Temperance Alcohol Physical Effects

A PHYSIOLOGIC CONSIDERATION OF THE FOOD VALUE OF ALCOHOL

With Especial Reference to the Experiments of Professor W. O. Atwater, Contained in Bulletin No. 69 of the United States Department of Agriculture

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It has been remarked that the medical men of the present day are distinguished above all who have preceded them by their practical knowledge of dietetics. It may with equal truth be said that the people of the present day exhibit more intelligent interest in the discussion of sanitary problems, both public and private, than any preceding generation, and this interest appears to be steadily increasing. In fact, it is a most encouraging sign of our advance in civilization, and a favorable evidence of our culture at this end of the century, that so large a proportion of the community is demanding exact information as to the positive and economic value of the various alimentary substances offered to man as his daily food. Probably there is no other substance of this kind which is attracting more general attention at this time than alcohol, nor about which the desire for an exact determination of the true food value is more insistent.

As to the cause of this gratifying interest in dietetics, it may in part be ascribed to the general increase of intelligence in the community, and it may have partly resulted from the activity of local boards of health, which may have forcibly directed public attention to the importance of the questions. A large share, however, in our opinion, in this country at least, may with justice be attributed to the systematic study of physiology and hygiene, including the scientific temperance instruction, which has for some years been a part of the regular course of study for all pupils in our public schools. This course has so commended itself to the judgment of the people that the national congress and—with the exception of Virginia, Georgia and Utah—every state of the Union, have passed laws requiring such instruction to be given to all pupils in all schools under federal or state jurisdiction. This study is popularly called "scientific temperance" because it includes special instruction as to the physiologic effects of alcoholic drinks and other narcotics when taken into the human body. To the untiring energy and zeal of the Department of Scientific Instruction of the Woman's Christian Temperance Union, too much credit can not be given for bringing about this gratifying state of affairs, nor to the superintendent of that department, Mrs. Mary H. Hunt, of Boston, under whose skilful management the efforts of the Union have been rewarded with such signal success.

Recently a criticism of the teachings contained in the text-books recommended by this department on the subject of alcohol has been made, and some of the statements, especially the one declaring alcohol not to be a food but that it is a poison, have been challenged. The recent experiments of Professor Atwater have been freely cited in support of the foregoing criticism, and also of the view that alcohol is entitled to rank as a food with sugar, starch and fat.

In the summary of the report of Professor Atwater's experiments, issued by the United States Department of Agriculture, the following paragraphs are found:

> As regards the special action of alcohol three important results were observed in these experiments. 1. Extremely little of the alcohol was given off from the body unconsumed, in the breath or otherwise. The alcohol was oxidized, i. e., burned, as completely as bread, meat, and other ordinary foods in the body and in the same way. 2. In the oxidation all of the potential energy of the alcohol was transformed into heat or muscular energy. In other words, the body transformed the energy of the alcohol just as it did that of sugar, starch and fat. 3. The alcohol protected the material of the body from consumption just as effectively as the corresponding amounts of sugar, starch and fat. That is, whether the body was at rest or at work, it held its own just as well when alcohol formed a part of the diet as it did with a diet without alcohol. The official summary further states that in unauthorized statements regarding these experiments, which have been widely disseminated, much more has been claimed for them than they legitimately cover.

The summary concludes with the following caution, which all who discuss the question will do well to heed:

> It should be remembered that the physiologic action of alcohol involves much besides its nutritive effect. Its influence on the circulatory and nervous functions is especially important. These matters are not treated in Professor Atwater's experiments.

It is to be regretted that this last statement did not accompany the newspaper reports sent out last June, five months in advance of the publication of any data on which they were based. If it had been made then, much misapprehension on the part of the public, in favor of the use of alcohol as a beverage, might have been prevented.

Previous to making an analysis of the results obtained by Professor Atwater, as published in "Bulletin 69," of the Department of Agriculture, in order to ascertain their real scientific import, it may not be amiss to briefly review the testimony of a few well-known authorities as to the value of alcohol as a food and its place in dietetics. Professor Atwater has said that "Whether alcohol is to be called a food or not depends upon the definition of a food." As he does not himself supply such definition, it is to be inferred that he is in accord with other physiologists upon the subject of what the requirements of a food should be. It is understood that a definition might be framed which physiologists generally could not accept. For instance, to adopt the legal definition, as contained in laws to prevent food-adulteration, "that the term food shall in-

clude every article used for food or drink by man," would be to settle the whole question offhand, since alcoholic liquors, being used for drink by man, would necessarily be food.

