sensitive, giving a positive reaction with a quantity of one microgram (0.001 milligram).

2. The average limit of perceptibility of bitterness of strychnine dissolved in distilled water to human taste was found to be five micrograms.

3. The addition of sodium chloride, or sucrose, decreased the apparent bitterness.

4. Marked differences in reaction time and place of detection on the tongue have been found in different individuals.

5. When each individual is standardized, it is possible to detect differences of five per cent without trouble.

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FOOD AS A PREVENTIVE MEDICINE.*

BY EDSEL A. RUDDIMAN.

Good health is the most important thing in life to have. Food largely influences good health. Therefore, food is the thing above all others which should receive our attention.

I have a little hesitancy in saying anything on the subject of food, because so much has been said and written; and yet in a way we have been more careless in this one thing than in anything else that we do. Of course if we all had perfect health there would be no need of pharmacy, but there is not one of us that would not gladly seek some other calling if that time should ever come.

Doctor Scoville (1), in an article entitled "Pharmacy, a Review and a Forecast," says: "The presence of the lunch counter in the drug store, which the old-time pharmacist views with misgivings, may be a real step in advance." I quite agree with him provided the pharmacist puts over the idea of what are the proper

* Scientific Section, A. Ph. A., Rapid City meeting, 1929.

things for him to eat. The use of drugs is quite dependent on the misuse of food.

The subject of what to eat is being studied by scientists and to some extent by the laity as it has never been studied before. The people in general want to know more of the details as to how they can get a better balanced and a complete diet. Some of the information which they accept is not always reliable. As for example: Because of certain advertising many persons think that raisins contain a large amount of iron. Analysis shows that many common foods are much richer in iron. Egg-yolk contains four times as much as raisins; beans three and a half times; whole wheat two and a half times; fresh spinach, prunes, dates, one and a half times. People not knowing better believe such advertising; reasoning, because it is in print it must be true.

Improper food has much to do in causing disease both directly and indirectly. An industrial firm recently kept a record of the number of hours lost by its employees for a given period and the causes of the absences. The conclusion arrived at was that over 80 per cent of the hours lost was due to stomach troubles. This means not only a loss to the employees but a greater loss to the employer because of the goods turned out and expensive machinery lying idle. Indirectly, improper food may result in a failure to build up a healthy resistance which perfect health requires; it may cause conditions which render the person more susceptible to disease. It may even be a factor in the production of criminal tendencies. We may eat a heavy meal at a banquet late at night and the next day know that we have done wrong, but each day we may eat a little too much or too little or not the right combination and not know that we have been indiscreet. One of the curses of the present day is eating too much. Of course food is not the only thing necessary for good health. Good air, sunshine, exercise, sleep and moderation in everything are essential.

Undoubtedly proper food contributes much to longevity—it cannot be otherwise; experiments made with animals prove it, although Dr. Pearl (2) of Baltimore after investigating fifty-one cases of persons who had lived to be ninety years old or over concludes that heredity is the greater factor.

If we could know and would eat the right amount of food and the right kind of food best suited for the age, work, sex, climate and conditions in general, there would be less disease and there would be greater efficiency both physically and mentally. In a recent number of the *Parents Magazine* is an article on "Intelligence Is Affected by Food" by Dr. Munroe (3). Among other experiments he reports one in which ten children were selected from average families, every girl having a sister and every boy a brother who were used as controls. Those selected were given a chocolate egg milk shake twice a day for seven months, in addition to the regular food which the controls had. Those who had received the milk shake gained in weight and in intelligence over the controls. The writer continues, "Many children are starved both before and after birth into habits of metabolism which would throttle the growth of an elephant, to say nothing of the delicate structures of the nervous system of the human being."

There are seven essential constituents of foods: (1) Proteins; (2) Fats; (3) Carbohydrates; (4) Mineral salts; (5) Vitamins; (6) Roughage; (7) Acid- and alkaline-producing ingredients. If any one of these constituents is lacking disease results. Many foods contain some of all of these, but so far as known not a single food contains them in proper proportion to promote growth and maintain life for any length of time.

