4-22-1919

Non-Nitrogenous Foods

Edna M. Boyd

Follow this and additional works at: https://digitalcommons.ursinus.edu/chem_hon

Part of the Chemistry Commons

Click here to let us know how access to this document benefits you.
NON-NITROGENOUS FOODS

by

EDNA M. BOYD, April 22, 1919.
BIBLIOGRAPHY

Chemistry of Cooking
W. Matthieu Williams.

Foods and their Adulteration
Harvey W. Wiley.

Essentials of Chemical Physiology
W. D. Halliburton.

Air, Water and Food
Woodman & Norton.
Life is dependant on the food supply. In the wear and tear of every day life, the body loses energy and the tissues break down. Wholesome food is a necessity for productive life. First, let explain what is meant by food. Food is that which builds up the body and furnishes energy for its activities; that which brings within reach of the living cells, which forms the tissues, the elements which they need for life and growth. Foodstuffs present a great variety. In general they may be divided into two great classes, nitrogenous and non-nitrogenous foods. I shall confine the following pages to the treatment of non-nitrogenous foods, which comprise water, fats, carbohydrates, and mineral salts—touching on the action taken on them by the body, their analysis, composition and adulteration.

From a standpoint of value of utility, water is the most precious food. Without it man dies in a few days. The average amount of water required by the body daily is three quarts. A large portion of this is taken thru the food. When it is realized that two-thirds of animal organisms is water, it can plainly be understood why water plays such an important role in life. Water functions in the various reactions of the body and also acts as a solvent, carrying not only nourishment in solution to the tissues of the human body, but also carries away the refuse material. It is a cardinal principle in all sanitary reforms to get rid of that which is useless as soon as possible. Metabolism which produces human energy is dependant upon the presence of water in the tissues. Too little water allows accumulation of the waste and a clogging of the bodily drainage system. Not only the quantity but the quality of the water must be considered. As a rule moderately soft waters are the best for any purpose. For drinking, water must be free from danger to health in the way of poisonous metals, decomposing matters and disease germs.

As was stated before, not only the quantity, but the quality of the water consumed must be taken into consideration. The questions naturally arise, what makes water unfit for usage, and where can water fit for usage be obtained. Drinking water may act as a carrier of the germs of at least two well known defined diseases, asiatic cholera, and typhoid fever. There is besides some tendency to disturb the system when a change is made from one kind of drinking water to another of radically different composition; as, a change from a hard middle west water to a soft New England water.

One source of drinking water is main water. In falling to the earth ammonia, carbon dioxide, and other soluble gases, dust and living organisms are collected. As soon as these substances are removed from the air, the rain water becomes a very pure source of supply and can be used for drinking purposes, if properly stored. There should be no connection whatever between the storage tank and any drain or sewer from a house or barn. No metal or other material which is injurious to the health should be used in building such a tank as rain water is soft and often slightly acid and therefore has considerable solvent power for most metals. There should be some way of wasting the first rain water that falls as not to load the storage tank with dirt. There should be an easy way of cleaning the tank frequently.

Surface water is another means of supply. This forms the main source as large cities are dependent upon it. The water may be collected in reservoirs. These should be uncovered and stripped of plant life as these are nearly all subject to more or less pollution. The water should be filtered or sterilized before using. A certain amount of self purification takes place in some cases; as, the removal of bacteria by means of sedimentation. Various plant and animal growths may be exterminated by the proper use of copper sulphate in quantities which will kill the small organisms, but not injure the human system.

Ground water, if gotten from a considerable depth, is an excellent source of water supply. Springs and shallow wells yield soft water, but are more subject to pollution. The deeper wells yield a harder water, but are free from pollution. The greatest danger comes from the shallow wells.
It can be replied:— that the water should (1) be free from sewage and all other waste products, (2) it should not contain excessive amounts of mineral matter (3) it should be colorless, odorless, and tasteless, and free from suspended matter. The part to be emphasized is that it should be free from sewage. The presence of sewage is determined first by counting the total number of bacteria per cubic centimeter and secondly, by looking for some type of distinctly sewage organism such as B. coli.