However useful such a definition might prove for purposes of preventing food-adulteration, it obviously does not touch on the very vital question of the real nutritive value of alcohol. The "Standard Dictionary" defines food as "any substance that, being taken into the body of animal or plant, serves, through organic action, to build up normal structure or supply the waste of tissue." This definition, on the other hand, is too restricted to admit alcohol as a food, for no physiologist, with any regard for his reputation, would assert, in the light of present knowledge, that alcohol serves "to build up normal structure or supply the waste of tissue." Within the limits of this definition, alcohol could not be admitted to be a food at all. It is to be noticed, however, that this definition entirely disregards the important class of thermogenic foods, which do not necessarily build up tissue, but which are destroyed in the system by oxidation, just as oil is burnt in a lamp, and which yield energy in the form of heat as a result of their combustion. If alcohol is to be regarded as a food, it is to this class of substances that it must be assigned. In fact, the utmost claim that is made by those who defend the use of alcohol as a food is that a small quantity, not exceeding 1½ or 2 ounces in twenty-four hours, for a healthy adult, can be consumed or oxidized in the human body, yielding up its equivalent in calories of energy, and that it is therefore capable of taking the place of a corresponding small quantity of fat or of carbohydrates in the food. In the summary of Professor Atwater's experiments already referred to, the statement is made that:

> The alcohol was oxidized, i. e., burned, as completely as bread, meat and other ordinary foods in the body and in the same way. In the oxidation all of the potential energy of the alcohol was transferred into heat or muscular energy. In other words, the body transformed the energy of the alcohol just as it did that of starch, sugar and fat.

The natural inference from this is that a moderate quantity of alcohol is an efficient and acceptable substitute for an equivalent amount of hydrogen and carbon

which might be contained in starch, sugar, or fat in the daily diet. Such an inference, however, is incorrect and misleading. It is incorrect because alcohol is not innocuous like sugar and starch, and it can not therefore be accepted as a substitute in any normal dietary. We have already quoted Professor Atwater's official summary, as saying:

> It should be remembered that the physiologic action of alcohol involves much besides its nutritive effect. Its influence on the circulatory and nervous functions is especially important. These matters are not treated in Professor Atwater's experiments.

A food, as we define it, is any substance which, when taken into the living human body, is capable of—usually after being subjected to the action of the digestive organs—entering, through the absorbent vessels, into the circulation, and of supplying assimilative material and potential energy to the cellular elements of the tissues, and of promoting normal metabolism and the general bodily health. The following less technical definition also, though simpler, seems to be what every definition should be, both exclusive and inclusive: "Food is any substance whose nature it is, when absorbed into the blood, to build up tissue, retard waste, or furnish energy to the body without injuring the latter." Or in still simpler and more popular form: "Food is a substance which is capable of assimilation and which, when properly administered, nourishes the body without injuring it."

When the statement is made to the public that a certain substance is a food the implication is that it is a wholesome and beneficial food under ordinary and appropriate circumstances. The scientific proof that a limited quantity of alcohol can be oxidized in the body, even though heat and force be liberated by such oxidation, would not make alcohol a food like sugar or starch, as has been hastily assumed to be the case, in the face of cumulative testimony, of experience and of physiologic investigation, to the contrary. Professor Atwater's own figures in his "metabolism experiments Numbers 7 and 10" do not support his claim that the alcohol "protected the material of the body from consumption just as effectively as the corresponding amounts of sugar, starch or fat," as we shall proceed to demonstrate presently.