Numerous surveys have been made of food eaten by different classes of persons in different vocations. The amounts of proteins, fats and carbohydrates have been determined and they vary widely with the condition of the person and the energy expended. The daily amounts reported vary from 86 to 300 Gm. of proteins, 60 to 100 Gm. of fats 240 to 550 Gm. of carbohydrates, giving from 2000 to 6000 calories.

This gives some idea of what is being eaten. It is generally accepted that the lower amounts are better. It has been suggested that 10 to 15 per cent of the necessary calories come from proteins. If 2500 calories are needed, 250 to 375 should be furnished by proteins which would mean that 62 to 94 Gm. of proteins should be eaten daily. The proportion of fats and carbohydrates can apparently be varied within quite wide limits.

The claim has been made that carbohydrates and proteins should not be eaten at the same meal and yet every vegetable and every fruit contains a mixture of these. In the stomach the presence of some protein may aid the digestion of starch, because the hydrochloric acid combines with protein and does not so readily acidify the mixture of carbohydrates and alkaline saliva and thus stop digestion by ptyalin. While proteins largely repair the waste of the body carbohydrates and fats supply the heat and energy. Carbohydrates are also necessary to aid the burning or utilization of fat. Experiments indicate that 1 Gm. of glucose is necessary for 1.5 Gm. of fat. A fat free diet, according to Burr (4), produces a train of symptoms suggesting a deficiency disease.

Some writers speak of starchy and non-starchy vegetables. There are but few edible vegetables if any that do not contain some starch and certainly none that do not contain carbohydrates. It is interesting to note the proportion of protein and carbohydrate in some vegetables as compared to the same ingredients in some foods which are generally considered highly carbohydrate. If we dilute whole wheat flour or potato with water so that the mixture contains the same per cent of water as carrots do, carrots will contain practically the same amount of carbohydrate as the mixture. Comparing such a dilution of wheat or potato with fresh carrots we have:

	Water.	Protein.	Fat.	Carbohydrate.
Carrot contains	88.2%	1.1%	0.4%	9.3%
Wheat with water	88.2	1.5	0.27	9.5
Potato with water	88.2	1.2	0.04	10.0

Comparing other common vegetables, as beets, lettuce, cabbage or parsnips, with the concentrated starchy foods, after bringing the per cents of water together, there is comparatively little difference in amounts or proportions of proteins, fats and carbohydrates. We can speak of vegetables as being concentrated or dilute but not as starchy and non-starchy. Fresh vegetables and fruits contain from 70 to 90 per cent of water.

Or if we evaporate the water from vegetables, we may be surprised at the high percentage of protein and carbohydrate. For the sake of comparison, keep in mind that dry whole wheat flour contains about 80% carbohydrates, dry beets contain 78% carbohydrates, carrots contain 79%, parsnips 79%, potatoes 85%, turnips 78%. Also keep in mind that average meat (which contains practically no carbohydrate) when dry contains about 55% protein while dry asparagus contains 30% protein, Swiss chard 31%, soy beans 40%, Brussels sprouts 40%.

Until recently the quality of protein had not been generally considered, but it is as important as the quantity. In the digestion of proteins, they are broken up into compounds known as amino acids. While the number of proteins is large, the number of known amino acids is not over twenty. The almost innumerable ways of combining acids and the large number of these acid radicals which may enter the protein molecule accounts for the large number of proteins. Certain amino acids are absolutely necessary for life while absence of others from food seems to have no effect. Amino acids circulate as such in the blood. This is one of the wonders of the human body that cells can take out of the blood such of the amino acids as are necessary and in correct numbers to make their own tissue.

