SCIENCE

[Entered at the Post-Office of New York, N.Y., as Second-Class Matter.]

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

EIGHTH YEAR. VOL. XVI. No. 396. NEW YORK, SEPTEMBER 5, 1890. SINGLE COPIES, TEN CENTS. $3.50 PER YEAR, IN ADVANCE.

BEVERAGES.

ALL beverages contain water as their chief constituent, and they may be divided into two classes, alcoholic and non-alcoholic.

Alcoholic Beverages.

Alcohol is the product of the alcoholic fermentation of any saccharine material, and these materials may be arranged in three groups: first, grapes and other sweet fruits which contain fermentable sugar or glucose, the expressed juice of which at once enters into fermentation on exposure to air; second, substances which contain common or cane sugar, the first step in the process of fermentation being the formation of glucose by taking up the elements of water; and, third, the various kinds of grains, potatoes, and other substances containing starch, which by the action of a peculiar ferment, diastase, naturally, or by the action of dilute mineral acids artificially, is converted into glucose.

FERMENTATION.—In the manufacture of both malt and distilled liquors the object is to convert the starch of the grain employed, by suitable fermentation, into alcohol. In the one case a low percentage of alcohol is striven for, and in the other the maximum amount that is capable of being produced.

Chemically speaking, fermentation takes place wherever an organic compound undergoes changes of composition under the influence of a nitrogenous substance called a ferment, which acts in small quantities and yields nothing appreciable to the fermented substance. These ferments are living minute vegetable cells, and different varieties are found in the various fermentations with which we are familiar, viz., alcoholic, acetic, lactic, butyric, etc.

In normal alcoholic or spirituous fermentation we find the minute vegetable cells commonly called "yeast" growing and multiplying, assimilating the sugar or glucose found in the infusion or solution (whether the glucose is derived from the starch of the grain, by the action of another ferment called diastase, or artificially prepared), and excreting a large proportion in the form of carbonic acid and alcohol.

Theoretically 105.3 parts of glucose, corresponding to 100 parts of cane sugar, would produce about 51 parts of alcohol and 49 parts of carbonic acid, but as a matter of fact Pasteur and other investigators have found that there were small quantities of other products present, so that the theoretical yield is not obtained.

Under the general name of ferment or yeast a large number of varieties and species are included, which resemble each other in form, but differ greatly in their properties and characters. The germs of these yeasts are everywhere floating in the air, especially in the hot summer months, and when they encounter a favorable soil for their development they grow and multiply like other plants under similar conditions; for instance, when they attach themselves to the stems and skins of fruit, they give rise to the "spontaneous" fermentation of grapes, apples, pears, etc.

In addition to the yeast germs, the air of any locality contains numerous living organisms, the mould, bacteria, and other micro fungi, for the most part injurious to the making of the wort or wine, and forming the true ferments of disease.

Among all these ferments several species will set up alcoholic fermentation in the wort or grape juice, and transform it into alcohol and carbonic acid, but all of them will not give a good product. On the contrary, the great majority of these spontaneous yeasts would have disastrous effects, for the brewer especially, decomposing the beer to such an extent as to render it unsalable.

The species called *Saccharomyces cerevisiæ* constitutes the large class of beer-yeast proper, and the one the best known and studied. Two varieties of *Saccharomyces cerevisiæ* are extensively cultivated, the high or upper (*obergährung, fermentation haute*), and the inferior or lower (*untergährung, fermentation basse*). The former is used with a high, 15° to 18° C. (59° to 65° Fahr.), temperature, the yeast and impurities rising to the top of the vat, whence they are removed by skimming; and the latter at a low temperature, between 4° and 10° C. (39° to 50° Fahr.), where the fermentation takes place slowly and the yeast settles at the bottom in a compact mass. Each variety will produce its own peculiar and characteristic fermentation. A mixture of either of these varieties with one or several other species of *Saccharomyces*, as *S. ellipsoidens*, *mycoderma*, etc.; results in disaster to the wort.