Even admitting that alcohol oxidized yields certain calories of energy, it has not therefore, *ipso facto,* any just claim to be regarded as a substance suitable for human food. On the contrary, this claim is completely disproved if its deleterious effects can be shown to more than counterbalance this slight advantage. It is true that such general effects on circulatory and nervous functions are admittedly beyond the scope of Professor Atwater's experiments, but they can not be omitted from a discussion of the use of alcohol as a food. In this connection we quote the well-known author of a standard text-book on physiology, Prof. William B. Carpenter, whose views, expressed nearly half a century ago, are as true to-day as they were then, having never been disproved. Professor Carpenter says:

> The physiologic objections to the habitual use of alcoholic liquors rest on the following grounds: 1. They are universally admitted to possess a *poisonous* character, exhibited when they are taken in tolerably large doses, by loss of appetite and muscular power and control over the voluntary movements, with partial paralysis of the sympathetic nervous system, leading to dilatation of the smaller vessels; while death is the speedy result of very large doses through the suspension of nervous power, which their introduction into the circulation in sufficient quantity is certain to induce. 2. When habitually used in excessive quantities, universal experience shows that alcoholic liquors tend to produce a morbid condition of the body at large, and especially of the nervous system, this condition being such as a knowledge of its *modus operandi* on the body would lead the physiologist to predicate. 3. The frequent occurrence of more chronic diseases of the same character, among persons in advanced life, who have habitually made use of alcoholic liquors in "moderate" amount, affords a strong probability that they result from a gradual perversion of the nutritive processes of which that habit is the cause. This perversion manifests itself peculiarly in the tendency to fatty degeneration of the muscular substances of the heart, of the walls of the arteries, of the glandular substances of the kidney and liver, and of many other parts; and thus gives rise to a great variety of forms of disease. 4. The special liability of the intemperate to zymotic diseases seems an indication that the *habitual* ingestion of alcoholic liquors tends to prevent the due elimination of the azotized products of the disintegration of the system, and thus induces a "fermentable" condition of the blood. 5. Extended experience has shown that, notwithstanding the temporary augmentation of power, which may result from the occasional use of fermented liquors, the capacity for prolonged endurance of mental or bodily labor, and for resisting the extremes of heat and cold, as well as other depressing agencies, is diminished rather than increased by their habitual employment; and the reason for this, so far as cold is concerned, is sufficiently obvious. Under ordinary circumstances of exposure to cold, the circulation of the blood through the vessels of the surface, owing to the contraction of the cutaneous capillaries, is greatly reduced, and much less heat is lost by contraction and radiation, the skin alone being a very bad conductor. When, however, considerable quantities of alcohol are taken more or less complete paralysis of the vasomotor nervous system is the result: the vessels of the skin no longer respond to the stimulus of cold, and the blood traversing them loses a large amount of heat; so that while in all instances where the quantity of alcohol consumed exceeds the moderate limits of 1½ to 2 ounces *per diem,* there is diminished power of resistance to cold, this is felt much more acutely in extreme cases, and death may take place from the general reduction of the temperature. On these grounds the author has felt himself fully justified in the conclusion that for physiologic reasons alone, habitual abstinence from alcoholic liquors is the best rule that can be laid down for the great majority of healthy individuals; the exceptional cases in which any real benefit can be derived from their use being comparatively few.

This positive and authoritative statement of the physiologic objections to the use of alcohol, even in moderate quantity, in the diet, concluding with a strong recommendation for habitual abstinence as the best rule that can be laid down for the great majority of healthy individuals, seems to be conclusive. It certainly should not be laid aside or lost sight of in any discussion of the questions of scientific interest regarding the effects of alcohol on metabolism, and its possible limited action as a force-producer or force-liberator in the human system.

The favorable effects of alcoholic preparations, when administered in certain conditions of disease, have been offered as an argument to prove the nutritive value of alcohol. This claim is summarily dismissed by Prof. J. Bauer, in the following statement: "I am, however, of the opinion that the favorable effects of the administration of alcoholic drinks in many instances are satisfactorily explained if we regard them solely as excitants and stimulants, those especially which contain no appreciable constituents other than alcohol and water, and estimate their nutritive properties as insignificant."[1] Clinical

observation therefore confirms physiologic teaching that alcohol is not a food, but is simply an excitant, yielding a comparatively insignificant amount of energy to the body.

