark green leafy vegetables, iron fortified cereals and whole grains; they may also take supplements of ascorbic acid (which enhances iron absorption) or of iron and have a greater intake of ascorbic acid from plant food. Whereas, in contrast, vegetarians in developing countries consume less ascorbic acid and animal protein, rely on low-iron food staples and consume more fibre, phytates and tea (which inhibit iron absorption) than do Western vegetarians.

Long term vegetarian women (56 in total), were studied in respect to iron status at the University of Guelph, Ontario, Canada[30]. Dietary analysis showed their intake of readily absorbable iron from flesh foods to be low and their intake of dietary fibre and phytate to be high. However, despite these factors, their serum iron, total iron binding capacity and haemoglobin measurements were adequate. It is evident then that vegetarian diets may or may not meet iron requirements depending on a variety of factors. Studies on calcium status in vegetarians and omnivores are interesting and not without unresolved questions. The protein intake of omnivores is generally higher than that of vegetarians and it is a known fact that nett calcium loss is significant in association with high protein diets, at least in short term experiments. To what extent this effect is involved in general osteoporosis (common in Western communities with increasing age), where protein intakes are moderately high, and over time periods of 10-20 years, has not yet been evaluated. There are studies citing lower rates of osteoporosis in vegetarians than in omnivores[31]. No significant difference in serum calcium levels were found between a group eating a vegetarian diet and a matched group eating a non-vegetarian diet in one dietary intervention study done at the University of Nebraska, Lincoln, Nebraska[32].

Conclusion

Lacto-ovo-vegetarian diets have similar nutrient composition to omnivore diets. Some studies show vegan diets to be low in vitamin B12. The fat content of the vegan diet is significantly lower and the polyunsaturated: saturated fatty acid ratio higher than in the omnivore diet. The fibre content of the vegan diet is about twice that of the lacto-ovo-vegetarian diet which is about three times that of the omnivore diet. Protein and essential amino acid content of the vegan diet is adequate though protein intake of vegans, in general, is lower than is usual with omnivores.

Physical measurements show no differences between lacto-ovo-vegetarians and omnivores. Vegans, however, have significantly lower body weights.

Biochemical tests show adequate nutrient status for all groups except in respect of vitamin B12 which may be low in strict vegans. Blood lipids reflect dietary intake. Total cholesterol is lower in vegans than in lacto-ovo-vegetarians which is lower than that in omnivores. Blood lipoprotein changes due to intervention with a lacto-ovo-vegetarian diet are favourable regarding coronary artery disease risk. Full discussion of studies on the effects of vegetarianism on child growth is beyond the scope of this report.

Vegetarian eating is a healthy alternative to meat eating if care is taken. The following guidelines would help to ensure this:

a) choose a wide variety of foods,
b) minimise fat and simple sugar intake,
c) choose whole grain products,
d) include a good food source of vitamin C to enhance iron absorption,
e) for lacto-ovo-vegetarians use low-fat milk products and limit intake of egg yolks,
f) for vegans use a fortified source of vitamin B12 or take a cobalamin supplement,
g) for infants and children take special care to ensure adequate nutrient intake, in particular, energy, iron and vitamin D,
h) avoid strict veganism for infants and children (also adults) without first consulting a qualified nutrition professional.

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嚴格素食者、素食者和雜食者
營養狀況的差異

摘要

良好計劃的素膳可以獲得推荐的每日膳食營養素的供給量，是肉食者一種健康選擇，乳一蛋素食者膳食中可獲得與雜食者相類似的營養素。嚴格素食者膳食中維生素 B_{12} 也許含量較低，脂肪含量明顯低下，高度不飽和：飽和脂肪酸比值較雜食者膳食爲高，纖維素含量約爲乳一蛋素食者膳食的兩倍，而乳一蛋素膳中纖維素含量約爲雜食者的三倍。嚴格素膳中蛋白質和必需氨基酸是充足的，但蛋白質進食較雜食者低。由於乳一蛋素膳對冠心病危險起促進作用，因而血脂蛋白發生改變。嬰兒和兒童有其特殊的需要，充份討論素食主義對兒童生長的影響是超出了該文的範圍。該文給予膳食指導，並建議選擇多種多樣的食物。

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