The wort and grape juice naturally present a proper soil for these harmful as well as for the proper or true ferments, and it is not surprising that the germs of the noxious flourish and develop to the detriment of the true yeast plant.

These yeast plants and germs are so minute as to require the use of a microscope with high-power objectives to discern and differentiate them. Like all other fungi, they are capable of distinct cultivation; and with the exercise of some care, and the assistance of a trained observer, a brewer, distiller, or wine manufacturer, after some experiments, could maintain a crop of such particular yeast plant as yields the best results and gives a uniform product.

This method of "pure" cultivation has been extensively

employed in breweries in Denmark, Germany, and elsewhere in Europe, and there is no scientific reason why the same system should not be carried on in this country to the great improvement of our beers and wines.

At the old Carlsberg brewery near Copenhagen, Professor Hansen has cultivated two varieties of bottom *S. cerevisiæ*, which give different results in practice. One gives a beer well adapted for bottling, and is chiefly employed for home use. The other gives a good draught beer, containing more carbonic acid than the former variety; it is not adapted for bottling, but is much preferred by German brewers, and is therefore chiefly cultivated for export.

Experiments upon an industrial scale are being carried on at Burton-on-Trent, in England, with different species of pure yeast. Several varieties of *S. cerevisiæ* have been separated from the yeast generally employed and cultivated, which, when used on a practical scale, give entirely different results, both as to flavor, brightening, attenuation, and mode of separation of the yeast. Experiments have also shown that these characteristics can be maintained unimpaired throughout a very great many successive fermentations in the brewery. Cultivations have been started from a single yeast cell, and with proper care have been maintained for a long time.

On a commercial scale the cultivation should be conducted in sufficiently large vessels to yield the necessary amount of yeast used for fermentation. For this purpose two vessels should be employed, one in which the wort or other sugar solution used for cultivation is sterilized by being boiled, then stirred and aerated, excess of pressure being prevented by means of air filtered through sterilized cotton; into the other (the fermenting vessel, previously sterilized by steam) the sterilized wort or sugar solution is forced, and pure yeast from the laboratory added. When the fermentation is at an end, the liquid is run off, the apparatus filled with wort or sugar solution, stirred, and very nearly emptied. The wort so obtained, and containing yeast, is then transferred to the brewing vessels; the residue in the apparatus, with the addition of sterilized wort, serves for the future production of yeast. Pure yeast can thus be continually obtained without fresh inoculation, as the small amount remaining in the fermenting vessel serves this purpose. These vessels are jacketed and provided with the necessary safety-valves, ventilators for admitting filtered air, exit tubes for the escape of steam and carbonic acid, thermometers and manometers for regulating temperature and pressure, and inlets and outlets for wort, beer, and yeast.

DISTILLATION.—The object of the distiller is to separate the alcohol contained in the fermented wort from the foreign matter with which it is associated. For this purpose he has resort to a still. The alcohol thus produced is not, as has been well known for some time, a single substance, homogeneous, always the same in its nature, form, and effects; on the contrary, it is an extremely variable body, of diverse chemical composition and physical characteristics; it is not *one* alcohol, but many, which chemists have divided into several series.

The distiller commonly divides the product of his still into three classes: (1) products with a bad taste, the heads; (2) alcohol, properly speaking; and (3) products with a bad taste, the tails. The first and third are kept separate from the middle, which is the most valuable portion. Table I., according to Dr. Rabuteau, gives the boiling points of these different products.

Table I.—Showing the Boiling Point of Different Products.