Direct testimony to the same effect is also given by Dr. Rudolf Rosemann, in an article "On the Influence of Alcohol upon Human Metabolism,"[2] in which he details the results of certain physiologic experiments similar in their scope to Professor Atwater's. As the result of these experiments, Rosemann concludes that alcohol does not possess the same power that starches and fats have, to protect the albuminous principles from wasting. This is contrary to the statement of the summary already referred to—which, however, as already intimated, does not appear to be in accord with Professor Atwater's own figures. Rosemann confirms the statement of Miura that "albumin-sparing is no primary action of alcohol" and concludes his article with the remark that, as a food, alcohol must be regarded merely "as an article of luxury (Genuss-mittel) because its action as a nutritive material is, solely and alone, the storing up of fat, which, generally speaking, is not a very desirable object." As regards its value to the sick, he says: "So much, however, can be regarded as certainly estabished; the hope that the calories of alcohol may be available for the protection of the proteids of the sick must be regarded as having no foundation. . . . Alcohol can no longer be looked upon as an efficient remedy for diet-therapy."

It is a curious but a well-established fact in physiology and pharmacology that the human system under certain circumstances is capable of gradually becoming accustomed to the actions of certain poisons, so that, when reguarly taken for a length of time, an adjustment of the nutritive processes and nervous forces to the new conditions takes place. In such cases the sudden taking away of the poison is usually accompanied by symptoms or disorder and disturbance of apparent health. This is seen in the case of the arsenic eaters of Styria, and in morphin victims, and also in the case of persons who are

[1] Ziemssen's Handbook of General Therapeutics, vol. i, p. 70. English edition, New York, 1885.

[2] Ueber den Einfluss des Alkohols auf dem Menschlichen Stoffwechsel. Ztft. f. Diätetische und Physikalische Therapie, Leipzig, 1898, p. 138.

accustomed to the constant use of alcohol as a part of their daily diet. That such individuals suffer from impaired vitality is a well-known clinical fact. It has been repeatedly observed by surgeons that patients accustomed to the use of spirits require much larger quantities of ether or chloroform to induce anesthesia for the performance of surgical operations. Unfortunately for such individuals, it is in just these cases that fatty degeneration and fibrous change have occurred in the heart, liver, and kidneys, and in these fatal accidents are most likely to occur from the effects of anesthetics.

At the present day, the weight of evidence is decidedly against the popular opinion that alcohol stimulates the nerve-centers. In opposition to Binz and his followers, Schmiedeberg, Bunge and others maintain that alcohol does not stimulate the central nervous system, the symptoms of excitement being not due to true stimulation of motor areas, but that these symptoms occur as the result of those areas being freed from control by the weakening of the highest functions of the brain—the will and the self-restraint. A recent authority, Professor Cushny, says that Schmiedeberg's theory seems the more satisfactory one—"for there is evidence on every hand that even the smallest quantities of alcohol tend to lessen the activity of the brain. . . . Evidences of the depressing action of alcohol on the brain are embarrassing by their number."[3] It is needless to stop to point out that neither sugar nor fat, taken into the body as food, cause any such depressing action on the nerve-cells as does alcohol, and this fact of itself is sufficient to stamp it as unfit for human food and to place it as a narcotic among medicinal substances in the class to which opium, the bromids, and anesthetic agents belong—a place that is usually assigned to it in our text-books on pharmacology and therapeutics.

Turning now to the examination of the details of Professor Atwater's experiments, we find that criticism is to some extent forestalled by the statement that they are only a portion of a series, the data of which are to be published at a future time, and that they are preliminary and not conclusive. It is to be noted, however, that the

[3] Text-book of Pharmacology and Therapeutics, Philadelphia: 1899, pp. 131, 132.

principal subject of the experiments was a man who had been accustomed from his youth to the use of a moderate quantity of alcohol in his diet. As already intimated above, it is questionable whether such an individual is in a strictly normal condition, and whether or not the results from such experiments could be accepted as applicable to healthy adults who had not become accustomed to alcohol. This point, however, we will not dwell upon. As therapeutists, however, we may express surprise that Professor Atwater, in his experiments, entirely ignores the physiologic effects of 300 c.c. of infusion of coffee given three times a day, as regards especially its influence on nutrition, as an *aliment d'épargne,* or *spar-mittel,* and that he counts it only as so much water. The nitrogen-content of caffein is an entirely subordinate question, just as it would be in the case of atropin or aconitin. There are many individuals in the community, we are convinced, whose nutrition would be seriously affected by one or two cups of coffee taken three times a day, and it might be well to repeat this series of experiments, leaving out this disregarded but disturbing factor in the problem. It is a matter of common knowledge that coffee may be well borne by those who are leading active lives in the open air, but is often badly borne by those who lead sedentary lives. Therefore, while the subject of the experiment might with impunity drink coffee three times a day while he was unconfined, it is quite reasonable to suppose that it would produce its characteristic effects to a greater degree when he was in the calorimeter.