While some proteins are more complete than others, there is no one which furnishes the necessary amino acids in proper amount to promote growth and maintain life, consequently proteins from different sources must be chosen, so that one will supplement another. The determination of which protein will supplement another has not been worked out satisfactorily to any great extent and the statements are often conflicting. The protein of wheat is deficient in the amino acid lysin, but protein of beans or peas furnishes a larger amount so that beans or peas supplement wheat. One cereal does not supplement another, neither does one legume supplement another. Milk is a general supplementary food. It is not as important to have a large intake of protein as it is to have proteins of excellent quality.

The nutrient constituents of meat and fish are chiefly proteins. It is claimed by some biologists that proteins from the animal kingdom are more easily digested than those from the vegetable kingdom and that they are richer in the amino acids necessary for life. Others claim that the vegetable proteins are as easily digested, provided the cell walls around them are broken. The unbroken wall has a detergent effect, preventing the access of the digestive ferment. Meat is perhaps more liable to carry pathogenic germs and to cause deleterious decomposition products in the intestine than vegetables. Although it is a disputed question whether a people living on both animal and vegetable food is a larger and stronger race physically and mentally than one which lives chiefly on one or the other class of foods, the race eating both is apparently the more aggressive and progressive.

The amount of protein which one should eat per day is a much disputed subject. Chittenden (5) of Yale Univesity experimented on three groups of persons—professional men, army men and college athletes. His conclusion was that about one-half the protein usually eaten is sufficient to give the best results, or about 40 to 60 Gm. Hinhede (6) of Denmark found that the amount of protein can be reduced to 45 and in some cases 25 Gm. and he claims that the men, although in good health at the time of starting, were in better condition at the end of the experiment. Most of these experiments extended over a period of seven to twelve months, not long enough to determine the ultimate result.

More is being written at present about vitamins than any other food constituent and we probably know less about them. We know them only by their effects or rather the effect produced by their absence. None of the vitamins have been separated in a pure condition, although a recent report tells of Swedish investigators (7) who claim that they have obtained growth by feeding crystalline carotin to rats which have been depleted of vitamin A, giving the inference that there is a close relationship between the yellow pigment carotin and vitamin A. Experiments in attempting to isolate vitamin A show that the amount present is extremely small, too small to be separated by present known methods.

Vitamins are manufactured in plants and perhaps in some animals (8), but probably not in humans. Vitamin C seems to be unnecessary in the food of rats and chickens, but their livers contain an antiscorbutic substance. Vitamin D can be produced in a very concentrated form by subjecting ergosterol to ultraviolet light. Over-irradiation may destroy the vitamin. Ergosterol is an unsaponifiable body found in ergot, cod liver oil, yeast and other sources. In a recent number of the *Biochemical Journal* (9) is an article in which the writers claimed to have obtained ergosterol from the brain of a mummy about 1500 years old and, on being irradiated, effects were produced on rats similar to the effects of vitamin D.

Vitamin C is found in many vegetables and fruits, but not generally in seeds. An interesting fact is that it is formed in the sprouting of cereals and legumes. It has been shown that bleached asparagus (10) and white head-lettuce (11), the parts generally preferred, are not nearly as rich in vitamins as the green parts. Lettuce grown indoors (11) proves to be as beneficial in the growth of rats as that grown outdoors.

Some work (12) has been done to determine the effect on the formation of vitamins when the vegetable or fruit is ripened after being picked. In one experiment four lots of tomatoes were compared: 1, green tomatoes; 2, tomatoes ripened in the air; 3, tomatoes ripened in ethylene; 4, tomatoes ripened on the vine. The four lots showed no difference in vitamin B. The same amount of vitamin A was formed regardless of the method of ripening, but the amount was larger than in the green fruit. There was more vitamin C in the vine-ripened tomatoes than air-ripened or ethylene-ripened and more in these than in the green tomatoes.

Undoubtedly the soil, fertility and climate have considerable to do with the formation of vitamins. Dye and Crist (13) experimented with lettuce on different soils and found that the vitamins varied, but they concluded that robustness of plant and particularly greenness had much to do with the variation.