Products of Distillation.	Boils at—	
	Degrees C.	Degrees F.
Products with a bad taste, the heads:—		
Aldehyde	20.8	69.4
Acetic ether	72.7	162 9
Alcohol, grain spirits, ethyl alcohol	78.0	172.4
Products with a bad taste, the tails:—		
Propyl alcohol	97.0	206 6
Butyl alcohol	109.0	228.2
Amyl alcohol	132.0	269.6
Valerianic ether	133 0	271.4
Amyl acetate and other nameless products	136 0	276 8

Aldehyde is a colorless, easily mobile liquid, having a specific gravity of 0.8009 at 0° C. (Kopp). Its vapor density was found by Liebig to be 1.532, who also states, that, when inhaled in large quantities, the vapors, of a peculiar ethereal suffocating odor, produce a cramp, which for a few seconds takes away the power of respiration. (Isidore Pierre compares its action to that of sulphurous acid.) It is miscible with water in all proportions, heat being evolved, and it is likewise soluble in both alcohol and ether. The addition of water raises the boiling point of aldehyde. It absorbs oxygen, and is slowly converted into acetic acid.[1]

Ethyl acetate or acetic ether is a mobile liquid possessing a penetrating, refreshing smell and a pleasant burning taste. It has a specific gravity of 0.91046 at 0° C. (Kopp). Its vapor density was found by Boullay and Dumas to be 3.016. It mixes with alcohol, ether, acetic acid, etc., in all proportions, and dissolves a large number of resins, oils, and other organic bodies. Its action in many cases, when used as medicine, resembles that of common ether, but it possesses a more agreeable taste and smell. It is also used for addition to the poorer classes of wine, liquors, etc.[1] According to Professor Dujardin-Beaumetz, the toxic dose of aldehyde is from 1 to 1.25 grams, and that of acetic ether 4 grams, per kilogram of the weight of the animal.

Methyl alcohol is the lowest form of the alcohol series, and when pure is a colorless, mobile liquid, having a vinous smell closely resembling that of ethyl alcohol. It has a specific gravity of 0.8142 at 0° C. (32° F.) (Kopp). The boiling point, as stated by various observers, varies from 58.6° to 66.5° C. (137° to 152° F.), owing to the great difficulty of obtaining it in a perfectly anhydrous condition. The difference between the densities of mixtures of methyl alcohol and ethyl alcohol with the same proportions of water is so small that the tables ordinarily used for the latter may be employed for most purposes in ascertaining the strength of the former.

Methyl alcohol is miscible in all proportions with water, ethyl alcohol, and ether. In its solvent and chemical properties it closely resembles ethyl alcohol.

[1] Roscoe and Schorlemmer's Chemistry.

Wood naphtha, pyroxylic spirits, is the name given to the impure commercial methyl alcohol. It is a very complex liquid, containing variable proportions of methyl alcohol, acetone, methyl acetate and formate, allyl alcohol, aldehyde, water, etc. The best commercial wood naphtha contains about 95 per cent of methyl alcohol, the common varieties from 75 to 90 per cent, and sometimes going as low as 30 to 40 per cent. It has a very characteristic odor, and if taken internally will generally produce nausea and other deleterious effects. Pure methyl alcohol, however, is free from these objections. Cases may be cited from the English court reports and daily papers where persons habitually drank methylated alcohol without any other toxic effect than that common to ethyl alcohol.

The higher alcohols, propyl, etc., have a greater toxic effect than ethyl alcohol. Brockhaus has recently personally investigated the effects of propyl, butyl, and amyl alcohols on the system. He found the disagreeable symptoms, giddiness, nausea, etc., to increase with the molecular weights of the alcohols, and amyl alcohol itself proved to be a very violent poison. According to the experiments of Rabuteau, amyl alcohol is fifteen times as intense as ethyl alcohol, and is even fatal in small doses. Amyl alcohol is one of the chief constituents of fusel oil.

An addition of 10 per cent of wood naphtha to ethyl alcohol lowers the boiling point of the mixture 3.3° C. (6° F.) (Ure).