As has already been stated, it is to be regretted that the subject chosen was one whose personal equation had been disturbed not only by the use of alcohol in small quantities from his youth, but also, and probably what is more important here, by the total abstention from all alcohol "for a time previous to the period of the experiments," during which period "he used only what was needed for the experiment."

Six experiments are detailed in full, called respectively, "Metabolism Experiments Nos. 5, 6, 7, 8, 9, and 10." It should be noted that after Experiment No. 8, some change was instituted in their conduction, consisting mainly in the method of "preparation and sampling of food materials," enabling the observers to obtain, as they

believed, "more accurate samples than had hitherto been possible;" so that the first four experiments should be considered in a group by themselves and apart from the last two, which form another, and perhaps more accurate, group.

Every scientist will appreciate the liability to error which is involved in the consideration of such a small number of experiments; but if they are all consistent in one respect, their evidence has a certain weight and can be accepted, especially as Professor Atwater has ventured to publicly announce certain deductions from them and thus made them legitimate subjects for criticism and discussion.

As stated in the summary issued by the United States Department of Agriculture, Experiments Nos. 7 and 10 apparently show that small or moderate quantities of alcohol can be consumed in the body and, also, that such combustion of alcohol is almost complete and results in its conversion into its equivalent of heat or potential energy, with but very little loss, from the body, of alcohol in an unoxidized—unconsumed—state. This, we believe, is already admitted by most modern physiologists, and it is not questioned, therefore, that small quantities of alcohol can, like other matters—foods—produce heat and energy in the body.

It is also stated, however, in the aforesaid summary, that it was observed as a result of these experiments that "the alcohol protected the material of the body from consumption just as effectively as the corresponding amounts of sugar, starch and fat. That is, whether the body was at rest or at work, it held its own just as well when alcohol formed a part of the diet as it did with a diet without alcohol." This may be true as far as it concerns the passive carbon and fat of the body, but it is certainly contradicted, in so far as it refers to the active and more valuable and important nitrogen and protein of the body, by Professor Atwater's own figures, given in the various tables printed in Bulletin 69—that is, as far as "rest experiments" are concerned, for, unfortunately, there is no experiment detailed in the bulletin in which alcohol was administered during a period of work, and we can not, therefore, contradict the assertion of the summary in that respect.

TABLE A, SHOWING INCOME AND OUTGO OF NITROGEN AND CARBON.

(Compiled from Prof. Atwater's report in Bulletin 69.)