To make an exact laboratory test it is necessary to know in the first place something of the surroundings of the water. This aids in knowing what to look for, and in confirming results. In all water analysis very small quantities are sought for and therefore all tests applied must be exceedingly delicate in character. As little time as possible should escape between the collection and examination of the sample. All samples should be tested within twenty-four hours of their collection. In chemical examination nitrogen is tested for as free ammonia, albuminoid ammonia, nitrates, and nitrites, chlorides in terms of chlorine, oxygen consumed, soap hardness, total solids and loss on ignition, iron and sometimes oxygen dissolved. Then the physical tests as color, odor, and taste are made.

It is of little use to provide pure air and clean water, if the food eaten is not capable of combining with the oxygen of the air, or of being dissolved in the water or the digestive juices. Fats are valuable for their protective purposes as well as for building up fatty tissue, but not muscle, and as a supply of heat. If it occurs in the same proportion as the nitrogenous element the need of the organism seems to be well met. Fats are compounds of fatty acids with glycerine and may be called glycerides or glycerine acids. After they are taken into the body and acted on by a fat splitting enzyme as Lipase from the pancreatic juice, they are split up by emulsification into the substances out of which they were built.

\[ C_3 H_5 (O.C_15 H_31 CO)_3 + 3H_2O = C_3 H_5 (OH) \cdot 3 C_15 H_31 CO.OH. \]

Palmitin (a fat)  \hspace{1cm}  \text{glycerine}  \hspace{1cm}  \text{Palmitic acid (fatty acid)}

Simple fatty acids are absorbed by the assistance of bile.

Stearic acid is the chief constituent of animal fats. Upon examination it is found to be granular like marble, but not so hard. When it is rubbed with the hands it differs from marble in betraying its origin by a small degree of unctuousness, but it can scarcely be described as greasy. It can be mixed with glycerine without any combination taking place. When heated with glycerine just to its fusing point and the two are agitated together, the combination is by no means complete. Instead of obtaining a soft, smooth fat, there is obtained a granular fat with small stearic crystals with glycerine amongst them. It is a mixture of stearic acid and glycerine and not a chemical compound.

A similar separation is what is said to take place in cooking fat. Fat as beef fat or mutton fat is perfectly smooth when raw, but drippings, whether beef or mutton are granular as everyone who has eaten bread and drippings well knows and the manufacturer of butterine knows only too well, the destruction or prevention of the granulation being one of the difficulties of the art. Heat when continued long enough, or raised sufficiently high effects an incipient dissociation of the fatty acids from the glycerine, and thus assists the digestive organs by presenting the base and acid in a condition better fitted for the new combination demanded by assimilation.

Home rendered lard is more granular than that produced by large concerns, because economy of fuel is practiced in conducting it, and therefore less dissociation is effected than in the domestic process.
Ordinary animal fat is not boilable under pressure of our atmosphere. On heating lard, it is not the fat which boils, but the water. To prove this some lard is taken, heated, raising the temperature gradually until sputtering begins. It is then tried with a thermometer and is seen that the temperature coincides with the boiling point of water. The oil remains the same. When the water is driven off the liquid becomes quiescent in spite of the rise in temperature. Soon a pungent smoky vapor comes off and the oil grows darker. This vapor is not the vapor of the lard, but the vapor of separated and recombined constituents of lard which is suffering dissociation. The volatile products pass off while non-volatile carbon (lard carbon) remains behind coloring the liquid. If heat is continued the carbon is left as residuum in the vessel. The noise and sputtering which is started immediately when an object to be fried is immersed in the hot fat is owing to the explosion of a multitude of small bubbles formed by the confinement of the suddenly expanding steam in the viscous fat, from which it releases itself with a certain degree of violence.

There is a great difference in flavor and taste between fried and stewed food. When fried the flavoring juices are retained. Many cooks are deceived in thinking that fat is used in frying merely to grease the pan and therefore only a thin film is used. There is actually a chemical reaction and accordingly a deep pan where food can swim in it is better and more economical. It is the fat which causes the carbonization of the food. This fat may be kept and used a number of times, but requires occasional purification. The principle on which the method is conducted is the refining of mineral oils. The purification is effected by agitation with sulphuric acid, which partly carbonizes and partly combines with the impurities and separates them in the form of a foul and acrid black mass—known technically as acid tar. This method is not available in the ordinary kitchen because of sulphuric acid which is a vicious compound. A purification can be effected in the home by appropriate frying. Raise the temperature of the fat to 140°–150°C; cautiously sprinkling upon it small quantities of water. The steam carries off the volatile fatty acids and removes the neutral offensive fatty matters that are decomposed by heat.