Ethyl alcohol, spirits of wine, ordinary or grain alcohol, is next to methyl alcohol in the ascending order of the alcohol series, is the alcohol on which the internal-revenue tax is levied, and is the alcohol with which most people are familiar. It is a limpid, colorless liquid, of a hot pungent taste, and has a peculiar pleasant smell. According to Mendelejeff, absolute alcohol boils under the normal pressure at 78.3° C. (173° F.), and has a specific gravity of 0.80625 at 0° C. (32° F.) compared with water at its maximum density, 4° C. Dr. E. R. Squibb, of Brooklyn, N. Y., in 1884 obtained alcohol of a specific gravity lower than that recorded by any previous observer, viz., 0.80257 at 4° C., or 0.80591 at 0° C. compared with water at its maximum density. Absolute alcohol, however, is comparatively unknown outside of chemists' laboratories. When we speak of alcohol, we generally mean the liquid that contains from 90 to 95 per cent by volume of absolute alcohol.

Ethyl alcohol is miscible with water in all proportions, a considerable evolution of heat and contraction in bulk taking place on admixture. It is nearly impossible to remove the last traces of water, owing to the tendency of alcohol to quickly absorb moisture from the air. It is a powerful solvent for fluid and solid bodies, both organic and inorganic. It absorbs many gases with considerable avidity. As found on the market, ethyl alcohol often contains traces of higher homologues, of aldehyde and acetic acid, of volatile oils, of various fixed impurities, both organic and inorganic, and is more or less fixed with water.

The tails or faints, as well as the still less volatile or ordinary fusel oil, are mixtures of several alcohols and fatty acid ethers, their relative quantities depending on the nature of the materials used in mashing, belonging to the higher series of alcohols, and consequently possessing greater toxic effects.

Propyl alcohol was discovered by Chancel in 1853 in small quantities in fusel oil obtained in the manufacture of wine-brandy. It resembles ethyl alcohol in its odor. It has a specific gravity of 0.8198 at 0° C., and boils, according to various observers, at from 96° to 98° C. The latter number is probably the correct one, as the boiling points of the normal alcohols increase 19.6° C. for every increment in composition of CH (Grimshaw and Schorlemmer). It is miscible in all proportions with water, but, on the addition of easily soluble salts, as calcium chloride, etc., it separates out from aqueous solutions. Propyl alcohol is not used in the arts or manufactures, but is chiefly employed in scientific research.[1] It is toxically more active than ethyl alcohol; the dose is from 3 to 4 grams per kilogram of the weight of the animal.

Butyl alcohol occurs in varying quantities in several fusel oils, and is especially found in the spirits from beet-root, potatoes, and grain. It was discovered by Wurtz in 1852. It is a somewhat mobile liquid, possessing a spirituous smell, but at the same time a fusel-oil odor, resembling that of syringa flowers. It boils at 108° to 109° C., and has a specific gravity of 0.817 at 0° C. At ordinary temperatures it dissolves in ten parts of water, and the greater part is separated from solution on the addition of easily soluble salts, chloride of calcium, common salt, etc. According to Rabuteau, it is toxically four times as active as ethyl alcohol, its dose being 2 grams per kilogram of the weight of the animal. It has a toxic action on the heart and blood, producing muscular trembling and in large doses convulsive spasms.

Amyl alcohol, so called by Cahours because it was chiefly found in spirits obtained from bodies containing starch (amylum), is commonly called potato spirits. It has been found since to occur in all fusel oils. Amyl alcohol was for a long time considered to be one distinct compound. Biot first drew attention to the fact that this body possesses the power of rotating the plane of polarized light to the left; and Pasteur, in 1855, pointed out that the rotary powers of different samples of amyl alcohol vary according to the source from which they are obtained. From this he concluded that the body termed amyl alcohol is a mixture in varying proportions of an optically active and an optically inactive compound. He succeeded in obtaining the two modifications of the alcohol, and experiments of later investigators have established that they do not possess an identical chemical constitution. Fermentation amyl alcohol is a colorless, highly refracting liquid, possessing a burning taste and a penetrating smell, boiling at 131° to 132° C., and solidifying at —21° C. Inhalation of its vapors produces difficulty of breathing, coughing, headache, and giddiness.[1] It kills rapidly, according to Dujardin-Beaumetz, in doses of from 1.59 to 1.75 grams per kilogram of the weight of the animal. Even in small doses it exerts a powerful effect, bringing about intoxication and coma, producing at first a violent excitement of the nerve centres, followed by depression of the sensitive and motive forces.