Experiment.		Nitrogen given in food.	Nitrogen gained or lost. + gain, — loss.	Protein given in food.	Protein gained or lost. + gain, — loss.	Carbon given in food.	Carbon gained or lost. + gain, — loss.	Carbohydrates given in food.	Fat given in food.	Fat gained or lost. + gain, — loss.
No. 5. Rest; no alcohol. .	4 days of experiment.	76.2	—2.7	476.4	—16.8	995.56	— 32.8	1102.0	378.8	— 31.2
	Last 3 days of experiment	57.15	+0.1	357.3	+ 0.7	746.67	— 17.3	826.5	284.1	— 23.1
	Daily average of 4 days	19.05	—0.675	119.1	— 4.2	248.89	— 8.2	275.5	94.7	— 7.8
	Daily average of last 3 days . . .	. . . .	+0.033	. . . .	+ 0.23	. . . .	— 5.77	. . . .	. . . . .	— 7.7
	1st day of experiment	. . . .	+2.8	. . . .	—17.5	. . . .	— 15.5	. . . .	. . . . .	— 8.1
No. 6. Work; no alcohol. .	4 days of experiment.	76.32	+4.4	476.4	+27.5	1346.72	—133 4	1511.2	611.6	—193.5
	Last 3 days of experiment	57.24	+4.3	357.3	+26.9	1010.04	— 80.6	1133.4	458.7	—124.1
	Daily average of 4 days	19.08	+1.1	119.1	+ 6.88	336.68	— 33.37	377.8	152.9	— 48.4
	Daily average of last 3 days. . .	. . . .	+1.43	. . . .	+ 8.97	. . . .	— 26.87	. . . .	. . . . .	— 41.4
	1st day of experiment	. . . .	+0 1	. . . .	+ 0.6	. . . .	— 52.8	. . . .	. . . . .	— 69.4
No. 7. Rest; alcohol . . .	4 days of experiment.	66.80	—7.7	417.6	—48.2	Inclu. alc. 874.24	— 66.4	Inclu. alc. 1253.6	272.8	— 57.3
	Last 3 days of experiment	50.10	—3.9	313.2	—24.4	655.71	— 55.3	940.2	204.6	— 55.3
	Daily average of 4 days	16.70	—1.9	104.4	—12.0	218.57	— 17.4	313.4	68.2	— 14.3
	Daily average of last 3 days . . .	. . . .	—1.3	. . . .	— 8.1	. . . .	— 18.4	. . . .	. . . . .	— 18.4
	1st day of experiment	. . . .	—3.8	. . . .	—23.8	. . . .	— 14.1	. . . .	. . . . .	— 2.0
No. 8. Rest; no alcohol. .	4 days of experiment.	83.00	0.	517.6	0.	1082.72	+ 86.7	1231.2	381.8	+113.3
	Last 3 days of experiment. . . .	62.25	+1.4	388.2	+ 8.7	813.04	+ 69.5	923.4	287.1	+ 84.8
	Daily average of 4 days	20.75	0	129.4	0.	270.68	+ 21.7	307.8	95.7	+ 28.3
	Daily average of last 3 days . . .	. . . .	+ .467	. . . .	+ 2.9	. . . .	+ 23.17	. . . .	. . . . .	+ 28.27
	1st day of experiment	. . . .	—1.4	. . . .	— 8.7	. . . .	+ 17.2	. . . .	. . . . .	+ 28.5
No. 9. Rest; no alcohol. .	4 days of experiment.	76.32	—2.3	478.4	—14.4	1046.16	+ 48 0	1367.2	276.0	+ 72.7
	Last 3 days of experiment	57.24	—1.5	358.8	— 9 4	784.62	+ 39.3	1025.4	207 4	+ 57.8
	Daily average of 4 days	19.08	—0.6	119.6	— 3.6	261.55	+ 12.0	341.8	69.0	+ 18.2
	Daily average of last 3 days . . .	. . . .	- 0.5	. . . .	— 3.13	. . . .	+ 13.0	. . . .	. . . . .	+ 19.27
	1st day of experiment	. . . .	—0.8	. . . .	— 5.0	. . . .	+ 8.7	. . . .	. . . . .	+ 14.9
No. 10. Rest; alcohol . . .	4 days of experiment.	79.00	—4.4	494.0	- 27.5	Inclu. alc. 1013.22	+ 50 3	Inclu. alc. 1681 6	126.4	+ 84.8
	Last 3 days of experiment	59.25	—3.0	370.5	—18.7	759.90	+ 30.3	1261.3	94.8	+ 52.6
	Daily average of 4 days	19.75	—1.1	123.5	— 6 9	253.33	+ 12.6	420.4	31.6	+ 21.2
	Daily average of last 3 days . . .	. . . .	—1.0	. . . .	— 6.25	. . . .	+ 10.1	. . . .	. . . . .	+ 17.5
	1st day of experiment	. . . .	—1.4	. . . .	— 8.8	. . . .	+ 20.0	. . . .	. . . . .	+ 32.2

Table A has been carefully compiled by us from the various tables included under the respective experiments in the Bulletin. Table B has been, in turn, compiled from Table A, for reasons to be mentioned later. A study of these tables will at once show that when alcohol is substituted in part for carbonaceous foods, *there is an increased loss of body nitrogen,* it being remembered that in each case the quota of food was primarily, as nearly as possible, that necessary to maintain the nitrogen and carbon equilibrium of the body. This same deduction is to be derived from a direct study of Tables 42, 44, 84, and 86 of the Bulletin and we can not, therefore, understand or accept the statement quoted above, that "alcohol protected the material of the body from consumption just as effectively as the corresponding amounts of sugar, starch and fat." In fact, comparing Experiment No. 7 with No. 5—the two being carried on under as nearly as possible similar conditions except that the former was with, and the latter without, alcohol—we find that although there was less of nitrogen, protein, carbon and fat given during the period of No. 7, there was a greater body loss of each of these food constituents, than in the corresponding data of Experiment No. 5.