Fat is best for frying purposes, the light colored drippings of roast beef and fat taken off of broth are to be preferred. Cotton seed oil, poppy seed oil and olive oil can also be used. When common sense and true sentiment supplant mere unreasoning prejudices vegetable oils and fats will largely supplant those of animal origin in every element of our dietary.

There may be some objection to seed oil as fat, as oils extracted from them contain more or less linoleine, which when exposed to the air combines with the oxygen, swells and dries. If the oil from cotton seed or poppy seed contain too much fat, it will thicken in conveniently when kept for any length of time exposed to the air. Palm oil in practically free from linoleine.

What is the chemical difference between raw and cooked fats? All cookable and eatable fats fall into the class of "fixed oils" so named by chemists to distinguish them from "volatile oils" otherwise described as "essential oils." The volatile oils (mostly of vegetable origin) may be distilled or simply evaporated away like water or alcohol, leaving no residue. The fixed oils under similar treatment are dissociated more or less completely. The volatile oils when heated, being distilled without change, are not cookable; while the fixed oils if similarly treated suffers various degrees of change as their temperature is raised, and may be completely decomposed by steady application of heat in a closed vessel without aid of any other chemical agent than heat itself. This "destructive distillation" converts them into solid carbon and hydrocarbon gases.

Fat occurs in mild and minute globules of oil suspended in water. The rising of those to the surface forms the cream. Butter is merely the oil globules aggregated by agitation or churning.

It is an open question whether butter may or may not act as a dangerous carrier of germs which occur in the milk. It is a question whether these germs rise with the cream survive churning and flourish in the fat. It is supposed that the bacteria, bacilli etc
which we see under the microscope to be continually wiggling about, are doing so to
obtain fresh food from the surrounding liquid and therefore, that if imprisoned in but-
ter would languish and die.

From this point of view butterine is safer. The cow is slaughtered, the waste
fat is skillfully prepared, made up into rolls and sold. There is no danger provided
it is not adulterated with cream from butter. The disease germs do not survive the
chemistry of digestion. They do not pass thru the granular tissues of the follicles
that secrete the living fat and therefore even tho the cow should have fed on sewage
grass moistened with infected sewage water, its fat would not be poisoned.

As to the comparative nutritive value of butterine and cream butter it is found
on experimentation that on an average of a little above one and one-half percent less
of the butterine was absorbed into the system than of the cream butter which is a very
trifling difference.

To distinguish between cream butter and oleomargarine the following experiment
was performed. A sample of butter about the size of a small chestnut was melted in an
ordinary table spoon. The fat was heated by a small flame and stirred with a splinter
of wood. The heat was increased so that the fat boiled briskly. The butter boiled
with little noise, producing an abundance of foam. The curd after boiling was very
small and finely divided. A sample of oleomargarine was boiled in like manner. This
boiled noisily, sputtering like a mixture of grease and water. Little foam was pro-
duced. The curd gathered in large masses.

There are a large number of oils and fats existing in the vegetable kingdom.
Some form is found in almost every plant. Nine-tenths of oils, glycerides or fats
are composed of fatty acids, and one-tenth of glycerine. When at ordinary temperature
the combination is in liquid form it is called oil; when in a solid state or semi-
solid is called fat. There are three important fatty acids found from a dietetic
point of view which go to make up the greater part of the fatty and edible vegetable
oils and fats; namely, oleic, stearic and palmitic acids.

Oleic acid is by far the most important as it constitutes the greater part
of nearly all these bodies especially oils. Palmitic acid existing chiefly in cer-
tain vegetable oils and fats. Stearic acid is found in a less degree. The glycerides
in which form they are found are called olein, palmetin and stearin. Some free acid
may be present, but usually in small quantities. These are more abundant in over-ripe
and older plants.