Valerianic ether is a colorless liquid, having an irritating taste, and an odor which has been compared to that of apples; it is met with in an extremely small proportion in fusel oils. The same is true in regard to amyl acetate, a colorless liquid of a peculiar and irritating taste, of an odor

[1] Roscoe and Schorlemmer's Chemistry.

that recalls that of pears. Both of these substances have been little studied by chemists.

In short, very complex in their compositions, which are still very imperfectly known, the spirits of commerce not only contain the ethyl, propyl, butyl, and amyl series of alcohol compounds, on which most research has been concentrated, but also a certain number of other products, as pyridin and several aldehydes of unknown composition.

Drs. Laborde and Magnan submitted a report to the French Academy of Medicine, Oct. 21, 1888, giving the results of their experiments with the higher alcohols and artificial bouquets, in regard to their toxic effects on animals, comparing the effects of the natural products with those of the artificial products.

All spirits consist of a more or less diluted ethyl alcohol containing traces of the higher boiling compounds, commonly called fusel oil, the proportion depending on the care exercised by the distiller in stopping the distillation when the vapor temperature rises above the boiling point of ethyl alcohol, and certain flavoring bodies depending on the material employed. The deleterious effects of raw spirits are attributable to the presence of these higher-boiling alcohols, which, by slow oxidation by exposure to the air, are more or less changed and converted into certain ethers which are comparatively harmless.

All spirits are colorless when first distilled, and if kept in glass or earthenware vessels would so remain; but being stored in oak barrels, the staves of which are generally charred, they gradually acquire a more or less topaz hue. It is therefore the tannin and other extractive matters of the wooden casks that produce the color in all spirits made by distillers. Rectifiers, however, generally use caramel or burnt sugar to color their goods.

Most nations are accustomed to consume alcoholic beverages, and in some of the most barbarous tribes a crude method of preparing alcohol is known. For instance, starchy roots are masticated, then spat into a vessel and allowed to ferment, the resulting alcoholic liquid being drunk with much satisfaction. In Alaska the Indians were accustomed to save up the rations of sugar issued to them by the Government till a sufficient quantity was obtained, when a solution was made with water, compressed yeast added, and the fermentation conducted near their fires, and the resulting alcoholic liquid was strong enough to produce intoxication when drunk in sufficient quantity. This resulted in the Treasury agent stopping the sugar rations.

Table II. shows the percentage of absolute alcohol contained in certain typical fermented and distilled liquors, and the results are the means of many analyses.

That cider should contain more alcohol than ale or porter may be a surprising statement to many readers.

The so-called sweet wines are nothing but artificial, that is, they consist of dry wines adulterated with alcohol and sugar. In Europe there are very stringent laws, in most of the wine-producing countries, against the sale, as wine, of any wine which is not the product of the fermentation of the juice of fresh grapes. All wines made from the second pressing of the marc or grape residue, with the addition of sugar, alcohol, etc., are compelled to be labelled, sold, shipped, etc., as artificial wines. These sweet wines are really diluted brandy sweetened; their alcoholic and sugar contents are nearly equal, and together form about one-half of the volume of the liquid.

[1] Rev. Ques. 4 s., T. 2, 1888, pp. 1369, 1423.

Table II.—Showing the Percentage of Absolute Alcohol in Certain Typical Beverages.

