

catch any entrained fluid in the gas; second, to cool the gas; third, to act as a water-check-valve protecting the pressure system of the generator from any external variation or excess of pressure. Furthermore, each generator is thus made independent of every other in the plant.

A signal whistle is provided which gives notice when the level of the solution of the generator falls below the prescribed limit. Glass sight-feed indicators on the solution tank and gas domes show the fluid levels and reveal the generation of the gases. Gage glasses connecting with the electrodes at intervals along the gen-

erator show the fluid levels in the body of the apparatus. To permit the emptying of solution from the generator when required, drain valves are provided. These are of the level-operated gate type, designed to obviate any leakage or wear due to the presence of solid matter in the fluid.

The only parts subject to deterioration and replacement are the rubber of the insulating nipples and diaphragms packing rims. Observations on this pure rubber insulation during the years of experimental work on this generator, demonstrate that it has a length of life highly satisfactory. The asbestos fabric of the

diaphragms has been proved to be strong and durable, and it has already been pointed out that mechanical deterioration of the fabric is minimized by the balancing of pressure and the reduction of fluid circulation within the apparatus. The up-keep cost on the filter press type generator has been reduced to the practical limit.

It is as completely automatic as a high-duty device can be made. Practically the only attention required in operation is a maintenance of the water supply, and calls only for a minimum of attendance—at the most, only a small part of one man's time.

# Is Vegetarianism Based on Sound Science?

## Theories and Results Briefly Reviewed

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It is said that the number of people adopting the vegetarian diet is largely on the increase. The high cost of meats in these days leads many a family to face the proposition of adopting the plan from an economic motive. What are the reasons for and against it?

Although vegetarianism has been taken up frequently from reasons which may be called emotional, there is also much testimony as to great improvement in the physical condition of those who have adopted it. For instance, of Sarah Bernhardt it is said that she has "demonstrated that a vegetarian diet makes one younger and more elastic and gives a clear brain and steady nerve." Senator LaFollette says that he can do twice the work he did on the mixed diet and his head is vastly clearer. August Rodin, the sculptor, considers that his imagination works more clearly and the general tone of his production is higher. Wu Ting-fang thinks he has cured himself of many ills in this way and he expects to be able to prolong his life to one hundred and fifty or more years by refraining from all meats. It has been noticed that much of this testimony comes from individuals who have become over-stout and needed to reduce their flesh, or from those to whom the change was made really one of general regulation of habits and control of diet.

Such testimonials as these are good, as far as they go. There is little doubt that many a person who has abused his body by overeating, or injudicious eating, would be much benefited by inflicting upon himself severe restrictions as to the amount, the kind, and the time of his eating. Testimony comes, however, also from others who have found that for themselves the attempt to live on the vegetarian diet has resulted, sooner or later, in a series of ailments and an impaired nervous condition. These cases are less likely to be heard from than the others. A statistical comparison of the testimony on both sides of the question, with statements as to the details of the conditions of the subjects, would be of interest.

The collection of such statistics which could be considered unbiased and fairly representative of human experience is impossible, but if one may infer from certain data on albino rats collected at Leland Stanford University, the case stands convincingly against the vegetable diet. Observations on the lower animals have the advantage that the effects of a particular dietary treatment cannot be influenced by any preconceived notion on the part of the subject as to how they will come out.

The report from the experiment is that: Rats fed on a mixed diet did more work, voluntarily, than those on a vegetable diet. The vegetarian rats aged much earlier in life. The growth of the vegetarians was greatly retarded. The ratio of maximum weights was 1.6 to 1 in favor of the omnivorous feeders. The effect on the general condition of the body was most overwhelmingly in favor of the omnivorous. The vegetarians were frail, weak, and showed extreme lassitude and indifference. The omnivorous were the reverse in all these respects. The average life of the omnivorous was 1,020 days, that of the vegetarians 555 days. This was a ratio of 1.83 to 1.

In this evidence every claim of the vegetarian meets a counter-claim. However, whether rats or men, whether statistical or unrelated, this type of evidence does not go deep enough and is not sufficiently definite to furnish a satisfactory basis for judgment as to the limitations of the method of treatment. With human subjects it has a disadvantage in the impossibility of eliminating personal prejudice and an advantage in the probable inclusion of a wide range of food materials within the designated field and a free choice of activity

not affected by experimental conditions. But one must ask what is the physiological explanation of any advantage of either type of food? Are there any specific values in animal foods which give reasons why they should be eaten?

