Chemistry of Vegetable Physiology and Agriculture.

New Researches on the Functions of Fungi and their Property of Inverting Cane-sugar. By A. BÉCHAMP (*Compt. rend.*, lxxxvi, 355—358).—The author is of opinion that the view is restricted which regards sugar as the necessary source of alcohol in fermentation, and microscopic plants as the only producers of alcoholic fermentation. He has shown that an aqueous solution of sodium acetate, or of ammonium oxalate, furnishes alcohol with certain moulds. Yeast from beer, perhaps all yeasts, produce alcohol in distilled water, without the presence of sugar. The following new facts support this physiological theory of fermentation :—

I. Normal urine, destitute of glucose, when undergoing ammoniacal fermentation, forms at the same time alcohol and acetic acid. In one of these fermentations the ferment consisted largely of bacteria and vibrios. After being well washed, this ferment was placed in a solution of sugar which had been creasoted. Hydrogen and carbonic anhydride were evolved, the sugar was partly inverted, and alcohol, acetic and butyric acids were formed. The ferment was not much changed; the vibrios disappeared, but it contained no torulas, myceleum, or cellules.

II. Starch-paste, treated with the same ferment, rapidly became fluid, with disengagement of hydrogen and carbonic anhydride. Alcohol, acetic, lactic, and butyric acids were formed. In many experiments no glucose could be found; soluble starch or dextrin fermented directly.

III. The granular deposits of old wines invert cane-sugar. They also act as alcoholic ferments. J. T.

Experiments on the Ripening of Grapes. By C. ST. PIERRE and L. MAGNIEN (*Compt. rend.*, lxxxvi, 491).—The authors find that as the grapes approach maturity, they evolve carbonic acid gas both in the dark and in daylight, this evolution taking place indifferently in air or any inert gas. When the experiment is carried on for a sufficient length of time, the quantity of carbon dioxide produced is always greater than the quantity of oxygen consumed. Grapes absorb or give off moisture according as they are kept in damp or dry places. When maturity approaches, the acids diminish and the sugar increases. The mechanism of ripening, according to the authors, is the following:—The acids and glucose are formed in the plant, and carried by the sap to the grape: here the acids are destroyed, whilst the sugar becomes concentrated. When the grapes become over ripe, the sugar is consumed in its turn. J. M. T.

On Relations between the Chemical Constitution of certain Organic Compounds and their Physiological Importance to Plants. By A. STUTZER (*Landw. Versuchs-Stat.*, xxi, 93—133).—In the first place, experiments were made to determine whether plants containing chlorophyll could obtain their total supply of carbon from oxalic or tartaric acid, instead of carbonic acid. Seeds of *Brassica rapa* were allowed to germinate in distilled water until the radicle and plumules were sufficiently developed; these plants were well suited for the experiment, on account of the small weight of the seed and the rapid growth of the young plant. They were then planted in a bed of sand, under a glass chamber, and watered with a feeding solution—containing ·2 per cent. of Nobbe's feeding-salt—to which freshly-precipitated calcium oxalate had been added. It was found that free acids, or even acid salts, would not answer for the purpose. At the top of the glass chamber two tubes were let in, and one of them connected with an aspirator, by which air freed from carbonic acid (by potassium hydrate) was drawn through. All joints were sealed with paraffin. The vessel was exposed to diffused daylight, except in the early morning when the sun shone on it for a short time. The plants grew well, and were of a good green colour. After 35 days they were removed, washed, and dried at 100°; then weighed. The increase amounted to 228 per cent. Wheat plants treated as above for 30 days gave an increase of 48 per cent.; but as there is a large store of nutriment in this grain, the difference in the increase compared with rape is easily accounted for. Other plants were also found to grow and form new leaves when submitted to the same treatment. On examining the gas, oxygen was found to have been evolved.

Experiments made with calcium tartrate, instead of the oxalate, gave with *Brassica rapa* an increase in weight of 133 to 150 per cent. in 17 days.

The author, therefore, concludes that plants containing chlorophyll can assimilate the carbon from oxalic and tartaric acids.

It was then necessary to determine whether this assimilation of carbon is due to an intermediate formation of carbonic acid, or whether it takes place directly. In the following experiments the air in the chamber was not only freed from carbonic acid at the commencement of the operation, but any carbonic acid that was given off from the plants during the trial was absorbed with potash. *Brassica rapa*, when treated with calcium oxalate under the above conditions, diminished in weight and died. *Poa annua* also lost all its chlorophyll, and finally the plant died. When calcium tartrate was substituted for the oxalate, rape was found to increase in weight during 17 days from 66 to 69 per cent., and a more fully-grown plant of *Viola tricolor* formed new leaves and buds. Carbonic acid was found to have been absorbed by the potash.