Beverage.	Number of Analyses.	Per Cent Absolute Alcohol.	
		By Weight.	By Volume.
Weiss beer, Berlin	26	2.73	3.42
" " American	28	1.73	2.18
Draught beer	205	3.36	4.20
Lager "	258	3.93	4.93
Export "	109	4.40	5.50
Bock "	84	4.69	5.86
Porter	40	4.70	5.87
Ale	38	4.73	5.91
Cider, American sweet	6	1.40	1.76
" well fermented	7	5 17	6.45
Wine, Europe	1,287	8.41	10.43
" California	130	8.64	10.73
Whiskey, Scotch	—	42.80	50.37
" Irish	—	42.30	49.90
" English	—	41.90	49.40
" American, corn	—	42.50	50.00
" " rye	—	42.50	50.00
" Russian	—	54.20	62.00
Brandy, French	—	47.30	55.00
Rum	—	42.20	49.70
German schnaps	—	37.90	45.00

The different varieties of beer and ale are among the lightest of the alcoholic beverages, the amount of alcohol they contain depending on how far the fermentation of the wort was conducted. In their endeavor to supply a light-colored beer, brewers are resorting to the use of malt substitutes, as glucose, as giving them more satisfactory results,—a practice that presents no objection on the score of health. Such light-colored beers, however, lack the full and fine flavor of a beer made from malt exclusively. In bottling their beer, in order to prevent further fermentation, resort is had to antiseptics, a practice which should be prohibited by law, as the quantity and kind of antiseptic used varies in the different bottling establishments: some brewers and bottlers, however, do not use antiseptics. The use of alkaline bi-carbonates to increase the head of gas is another adulteration of bottled beers. When hops are scarce, and consequently dear, resort is had to other bitters, as gentian and quassia; but that brewers habitually employ unwholesome bitters, as strychnine and picric acid, is extremely unlikely, because, if for no other reason, their sales would decrease on the mere suspicion of such practice. According to the internal revenue law (R. S. 3,337), every brewer is compelled to keep books in which he enters from day to day the kind of malt liquors made, the estimated quantity produced, and the actual quantity sold, and an account of all materials, including grain or malt, purchased by him for the purpose of producing such fermented liquors. At the end of each month the brewer has to send a copy, duly attested under oath, of

such daily records to the Commissioner of Internal Revenue at Washington. If in such returns the employment of unwholesome material was reported, an investigation would be made by the proper revenue officer, and an explanation demanded from the brewer. Thus some sort of check is exercised over the use of poisonous materials. The production of distilled and fermented liquors in the United States since 1863, when a revenue was imposed on the same, is shown, at intervals of five years, in table.

Table III.—Showing Production of Distilled and Fermented Liquors, at Intervals of Five Years, in the United States.

Year ending June 30.	Liquors [1] (Gallons).	
	Distilled.	Fermented.
1863	16,149,954	62,205,375
1868	7,224,809	190,546,553
1873	65,911,141	298,633,013
1878	50,704,189	317,485,601
1883	76,762,063	550,494,652
1888	71,565,486	765,036,789
1890	83,535,165	854,420,264

While the production of distilled liquors has only increased five times, that of fermented liquors is fourteen times, what they were in 1863.

One fluid ounce or half a wine-glass of whiskey, rum, or gin, containing fifty per cent by volume of absolute alcohol, is equivalent in alcoholic strength to five ounces of light red wines, as claret; eight ounces of well-fermented cider; to nine ounces of ale or porter; to ten ounces of lager beer (over half a pint); and to twenty-three ounces of American weiss beer. The intoxicating effects, however, would be more rapid and pronounced in the case of the ardent spirits than they would be with the equivalent amounts of beers, owing to the more concentrated form and consequently quicker absorption in the circulation of the alcohol in the former as compared with its dilution in the latter beverage.

EDGAR RICHARDS.

[To be continued.]

THE STANDARD OF LIVING IN THE UNITED STATES. [2]

IN discussing the standard of living in the United States, I shall consider the producing classes as the people. They constitute the great majority, embody the vital forces of the nation, and represent its life and distinctive character.