Sherman (14) made an attempt to establish units for measuring the amounts of vitamins. The U. S. P. gives a standard in units for cod liver oil. These units are not entirely satisfactory.

Cooking vegetables and fruits undoubtedly destroys vitamins to some extent, particularly vitamin C. Under the most advanced methods as practiced now, canning (15) seems not to do much harm. Tomatoes may be canned without apparent injury. Canned goods often retain the vitamin activity better than the fresh fruit kept in storage. Long continued low heat is more destructive than a short high heat. Drying vegetables (16), as cabbage, potatoes and carrots lessens the amount of vitamins and keeping dried vegetables for months seems to cause a further loss, although dried orange juice preserved its activity after 5 years' storage (17). Peaches (18) dried after being sulphured did not lose their activity, but those not sulphured did. Freezing (19) seems to have but little or no effect.

The maximum and minimum amounts of vitamins to produce the optimum of health have not been determined. There is no question but that there is a minimum amount. It has not been proved that there is a possibility of getting too much vitamin, but some experiments made with irradiated ergosterol indicate that such might be the case. There is more danger of getting too little than in getting too much.

Until recently but little attention has been given to the mineral constituents of foods, except iron, calcium and phosphorus. Now we know that other mineral elements are essential. Much has been written on what form of iron is most effective and many contradictory statements have been made. Mendel (20) says "The once debated question of the superiority of calcium, phosphorus and iron when furnished in some organic combination no longer excites interest since it has been observed that inorganic sources of these elements can apparently serve the requirements adequately. The evidence available points to the probability that these elements are ionized in any event before they enter the blood stream."

Of course a trace of iodine is necessary to prevent goitre. There is recent evidence to show that copper has a positive effect in increasing somewhat the production of hemoglobin, particularly when accompanied with iron. In some cases a combination of copper, iron and manganese seems to be still better. It has been suggested that it is the copper (21) in liver which makes it valuable in anemia, because the ash of liver or the hydrogen sulphide precipitate of the hydrochloric acid extract of the ash has a similar effect. The ash of lettuce relieves the anemia caused by a milk diet. Lindow, Elvehjem and Peterson (22) give the amounts of copper in various foods, ranging from 0.1 mg. in celery to 8.6 mg. in lima beans, to 44 mg. in calves' liver, based on 1 Kg. of fresh material.

Bertrand and Benzon (23) report finding zinc in many of the common vegetables, varying from 0.3 mg. in plums to 52 mg. in kidney beans. Many vegetables contain manganese (24). Traces of aluminum, arsenic, boron, bromine, cobalt, fluorine, iodine, lithium, nickel, silicon, strontium, titanium, vanadium have been found in plants and animals. These minerals may have a greater significance for plants than animals, but they enter the body and may have a necessary function. As might be expected the minerals and their percentages vary with the soil on which they are grown. In examining wheat Greaves and Hirst (25) found that the per cents varied with the soil, irrigation, climate and variety of seed.

Foods on being burned may leave an ash which is either acid, neutral or alkaline and the degree is measured by the number of cubic centimeters of $N/10$ alkali or acid required to neutralize it. Similar results take place when food is burned in the body. Most fruits and many vegetables produce alkaline products while cereals, meat, eggs and fish give acid products, and these may lessen the alkalinity of the blood and tissues which, according to some physicians, tends to cause acidosis, colds and other affections. It thus becomes necessary to choose foods whose decomposition products taken as a whole are on the alkaline side.

With this general information, how are we to choose the special foods which we should eat? This is a problem which at present each must to a certain extent solve for himself. It is one of the biggest problems to be tackled and it is well worth all the energy and attention we can give it. It will take several generations to overcome the evil tendencies and results which have been inherited and we must not lose sight of the possible effect for good or for evil on the coming generations. There are a number of men and institutions which give definite and specific instructions as to what should be eaten and what combinations should be made. Probably all of the directions have some good and some bad. In many cases the person laying down the rules has been sick or abnormal and the conditions are different from those of a normal individual.