These oils are of great chemic value as they produce a great amount of heat
when burned becoming a great hygienic and dietetic significance in the production of
animal heat. Oils and fats have the highest calorific power of all foods and is there-
fore a valuable constituent of food in respect to the production of energy.

The forms of crystals which the fat assumes on solidifying are valuable in-
dications of the nature of the oil. The test is of greater delicacy if the fat is
first saponified and then the fatty acid is separated, subjecting it finally to crystal-
lization. Almost all oils and fats are soluble in ether and petroleum ether, and in-
soluble in alcohol. The exception is castor oil which is insoluble in ether and sol-
uble in alcohol.

The distinction in the physical characteristics of fats and oils is even hard-
er to determine than their chemical composition as they have about the same color, or
slight variation (amber tint) and about the same taste. The various oils and fats can
be distinguished effectively by the refractive index or Reichert Meissa number.
Vegetable oils are highly useful for a hygienic purpose as they are easily assimilated and digested—producing a physical effect upon the process of digestion which is a matter of importance. These oils can be used instead of lard or other animal fats in the preparation of bread and pastry—serving the purpose of shortening. They can also be used for frying purposes as stated before.

Olive oil is the most edible vegetable oil. Its quality varies according to the country from which it comes, the degree of maturity of the olives from which the oil is extracted, the method of expression employed, and the character of refining to which it is subjected.

Carbohydrates are taken into the body in the form of sugar and starches from scores of plants, gums, pectins, and dextrin. All have a certain food value dependent probably upon the utilization of the various mixtures with which they are taken into the alimentary canal. Carbohydrates consist of carbon, hydrogen, and oxygen in various proportions. When taken into the body they are acted upon by enzymes into simpler sugars, as in the case of cane sugar into dextrose and lactose:—C12 H22 O11 plus H2O equals C6 H12 O6 plus C6 H12 O6. By further oxidation it yields simple acids in which form they can be assimilated. Starch must first be converted into sugar. This is done by the action of ptyalin in the saliva. It is first converted into soluble starch (2) erythro dextrin (3) acrocs dextrin. (4) maltrose which is a simple sugar. Amylase of the pancreatic juice, maltrose and lactase of the intestinal juice act upon carbohydrates. The waste products are very simple—being carbon dioxide and water which are easily gotten rid of. After assimilation carbohydrates build up fat and add to the heat supply.

The chief source of our carbohydrates is vegetables. Upon close examination it is seen that vegetables are composed of a minute cellular substance and a pulpy substance. This cellular substance comprises more than one half of the substance of most vegetable composition. Next to the enveloping constituent of the vegetable we use as food is starch. Excluding water, starch constitutes about three-fourths of our "staff of life."

Upon taking a piece of dough, made in the usual way by moistening wheat flour and putting it in a piece of muslin and working it with the fingers under water, the water becomes milky, and the milkyness is seen to be produced by minute granules that sink to the bottom when the agitation of the water ceases. These are starch granules. Upon viewing under a microscope they are seen to be avoid particles with peculiar concentric markings. The form and size of these granules vary, but the chemical composition is always the same. The ultimate chemical composition of starch is the same as cellulose. The difference of chemical and physical properties indicates some difference in the arrangements of their elements.

In cooking vegetables the work to be done is to soften the cellulose tissues by the action of hot water. There is nothing to avoid in the direction of over heating. Cellulose is peculiarly difficult to digest. Simple hydration takes place in the case of starch. When heated to a little above 140° F. an absorption of water takes place thru the envelope membrane of the granule. The grain swells up—the mixture becoming pasty and viscous. A little mechanical violence (mere stirring) now breaks up these abated granules and we obtain the starch paste. If this paste be dried by evaporation it will not regain its former insolubility, but readily dissolves in hot and cold water. If heat is still raised to boiling and boiling continued, the mass becomes thicker and thicker. If boiling is continued sufficiently long the starch will be converted into dextrin. However, there will be no change in the chemical composition. The technical name for this condition is "isomerism."
Starch and dextrin are said to be "isomeric". Conversion is very important as starch cannot be assimilated until it takes place.

