the center of a large mass of well-cured hay may start fermentations throughout the whole mass of material. With the migration of these fermenting zones from point to point there may finally be found somewhere a zone having the optimum conditions of moisture, temperature and air supply that lead finally to ignition. If this necessary coincidence of optimum conditions does not obtain, the stack, after several months of fluctuating changes of temperature, begins to cool down, with perhaps an occasional sporadic elevation of temperature at isolated points. The impeded penetration of air prevents the accelerated oxidation of the unstable organic residues; these are only very slowly oxidized and when the stack has finally approached the temperature of the outside air, these once highly oxidizable complexes are so sufficiently stabilized that the stack may be opened up without danger.

While this sketch of the chemical processes involved in the spontaneous heating and spontaneous ignition of hay is probably in general correct, there are many details of the problem that must be worked out under carefully controlled quantitative conditions. We need observations upon the production of heat, consumption of oxygen and evolution of carbon dioxide, water, etc., by large masses of fermenting hay in a respiration calorimeter, for it is only in this way that we can determine how much of the heat is produced as a result of anaerobic reduction-oxidation reactions and how much is produced by atmospheric oxidation. We need more observations upon the elementary analysis and heats of combustion of hay at various stages of spontaneous heating. We need further research on the nature of the solid, liquid and gaseous organic compounds that are produced in both the anaerobic and aerobic fermentations of hay, particularly of those elusive intermediate compounds which are the most difficult of all to detect. We need more knowledge of the phenomena of moisture migration and heat transference in large masses of hay. We need also more exact information as to the temperatures of ignition of hay at different stages of the fermentation process. When fundamental knowledge upon these and other points has been acquired we shall be able to visualize more clearly the details of the complicated reactions that take place in the spontaneous heating and spontaneous ignition of hay and other agricultural products and to arrive at the best practical means for reducing the enormous economic losses from this cause.

BREAD QUALITY OF WHEAT PRODUCED IN AQUEOUS CULTURE MEDIA

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AMONG the causes of differences in the bread properties of wheats, those related to the quality of their proteins are of much interest to cereal chemists. Quality in flour as affected by the character of protein appears to be a very definite entity when expressed by baker's marks, and while the loaf of bread is and perchance always will remain the ultimate criteria of quality, nevertheless the concept "quality of protein" is still an intangible term, lacking a precise chemical definition. The interested trades feel a real need for simple and reliable tests of protein quality, which apparently may vary from season to season in accordance with the vagaries of climate; consequently experiments were designed to attack the problem from another angle, namely, by the water culture method, whereby specific treatment could be accorded the material selected for milling and baking operations.

Wheat protein is supposed to be identical in chemical composition among varieties. The fact of differences in the character of bread due to protein would, in lieu of differences in quantity thereof, be accounted for by differences in its physical character. It is known that the physical state of colloid particles varies with the nature of the medium surrounding them, and as plant sap is a more or less concentrated salt solution, it appeared as not improbable that variation in the quality of wheat protein might reflect certain features of plant sap. The fact of variation in the concentration and composition of plant sap with cultural treatment and also the differences in physical character of starches derived from the same source also were suggestive as to the type of experiment required to throw more light on the protein problem.

To obtain such data, the writer grew wheat in aqueous culture media on a scale large enough to provide samples for milling and baking operations. The plants were grown in a series of tanks filled with water, over which a seed bed was mounted, and which permitted production of a crop in culture media that could be altered at will.

Full description of the technique of crop production in a water medium by mass planting will appear in due season. As a preliminary note, however, it may be stated that the essential features of the method consisted primarily of (1) a seed bed mounted over and in contact with a water surface, so that the crop could be planted by mere broadcast scattering of the seed and grown to maturity without further replanting; and (2) the use of "fertilizing units," a single bottle per tank containing all elements required for growth of plants in water which being once applied requires no further attention and thus eliminates much of the tedium associated with classical water culture experimentation. The seed bed consisted of poultry netting stretched tightly over the top of the tanks. Burlap placed on the netting furnished support for the seed sown thereon. A thin layer of sawdust covered the seed to maintain the required moisture conditions for germination. With the sprouting of the seed, the roots penetrated the burlap and extended into the water and the plants grew to maturity in place as seeded. The "fertilizing units" contained ten elements, of which those required in relatively large amounts were supplied by the ordinary grade of fertilizer applied to land and those required in small amounts were supplied from equally inexpensive sources. Ordinary tap water was used. From 800 to 1,400 grams of dry grain was grown per reservoir, having 25 square feet of seedbed. The maximum yield obtainable per 25 square feet of water surface has not been determined, but apparently is decidedly larger than can possibly be obtained per equal area of soil surface.