In determining diets we must not forget that the infant and growing child, the pregnant and nursing mother should have certain things which are not required by the ordinary adult. An adult will thrive on a diet on which a growing child will not. The child needs more minerals and vitamins.

Judging by the work done by McCollum, Osborne and Mendel, Sherman and others, there is but little difference in the digestion of various starches, provided the cell wall and the covering membrane are broken as they usually are in cooking. What little difference in nutritive value of the cereals there is seems to be in favor of wheat and this largely because of the protein.

In general it seems advisable to eat more vegetables for several reasons. They are more dilute and the appetite is satisfied before an excess is eaten, but on the other hand it is necessary to eat some concentrated food to get sufficient nutrition. Vegetable proteins supplement those of cereals. Vegetables contain vitamins and mineral salts. Some vegetables excel in one thing and some in others; tables showing the nutritive principles in common foods are given in "Sherman's Chemistry of Nutrition," and in other references appended. Above all moderation in eating must be practiced just the same as in anything else and if we do that we will have started toward better health. To quote Henry Ford, "The commonest thing we do is the thing we know the least about—eating."

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THE DETERMINATION OF DEXTROSE IN CONCENTRATED SOLUTIONS.*

BY EDMOND E. MOORE.[1]

The determination of dextrose in solutions containing from 35 to 50 per cent of this compound is of much importance in pharmaceutical laboratories. The usual reduction of divalent copper requires considerable time and for that reason it is not entirely satisfactory for control work. The same objection holds for the determination of total solids: in this case we have the added objection that any foreign material such as buffer salts or preservatives in the solution will increase the weight. The specific gravity method is quick and accurate if there are no other substances present. The optical rotation is not affected by any of the usual preservatives or buffers and this method is, therefore, the most satisfactory for the assay of solutions made from C. P. or U. S. P. dextrose.

The U. S. P. X expresses most of its physical constants at 25° C. which is the temperature we have chosen for both our specific gravity and polariscopic determinations. It was necessary to secure the data used in these determinations in this laboratory, as none could be found in the literature for dextrose solutions of the concentrations with which we are dealing and at the temperature which we feel it is advisable to use.

Determinations.

Weighings.—All weighings were made with brass weights in air.

Specific Gravity (d^{25}_{4}).—A specific gravity bottle was used which had been calibrated with water at 25° C. and the volume of water at 4° C. calculated.

Optical Rotation (R_{25}).—A 200-mm. tube and a sodium light were used and the temperature was maintained at 25° C. The usual precautions were taken to prevent errors due to mutarotation.

Data.—Determinations on solutions of known strength made with Dextrose C. P. supplied by U. S. Bureau of Standards, and freshly distilled water.

DENSITY AND OPTICAL ROTATION OF CONCENTRATED DEXTROSE SOLUTION.

	Dextrose.			Polariscope.	
	Per cent.	Gm. per 100 cc.	(d^{25}_{4}).	Reading.	Degrees (R_{25}).
1	35.22	40.38	1.1468	43° 36′	43.60°
2	37.19	43.01	1.1566	46° 40′	46.67°
3	39.53	46.19	1.1682	50° 20′	50.33°
4	41.12	48.34	1.1760	52° 42′	52.70°
5	42.95	50.92	1.1854	55° 40′	55.66°
6	44.93	53.70	1.1953	58° 40′	58.66°
7	47.25	57.04	1.2071	62° 36′	62.60°
8	47.93	58.03	1.2105	63° 42′	63.75°

Neither the specific gravities nor the optical rotations of dextrose solutions are straight line functions of the concentrations. However, if the data given in the

* Division of Medicinal Chemistry, A. C. S., Atlanta meeting, April 1930.

[1] Swan-Myers Company, Indianapolis, Indiana.