One form of nearly pure starch is tapioca. This is obtained by pulping and washing out the starch granules of the root of the manihot; then, heating the washed starch in pans—stirring it white hot with iron or wooden paddles. This cooks and breaks up the granules, and agglutinates the starch into nodules which are thereby coated with dextrin, to which gummy coating some of the peculiarity of tapioca pudding are attributable. It is a curious fact that this manihot root from which our harmless tapioca is obtained, is terribly poisonous.

The most familiar of starch food is the potato. In boiling the potato the change effected appears to be simply a breaking up or bursting of the starch granules. There is a question whether potatoes are better cooked with their jackets on or off. From 53 to 56 percent of the saline composition of the potato is potash. Potash is an important constituent of the blood. Potash salts are freely soluble in water. It is evident that the skin of the potato must resist the passage of the potash into the water.

The next source of our carbohydrates is cereal foods—75% of which is starch and sugar. In the United States, Buckwheat and rye are the most commonly used. Barley is not used as a human food. Its chief use is in making fermented beverages. The granules of the buckwheat starch are very characteristic—consisting of chains or groups of more or less angular granules with a well-defined nucleus and without rings or with very faint ones. Wheat is the most important cereal. The starch granules ordinarily show rings and helix in a few cases only under the most favorable conditions, although there are sometimes cases where the striations are quite distinct.

Starch in its pure form is derived from cereals, especially maize—sold as corn starch. It is sometimes taken from peas, beans and potatoes.

Sugar belongs to the class of bodies known as sucrose or saccharose—its chief source being from sugar cane or sugar beet. The common form for usage of sugar in this country is in the form of sirups—Maple sirup is the product of the evaporation of the juice of the sap of the Maple tree to a consistancy in which only about 25 to 30% of its weight is water. Sugar cane sirup is made by expressing the juice of the sugar cane, clarifying, and evaporating it.

A very common form of sugar is molasses. There must be a distinction made between sirups and molasses. A sirup is the direct product of the evaporation of the juice of a sugar yielding plant or tree without removal of any of the sugar. Molasses, the same process is applied with the exception of the fact that sugar has been removed at least partially by crystallization and some kind of mechanical separation of the crystals from the remaining liquid. Molasses, therefore, to use a chemical term, may be considered the "mother liquid" which has produced the crystallization of the sugar.

Upon the analysis of molasses it is found to contain: Solids 8%, sucrose 53%, dextrose 8.76%, levulose 8%, ash 4%, albuminoid 30%, amides .94%, acids and gums 4.50%.

The following test was made for starch:—A freely cut potato was taken and a drop of iodine solution dropped on it. A blue color immediately appeared—showing the presence of starch.
The following test was made for sugar:- A small piece of bread was taken and boiled in some water. The solution was then filtered and one part tested for dextrin by adding some iodine solution. A reddish brown color was produced proving the presence of dextrin. The other portion was hydrolyzed by means of hydrochloric acid to convert the dextrin into sugar. To this a little Fehling’s solution was added and the solution heated. A reddish brown precipitate showed the presence of sugar.

Mineral salts are gotten mostly thru fruits and vegetables. Certain elements go with the nitrogenous portion as gluten and its congeners, in these are found sulphur and phosphorous. Potassium is a constituent of barley. Iron, tartaric acid, malic acid are found in fruits. These elements are necessary to replenish those worn out in the body; as potassium is a constant constituent of protoplasm, in muclein, and certain complex fats. Sodium is found in the blood corpuscles. Iron is present in pigment of the blood, called haemoglobin. Potash is the principal mineral substance found in fruit. Phosphoric acid is also found and sometimes a notable quantity of silicic. Fruit, also quite universally contain iron. The ash of the tamarind contains large quantities of silicic. The ash of the bananas contains large content of chlorine and low content of lime and magnesia. Important acids are found in fruit: as, malic acid in apples; citric acid in lemons and oranges; tamaric acid in grapes. Acid alone would not be of any food value, but are found in combination with postash and other bases.

Fruit is not only valuable for its food value, but because of the general effect which it has upon the digestive operation. They are conducive to health in many ways;--acting as a mild laxative. The combination of acids, bases, pectins, and sugars favor a free and natural progress of food thru the alimentary canal.