Three sets each of an array of seven varieties were grown, two in water, one in soil. Of the former, one was located under glass, the other in the open field. The soil set consisted of plats in the open field. All samples grown in liquid media received similar treatment up to the heading stage. When that state of development was obtained, the solution of each reservoir was drained, the fertilizing units removed and fresh water supplied. Then the treatment was altered: One reservoir out of every set of two received a new fertilizing unit, thus reproducing therein for the final growth period the same culture medium in which all samples were started. The other reservoir received no salts, the crop being allowed to grow to maturity in a nutrient-free medium. Thus the length of the period during which nutrients were available for absorption was made to differ. In the one case, the salt content of the mature plant was expected to be low, as no nutrients were available for absorption during the latter part of the growth period. In the other case, it was expected to be high because all elements were available in relatively large quantities throughout the entire growth period. The soil-grown crop received a very heavy application of $NaNO_3$ at approximately the same growth stage as that at which the crop grown in liquid medium had the nutrients removed. The conditions in regard to the supply of nutrients in the soil-grown crop were in essence similar to those of the crop grown in liquid medium which contained nutrients throughout the entire growth period of the plants, save as to amounts of nutrients available which were assumed to be less in the soil than in the liquid medium.

From an agronomic standpoint, yield is an important consideration in growing a crop for investigations dealing with the bread quality of wheat. In field culture, variation in yield may or may not reflect itself in the baking properties of the flour. However, as these experiments were not designed to show the conditions under which such correlations are obtained—or failed to be obtained—no consideration will be given to the physiological properties of the culture media in respect to their effects upon yields, save in one aspect. With all varieties grown in liquid media, both under glass and out of doors, larger yields of grain were obtained from the reservoirs that did not contain any nutrients during the latter part of the growth period, than were obtained from those which contained an abundance of nutrients throughout the entire growth period of the plants. These results, at first consideration somewhat surprising, are, however, in full accord with the observed facts of nature, namely, that for a considerable portion of their growth, many plants rooted in soil thrive in a media low or nearly depleted of available nutrients, granted of course that the supply was adequate during their early growth stage. This condition exists because plants have a higher rate of absorption of nutrients than the soil has of making nutrients available.

Analyses of the crops revealed that the percentage of water soluble and also total ash in the plants grown in the liquid media varied with the treatments, and was higher in the cultures where nutrients were available throughout the entire growing period than where they were absent during the latter part of the growth period. Likewise, the ash of the grain varied similarly with the treatments, but it was of decidedly lower value than that of the straw. The grain harvested from the reservoirs in which the supply of nutrients was not restricted was not so well filled as was that obtained from the reservoirs in which nutrients were restricted. The filling of the individual kernels in a head of wheat appears to be largely a matter of adequate production of carbohydrates by the plant and its translocation into the kernels. It appears, therefore, that the failure of the grain to fill properly was, in part, due to the excessive absorption of some of the inorganic nutrients, and the consequent effect in the restriction of the production of carbohydrates. Within limitation, the amount of carbohydrates in wheat plants appears to be inversely related to that of the absorption of inorganic elements, but whether this relation applied to all elements expressed as total ash or only certain ones thereof, was not deducible from the data. The percentage of ash of the patent flour also varied with the treatments, but it was of decidedly lower value than that of the grain, the range being 0.4 per cent. to 0.7 per cent.

Milling and baking operations were performed according to the directions of Standard Mills for their experimental laboratories. Apparently the yield of the various mill products of wheat was not altered by the treatments. Only patent flour was used for the baking tests and the bread produced therefrom showed decided differences in quality, both as to varieties and the cultural treatments employed.

The data obtained are as yet too fragmentary to indicate how the nature of plant sap affects the colloidal state of the proteins and starches. Apparently the ash content of flour throws no light on the matter. The ash content of the straw varied from 3.5 to 17 per cent. among varieties and treatments, and while the quality of the bread did not vary correspondingly with that of the ash, it was evident that some type of relation did exist.

It soon became apparent that, in order to clarify this relation, it was necessary to differentiate two fractions of the total amount of each element absorbed, one on which yield was dependent, and one on which it was not. The fact that yield of grain was not restricted by the absence of nutrients in the culture medium during the latter growth period of the wheat plants indicated the arrival of a stage in their development when the absorption of nutrients no longer had nutritional functions. This growth phase was not identical with all elements. Neither was it fixed for any element, as conditions which affected the rate of supply of nutrients during the early growth of plants affected the time of arrival of that period. The crop-yielding power of various increments of any element absorbed by plants from the culture media varied with the time of their absorption; those which were absorbed early possessing greater power than those absorbed late. Corresponding to this difference in yielding power, other differences in the properties of the absorbed nutrients may be assumed. Among these are composition and concentration of plant sap. While the amounts of nutrients absorbed at maturity do not give a true picture of these properties of sap during growth, nevertheless they do indicate the direction of possible fluctuations in these characters. It appears safe to assume that the concentration of the sap of plants due to the nutrients on which yield is dependent is less than that due to nutrients which can not function causatively. The absorption, occurring too late, becomes excess because of the brevity of time remaining for utilization. The quantity absorbed too late to function causatively is superimposed upon that which functions causatively with corresponding effect on concentration of the plant sap.