The physiologists and nutritional chemists have generally put it about this way: Although proteins, carbohydrates, fats, and salts are found in both classes of food, meat is *par excellence* a protein food, and the cereal grains and other vegetable products are carbohydrate foods. Fats and oils are abundant in both kingdoms; but, as a matter of fact, those which have been most used as foods are of animal origin. Proteins, carbohydrates, and fats are all used by the body for the production of heat and muscular energy; proteins also serve a specific need as building material in replacing the wear and tear of the body. Since all are present in vegetable foods as well as in animal foods, it is possible for a person to subsist on food of either type to the exclusion of the other; but a large use of meat means a large amount of protein, and the question of the liberal use of meat involves the much-discussed question of the desirability of a high-protein or a low-protein diet. As is more and more fully realized of late years, this last question of the protein requirement needs to be settled more on the ground of quality than of quantity, and until much more information is gathered with regard to just what proteins are of greatest value to the animal body it will be best to advocate a rather liberal allowance of protein, selected from as wide a field as may be. It is generally recognized that a large excess of protein is undesirable, and a diet made up entirely of meat could be endured only by those living in the Arctic regions and under strenuous exercise. On the other hand, a vegetable diet generally has so low a protein content that a large bulk of it must be eaten in order to secure a sufficient supply of protein.

The bulkiness of a vegetable diet is increased by a considerable content of water and of indigestible material, especially cellulose. But these factors are in themselves advantageous in a degree, because they facilitate the movement of the food along the digestive tract. A meal that is completely digested may be, like the inherited fortune, too much of a good thing obtained with so little of exertion as to make the recipient lazy and incompetent. On the other hand, poverty may demand such strenuous work as not to allow the worker to take advantage of all the good things that come along free. The indigestible materials themselves prevent the digestion and absorption of some of the digestible materials.

An excessive bulkiness may be avoided in part by the selection of foods that supply fats, for fat is a concentrated food. Fat is usually well digested, and a pound of fat furnishes more than twice as much heat to the body as a pound of carbohydrate or of protein. If fat meat, butter, and cream are taboo, substitutes from plant origin must be sought. For that reason, nuts are more freely used in the vegetarian diet than in the mixed diet. They furnish considerable fat and at the same time protein and carbohydrates in a form that is not bulky. They should be served ground or be well masticated.

Another form of fat of vegetable origin is found in the various hydrogenated vegetable oils which are coming into use of late, such as crisco. Several recent tests made in Germany and in America as to the utilization of hydrogenated peanut oil, sesame oil, and cottonseed oil all give evidence that these oils are without injurious effect on dogs and men, and are about as well digested and utilized as the lard with which they

have been compared. In the experiments carried out with men in Jefferson Medical College, in Philadelphia, for example, the lard was utilized to the extent of 94.7 per cent and the hydrogenated oil (from cottonseed) to the extent of 93.33 per cent. The United States Department of Agriculture has begun an extensive investigation of the food value of various animal and vegetable fats in household use. A report on the digestibility of lard, beef fat, mutton fat, and butter has already been published (U. S. Dept. Agr., Bul. No. 310, 1915). The digestion percentages are: for butter fat and lard 97, for beef fat 93, and for mutton fat 88 per cent.

One need not, therefore, object to the vegetarian diet on the ground of the fat requirement in these days when so many forms of fat are brought to our markets. The war, however, is causing a rush of fats to the soap factories, because the soap-making process furnishes glycerin as a side-product, and the demand for glycerin for explosives is at present practically unlimited. The Germans are saving the raisin seeds from the mince-meat factories, in order to extract the oil which the seeds contain.

Under the conditions of scarcity of food, however, the greatest drain on the physical well-being is due to insufficiency of proteins. A certain amount of the protein components absolutely must be given with the food, or the body must find them by breaking down its own tissues. A man weighing 156 pounds contains about 30 pounds of protein, or 20 per cent of his live weight. If the man starves, he loses 5 parts per thousand of his protein store daily. If he is not starved but on a limited diet, carbohydrates and fats may somewhat reduce the loss but cannot entirely replace it. Of the proteins he may take to prevent this loss to the body those from animal sources are more effective than those from plant sources. Data from Rubner's laboratory, in Berlin, show the following as the lowest amounts of protein of the different kinds which, with an abundance of carbohydrates and fats, may suffice to keep the body from loss of protein:

|                          |          |
|--------------------------|----------|
| Meat protein .....       | 30 grams |
| Milk protein .....       | 31 "     |
| Rice protein .....       | 34 "     |
| Potato protein .....     | 38 "     |
| Bean protein .....       | 54 "     |
| Bread protein .....      | 76 "     |
| Indian corn protein..... | 102 "    |

The numbers show that of this list much larger amounts are required of the bean protein, the bread protein, and the Indian corn protein than of the meat protein or the milk protein.

Such observations as these show plainly the advantage of animal protein over vegetable proteins in the extreme emergency. Another observation which has repeatedly been made, and which shows the advantage of the animal proteins, is that in general they are much more nearly all absorbed from the alimentary tract than are the vegetable proteins. There is considerable waste in the use of plant proteins. Certain recent experiments indicate that this form of waste is due largely to what might be called the style of package. If the nutritive material is covered by a case of indigestible material, or even intimately mixed with such indigestible and hard, insoluble material, it may be expected that a part of it will escape unchanged. That is the condition in much of the cereal foods and vegetables. The waste due to the rapid movement of such foods through the canal is another hindering factor already mentioned. The animals that habitually live entirely on vegetable products are provided with means for reducing this waste. They can digest cellulose and they