Certain precautions should be taken in eating fruit. Immature and imperfect fruit is unwholesome. Moreover, fruits are often subjected to infection with eggs of various kinds of insects and these organisms, larvae and eggs may be introduced into the stomach with more or less injurious effects. The natural and most wholesome condition of fruit is in the raw state. Cooking, however, sterilizes it and makes the consumer secure against any infection.

The apple is the most common form of fruit. Sugar and acids are the chief factors in their palatability not excluding the delicate flavor imparted by essential oils and ethereal substances, which to present in such small quantities as not to be measured chemically. Nevertheless, are highly valuable in making up the total effect of palatability and wholesomeness. Malic acid is the chief acid found in apples—existing throughout the entire growth, but being more apparent in the green and immature apple.

Upon analysis of a ripe apple it was found to contain:—Solids, 19.64%, fruit sugar, 7.70%, cane sugar 6.61%, starch 1.17%, acidity as malic acid .55% ash .27%.

The composition varies with the variety, character of the season in which it grew and with the individual sample.

Must as it is of importance to have water of good quality as well as of correct quantity, so is it important to have pure and safe food. We may have our food prepared in the correct way, and in proper proportion as far as protein, fats and carbohydrates are concerned, but if they are adulterated or sophisticated they will not serve their ends. First, let us understand what adulteration and sophistication are. To adulterate is to debase "to make impure by an admixture of baser material. To sophisticate is to substitute an entirely different article in place of the original one.
Foods are adulterated and made to appear natural by means of coloring matter and preservatives. The coloring matters most commonly used are coal tar dyes and carmel. Salicylic acid, formaldehyde, benzoic acid, and boric acid are used as preservatives. Much food, therefore, that is unwholesome and unfit for consumption is sold on the market.

Butter is commonly preserved by means of boric, benzoic, and salicylic acid. These preservatives can be detected by the following test:-

Mix about 50 gms. of butter with 25 cc of chloroform in a separatory funnel and add 100 cc of dil sodium carbonate solution and mix the whole solution. After the separation of layers, examine the aqueous layer for boric and benzoic acid.

To test for boric acid make 25 cc of the solution alkaline with lime water and evaporate to dryness. Charr the residue over the flame. Digest the residue with 15 to 20 cc of water and add hydrochloric acid until the mixture is faintly acid, filter and add 1 cc of acid in excess. Place a strip of turmeric paper in solution and evaporate to dryness. If boric acid is present, the paper will turn a peculiar red color.

To test for benzoic acid acidify the solution with sulphuric acid, extract with ether and evaporate. Treat the residue with 2 or 3 cc of strong sulphuric acid. Heat until white fumes appear--when the organic matter is charred and benzoic acid is converted into sulpho-benzoic acid, add a few crystals of ammonium nitrate which causes the formation of metadimetabenzoic acid. When cool dilute with water and add ammonium hydroxide in excess and a drop or two of ammonium sulphide. The nitro compound becomes converted into ammonium metadimetabenzoic acid which has a red color.

No test is made for coloring matters since these are allowed and therefore not counted as adulterations.

It is a common matter to have adulterated fats and oils because of their nature. Olive oil is subjected to a systematic and extensive adulteration. Cotton seed oil is generally used. Sometimes it goes as far as total substitution as in the case of packing sardines and pilchards.

Starch is subjected to a great extent to adulteration. Mixtures of rye, Indian corn, flour, wheat flour and other ground cereals are used. The chief means of detecting such adulteration is by means of the microscope. In some countries powdered inert white mineral matter is used.

An example of the adulteration of a pure starch food may be that of tapioca. True tapioca should only be made from the starch of cassava. Any starch derived from any other source whatever may be subjected to the same process of heating and forms an imitation tapioca which possesses many of the physical and probably all the edible properties of the genuine tapioca. The addition of any other starch than that of the cassava is pure adulteration.

Adulteration cannot be carried to such a large extent in case of fruits. Those best known and most frequently practised is that of putting the best fruit on top of fruit bruised by careless gathering and fruit infected by insect life. The egg is often laid in the early development of the fruit and by the time it is ready for consumption the larva stage is reached and the worm has produced ravage to a great extent. The farmer is not altogether responsible, but he can control some cases by the use of the spraying machine.