By precluding the absorption of nutrients during the latter growth phase of wheat, the relation of the crop-producing value of varying quantities of an element to that of yields of grain can be determined. With some qualification, this relation can be expressed as a straight line function for all elements. At no period of the development of wheat will the absence of either nitrogen or phosphorus in the culture medium preclude reproduction, and the magnitudes of yield become a given multiple of the quantities of either of these elements absorbed during the early growth phases of the plants. This straight line relation is contingent on sufficient time subsequent to the absorption of the quantities in question to permit the plants to elaborate the materials into the maximum amount of product possible which is defined by the lowest percentage of the element in the composition of the mature product. Absorption of these elements occurring too late in the life of wheat to effect yield reflects itself in the composition of the plants, and is expressed for the specific elements in question by the degree it exceeds the minimum percentage obtainable in the mature product. But in the case of iron, calcium or potassium, the relation is not so simple because the absence of any one of these elements at certain growth phases will preclude reproduction, even though their presence in the medium at a former growth phase had resulted in considerable vegetative development. Only after certain minimum quantities have been supplied to bring the plants to such a state of development that the first increment supplied thereafter will effect grain production, are yields proportional to varying amounts of the element absorbed.

It is inferred from these relations between yields and quantities of various elements required that the physical properties of the plant sap arising from the truly nutritive quantities of each of the elements absorbed does not vary save by those factors which are part and parcel of growth. Changes are features of growth. A definite type of reactions or characteristics prevails, or follows one after another, in the constitution of plant sap with the circumstances of growth. But the plant is always exposed to secular forces which may intensify or lessen the rate of changes of the components of the truly nutritive character of plant sap. Nutrients which can not function productively thus become the cause of variation of the physical properties of plant sap because they are superimposed on those which define the type.

Wheat varieties vary more or less markedly as to the amount of an element required per unit weight of grain produced. Furthermore, the ash content of their straws varies with the elements absorbed. Subtracting the amount of nutrients required for any measure of yield of any variety from that of its ash, one obtains a measure of the quantity of material which caused secular variation in the plant sap. Better bread was obtained from wheats having a relatively large excess of salts in the straw beyond the minimum required for the yield obtained than from those having none or only a small excess.

OBITUARY

RECENT DEATHS

CHARLES WILFORD COOK, professor of economic geology at the University of Michigan, died on February 17 at the age of fifty years. He had been connected with the department of geology for twenty-five years and was well known for his work in economic, and especially in oil, geology.

DR. CHARLES SPENCER WILLIAMSON, head of the department of internal medicine of the University of Illinois Medical College, Chicago, died on February 15 at the age of sixty years.

Nature reports the death of Lieutenant Colonel John Stephenson, known especially for his work on the oligochaetes, from 1912 to 1920 professor of biology and principal of the government college at Lahore, India, and later until 1929 lecturer in zoology at the University of Edinburgh.

PROFESSOR ALFRED SCHAARSCHMIDT, head of the Institute of Chemical Technology at the Technische Hochschule, Charlottenburg, has died at the age of forty-nine years.

THE death is announced of Dr. Johannes Schmidt, the biologist and oceanographer of Copenhagen.

SCIENTIFIC EVENTS

THE SCHOOL OF MEDICINE OF ROSARIO

A CORRESPONDENT of the *Journal* of the American Medical Association reports that the board of directors of the School of Medicine of Rosario, Buenos Aires, recently resigned because the directors have had some difficulties with the students. The new board of directors has expressed a wish to nullify many of the regulations made by the previous boards for the management of the school. The School of Medicine of Rosario is dependent on the University of Litoral. The university controls seven medical schools and also other scientific centers. One of those centers, the Escuela de Agronomía y Veterinaria of the province of Corrientes, has more teachers than students. As a result of the economic conditions, the government recently reduced the yearly allowance of the University of Litoral, which in turn reduced the allowances given to the medical schools and scientific centers under its control. The medical school of Rosario could have met this deficit by reducing some of its expenses. There are, for instance, three courses on the same subject (psychiatry); many other subjects which are not strictly of a university nature could have been discontinued. However, in order to economize, the salaries of the professors were reduced. Drs. Ruíz and Hug, directors of the institutes of anatomy and of pharmacology of the medical school of Rosario, whose contracts expired, refused to sign a new contract at a reduced salary. Then the board of directors decided to eliminate the course of pharmacology. However, the students and some professors opposed dropping the course and finally they decided to continue it. The vacancies left by Drs. Ruíz and Hug were reported so that applications for the positions could be made. The monthly salary to be given professors in those positions is 500 pesos ($130) as directors of the institution and 300 pesos ($78) as professors, making a total of 800 pesos ($280) a month. However, this amount is more theoretical than real, because, owing to taxes, the salary is reduced to 700 pesos ($182). The full time professors of the medical school of Rosario had 1,300 and 1,500 pesos ($338 and $390), respectively, for their monthly salary. By giving them only 700 pesos the school saves 1,500 pesos a month, although the full-time system is sacrificed. Those full-time professors have devoted the past ten or fifteen years to laboratory research and now they are compelled to practice medicine or do other things for a living, while their places are taken by others who have not had so much experience. There were five full-time professors in the medical schools of Argentina. By the elimination of these two there are now only three (Drs. Houssay, Lewis and Elizalde).

AUSTRALIAN FOSSILS FOR THE HARVARD MUSEUM

THE largest and most complete specimen of a plesiosaur ever discovered in Australia is included in the collections made by William E. Schevill, assistant