In spite of the preliminary feeding of the subject on the selected diet for several days prior to his entering the calorimeter—or chamber in which he lived continuously during the entire period of the experiment—it was found "that the loss of nitrogen was greater, or the gain less, on the first than on the succeeding days." This was the case in every one of the experiments detailed, and is explained in the Bulletin as follows: "Assuming that the nitrogen lag is short, this may perhaps be connected with the slight mental excitement which accompanies the accommodating of the subject to the conditions of life in the chamber." At any rate, it shows that the personal equation can be, and was, for a time disturbed by the experiment, and that the conditions were not absolutely normal.

Moreover, it is evident that the daily average of the factors for the entire four days spent in the calorimeter will not be the same as that for the last three days of the experiment, and that the average of the latter will be more correct for the given conditions. For this reason Table B, with its respective subdivisions, was prepared.

Moreover, it is also to be noted that this disturbance on the *first* day, involving a greater loss, or lessened gain, of nitrogen and protein, is *always more marked* in the experiments in which alcohol was made to take the place of food, indicating that it—alcohol—tended to create a condition of more unstable equilibrium in the body, as well as to deprive the latter of part of its nitrogen and protein store.

In conclusion, Professor Atwater's own experiments and figures only serve to confirm the opinion so well expressed by Fothergill, that the consideration of alcohol as a "force-producer" can never be entirely dissociated from the fact that it is also a "force-liberator," and that the evils of the latter function overbalance in result the benefits of the former.

TABLE B, SHOWING GAIN OR LOSS OF NITROGEN, ETC.

Experiment.	Nitrogen.	Protein.	Carbon.	Fat.
a, Daily average for all four days.				
No. 5 Rest; no alcohol . .	−0.675	− 4.2	− 8.2	− 7.8
" 6 Work; no alcohol . .	+1.10	+ 6.88	−33.37	−48.4
" 7 Rest; alcohol	−1.9	−12.0	−17.4	−14.3
" 8 Rest; no alcohol . .	0	0	+21.7	+28.3
" 9 Rest; no alcohol . .	−0.6	− 3.6	−12.0	+18 2
" 10 Rest; alcohol	−1.1	− 6.9	+12.6	+21.2
(*b*) For first day only.				
No. 5 Rest; no alcohol . .	−2 8	−17.5	−15.5	− 8.1
" 6 Work; no alcohol . .	+0.1	+ 0.6	−52.8	−69.4
" 7 Rest; alcohol	−3.8	−23.8	−14.1	− 2.0
" 8 Rest; no alcohol . .	−1.4	− 8.7	+17 2	+28.5
" 9 Rest; no alcohol . .	−0.8	− 5 0	+ 8.7	+14.9
" 10 Rest; alcohol	−1.4	− 8 8	+20.0	+32.2
(*c*) Daily average for last three days.				
No. 5 Rest; no alcohol . .	+0.03	+ 0 23	− 5.77	− 7.7
" 6 Work; no alcohol . .	+1.43	+ 9.97	−26.87	−41.4
" 7 Rest; alcohol	−1.3	− 8.1	−18.4	−18.4
" 8 Rest; no alcohol . .	+0 47	+ 2.9	+23.17	+28.27
" 9 Rest; no alcohol . .	− 0.5	− 3.13	+13.0	+19.27
" 10 Rest; alcohol	−1.6	− 6,21	+10.1	+17.5

Note that in any one experiment the food is the same in quality and quantity for each of the four days of that experiment.
— Loss. + Gain.

Therefore, we are forced to the conclusion that Professor Atwater has produced practically no evidence whatever to support the claim that alcohol is a wholesome or useful food, nor to change the generally accepted view that its physiologic action on the human body is destructive and never constructive.

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