Oxalic acid consists of two carboxyl groups, COOH.COOH, and it may be inferred from the above results, that the carboxyl is oxidised into carbonic acid and water before the plant can take up the carbon; whereas the alcoholic groups, (CHOH), contained in tartaric acid can be applied directly to the formation of carbo-hydrates in plants. It has not been determined, however, how this splitting up of the molecule of tartaric acid takes place, but it is most probable that at the moment of separation the COOH-groups become oxidised into CO_2 and H_2O, and do not previously form oxalic acid.

It was found, on comparing these two sets of experiments, that about the same quantity of tartaric acid had been absorbed in each case, but in the latter—with an atmosphere kept constantly free from CO_2—the increase in the weight of the plants amounted to only about one-half of that found in the former instance, when the CO_2 was allowed to remain, and so became finally assimilated. It may, therefore, be taken for granted that the carboxyl group must be oxidised into carbonic acid and water, before plants can take up the carbon; but the alcoholic group, on the contrary, is at once absorbed, without intermediate oxidation.

In experiments on the effect of glycerin on rape—which also contains the CHOH-group—the plants increased 126 per cent. in 17 days, although the air was kept constantly free from CO_2.

Fungi were next grown in solutions containing various salts. It is well known that the fungi do not contain chlorophyll, and as they exhale CO_2, they cannot feed directly upon it; they will behave towards organic compounds, therefore, in the same manner as green plants grown in an atmosphere free from carbonic acid.

Penicillium glaucum was sown in flasks of about two litres' capacity. The feeding solution contained ·2 per cent. of a mixture composed of magnesium sulphate, potassium chloride, and ammonium phosphate. Air was freely admitted, as the mouths of the flasks were only covered with a watch-glass, in order to keep out the dust. They were exposed to diffused daylight. Temperature 15—25°. Pure oxalic acid was added in quantities varying from 1 to 5 grams, and the quantity of feeding solution varied from 1 to 2 litres. In some cases, the oxalic acid was neutralised with ammonia; but even when left for 63 days, no fungoïd growth took place. If, however, other compounds were added containing the CHOH-group—such as glycerin, citric acid, lactic acid, acetic acid, hippuric acid, or succinic acid—there was abundant growth of the fungus. With formic, butyric, and valeric acids, however, no fungoïd growth was produced; this was probably due to their thermo-dynamic relations.

The following were the results finally obtained:—

I. *Carboxyl.*—The fact that the plant cannot take up the carboxyl-group as a direct source of carbon is contradictory to the views of Liebig and Rochleder. They state that oxalic acid is formed from carbonic acid by the plant, thus leading to the formation of other compounds.

II. *Carboxylated Hydrocarbons.*—Some of them can give carbon directly; for instance, acetic and succinic acids. Butyric and valeric acids cannot.

III. *Hydroxylated Hydrocarbons.*—Ethylic alcohol and glycerin can afford a direct source of carbon. Amylic alcohol cannot, however; probably on account of heat relations.

IV. *Carboxylated Hydroxylated Hydrocarbons*, such as lactic, malic, citric, tartatric, and glyceric acids, are especially characterised as furnishing their carbon directly to plants.

V. *Carbonic Oxide and Aldehyde* cannot give carbon.

R. C. W.

On Irrigation with Spring- or River-water. By J. König (*Landw. Versuchs-Stat.*, xx, 185—187).—This paper contains analyses showing the changes in composition exhibited by water which had been used for irrigating a highly siliceous soil. In the winter months this change was but slight, except as regards suspended matters. In summer, however, the diminution of dissolved matters was well marked, and more so in proportion as the temperature was higher.

The author considers it of great importance that water, after being thus used several times, should be exposed to air in order that it may again become charged with oxygen. Ch. B.

On the Silicates of the Shell-Limestone, and their Importance in the Formation of Soils. By G. Weise (*Landw. Versuchs-Stat.*, xxi, 1—17).—This paper contains analyses of the silicates contained in the shell-limestone found in the neighbourhood of Jena. The author regards these silicates as of great importance for agriculture, inasmuch, as by their decomposition under the influence of water containing carbonic acid, they afford large quantities of potash. Ch. B.