An analysis of the conditions which mould the life of the people representing the civilization of the world leaves no room for doubt that the American standard of living is the highest known. The barrier of primogeniture, the repression of caste, the compulsion of social distinctions, are obstructions in the path of ambition which have no existence here. In this country there are no barriers to wealth or station which capacity and persistence cannot sweep away. Physical influences are here in harmony with the intellectual. The western world, in its most temperate zone, with long reaches towards the tropics and approaches towards the north pole, with a breadth bordered by the two great oceans of the world, and spanning practically the possibilities of climate by altitude, is in extraordinary measure independent of other lands. Its resources invite development; and social and political freedom stimulate noblest daring and highest enterprise in their utilization. Here the laborer stands on a relatively elevated plane. If native born, he has no conception of the limitations by which the life of his brother in other civilized countries is restricted. He requires more and better house room, food in larger quantity and greater variety, clothing for his family, books and facilities of education for his children, and something for social life, amusement, and even charities. He is apt to be interested in politics, in social or beneficiary or religious organizations, and oftentimes in all of these. I would not aver that his foreign brother does not possess similar tastes and preferences, but hold that his exercise and enjoyment of them are in more restricted measures, under the limitations of purse and social usages.

Want is not unknown here; the poor and afflicted are everywhere. A comparison with the most favored foreign country will suffice. The Tenth Census returned 66,203 paupers, or 1.32 to every thousand of the population. The record of 1850 was 50,353, or 2.17 to every thousand. This shows a gratifying decrease in pauperism in a period remarkable for increase of national wealth. In England and Wales the number of paupers in 1873 receiving relief in the several unions and parishes under boards of guardians was 887,345, and in 1888 the number was 825,509. The returns do not quite cover the entire population, which was 28,628,804 in 1888, but assuming that they cover all of England and Wales, the number would be 28.8 for every thousand people. This is in violent contrast to the situation in this country.

In the use of food our people are excessive and even wasteful. According to accepted statistics, Great Britain consumes an average meat ration not over two-thirds as large as the American; France scarcely half as large; Germany, Austria, and Italy still less. But the laborer's dietary is improving in those countries. It has already greatly improved in England. The average consumption of meat in the United States is probably not less than 175 pounds per annum. Of other civilized nations, only Great Britain exceeds 100, and many of them scarcely average 50 pounds. The consumption of the cereals, by man and beast, is three times as much, in proportion to population, as in Europe. For the past ten years the average has been 45 bushels for each unit of population, while the usual European consumption does not vary greatly from sixteen bushels per annum. While all is not used as food for man, no small part of it contributes to the meat supply.

The average consumption of wheat for bread is nearly five bushels, and about three bushels of maize and one bushel of oats and rye, or approximately nine bushels for each inhabitant. The average European consumption of wheat is about 3.5 bushels. In the consumption of fruits, the difference between this and other countries is marked with unusual emphasis. Small fruits, orchard fruits of all kinds, and tropical fruits, as well as melons of many varieties, are in profuse and universal daily use in cities and towns, and in the country the kinds locally cultivated are still cheaper and more abundant in their respective localities, though scarce in the regions of recent settlement and those unsuited to a wide range of species. The consumption of vegetables is not excessive.

The American people are no less profuse in clothing than in food. This country is a favored land in fibre production. More than four hundred millions of dollars is the comfortable sum which represents the present fibre product; in the form of cotton, wool, hemp, and flax. There is also experimental production of silk, ramie, sisal, jute, and many others suited to the climate, some of which will ultimately become the foundation of industries. More than half of the material for the cotton factories of the world is grown here, and a third of that is manufactured and mostly consumed at home. If 65,000,000 people require one-sixth of the cotton manufactured in Europe and America for the use of nearly 450,000,000 inhabitants of these continents, and of the millions in India, China, Japan, and other countries obtaining

[1] Under the name of distilled liquors are included whiskey, rum, gin, high-wines, and alcohol; and under the name of fermented liquors are included beer, lager beer, ale, porter, and similar fermented liquors (Ann. Rpt. Com. Int. Rev. 1889).

[2] Abstract of an address before the Section of Economic Science and Statistics of the American Association for the Advancement of Science, at Indianapolis, Ind., on Aug. 20, 1890, by J. Richards Dodge, vice-president of the section.