XIX. *On the Preparation of Artificial Yeast.* *By* George Fownes, *Ph.D.*

IT often becomes a matter of great practical importance to have it in our power to excite the vinous fermentation under circumstances in which ordinary yeast cannot be obtained. In making bread, for example, although the use of yeast may be avoided by employing what is called "leaven," or dough which has already become sour and partly putrefied by spon-

taneous change—a practice which has been followed from the most remote antiquity, and is still occasionally in use—the bread so made is always to be distinguished by a peculiar sour and nauseous taste and smell, and can never bear comparison with that fermented by yeast.

The object of the present notice is to point out a method by which yeast of the most unexceptionable quality can be artificially produced at will. I am aware that some substitute for ordinary ferment in brewing has long been known to certain persons, who go about the country and impart their secret to those who are willing to purchase it: of the nature of this preparation I am ignorant, and a reference to systematic chemical works will suffice to show, that whatever it be it has never been made public.

On turning to Berzelius, it will be found stated*, that although the reproduction, as it were, of yeast, the conversion of a small into a large quantity, is a very easy thing, yet to produce that substance from the beginning is very difficult. He describes a process for this purpose on the authority of Dr. Henry, and which consists in taking a strong infusion of malt, saturating it with carbonic acid, and then exposing it for some days to the proper fermenting temperature, when a small quantity of yeast is gradually formed and deposited, which may, by various contrivances, be made to give origin to a larger. I shall have occasion to notice presently the behaviour of a malt infusion when left to itself at a temp. of 70° or 80° F. for some time, and to show that the addition of carbonic acid is wholly unnecessary.

The principle of induced chemical action, which Liebig has assumed to explain a great number of those extraordinary phænomena to which Berzelius gave the term "Catalysis," and which principle has been so fully confirmed, and even, perhaps, extended by the late valuable researches of MM. Boutron and Fremy on the formation of lactic acid, serves to solve this difficulty, as it will doubtless many others of far greater magnitude and importance. It has been shown that "the kind of chemical change going on in the decomposing azotized body or ferment, determines the kind of decomposition which shall occur in the neutral ternary substance, subject to its influence;" that diastase, for example, according to its peculiar condition, whether fresh from the germinated grain, slightly putrefied, or in a still more advanced state of that change, possesses the singular power, in the first case, of changing starch into dextrin, and ultimately into grape sugar; in the second, of causing the conversion of sugar into lactic

* Lehrbuch, vol. viii. 89. foot note, third edition.

acid; and in the third and last, of exciting the vinous fermentation.

Now if common wheaten flour be mixed with water to a thick paste, and exposed, slightly covered, to spontaneous change in a moderately warm place, it will be observed to run through a series of changes which seem very closely to resemble those described by MM. Boutron and Frémy in the case of diastase.

About the third day of such exposure it begins to emit a little gas, and to exhale an exceedingly disagreeable sour odour, much like that of stale milk; after the lapse of some time this smell disappears, or changes in character, the gas evolved is greatly increased, and is accompanied by a very distinct and somewhat agreeable vinous odour: this will happen about the sixth or seventh day, and the substance is then in a state to excite the alcoholic fermentation.

A quantity of brewers' wort is next to be prepared in the usual manner, by boiling with hops; and when cooled to 90° or 100°, the decomposed dough before described, after being thoroughly mixed with a little tepid water, is added to it, and the temperature kept up by placing the vessel in a warm situation. After the lapse of a few hours active fermentation commences; abundance of carbonic acid, having its usual agreeable pungent smell, is disengaged, and when the action is complete and the liquid clear, a large quantity of excellent yeast is found at the bottom, well adapted to all purposes to which that substance is applied.

In one experiment the following materials were used:—a small handful of ordinary wheat flour was made into thick paste with cold water, covered with paper, and left seven days on the mantel-shelf of a room where a fire was kept all day, being occasionally stirred: at the end of that period three quarts of malt were mashed with about two gallons of water, the infusion boiled with the proper quantity of hops, and when sufficiently cooled, the ferment added. The results of the experiment were, a quantity of beer, not very strong, it is true, but quite free from any unpleasant taste, and at least a pint of thick barm, which proved perfectly good for making bread.

It appears to me that this simple plan would enable distant residents in the country, and settlers in the colonies, to enjoy the luxury of good bread when a little malt could be got—a very easy home manufacture from grain of any kind: the hops might probably be omitted when the yeast alone was the object.

A moderately strong infusion of malt which has not been boiled, suffered to stand in a warm place for some days,

speedily becomes sour and turbid, and begins to evolve gas; this change rapidly progresses, carbonic acid is given out plentifully, and a deposit of thick insoluble whitish matter formed, which readily excites fermentation in a dilute solution of sugar; the supernatant liquid contains alcohol, acetic acid, and, I believe, lactic acid.

When wort which has been boiled and hopped is set aside to decompose spontaneously, the change it undergoes appears to depend very much upon its strength. When weak, three or four days elapse before anything is noticed; a scum then collects upon the surface, and a brown flocculent substance is thrown down, which is incapable of exciting fermentation in a solution of sugar, while the liquid gives off a flat, offensive smell. If the infusion experimented on be stronger, then the change is different: the liquid becomes turbid from the separation of a yellowish adhesive substance, a good deal of gas is very slowly emitted, alcohol is formed, and the deposit at the bottom of the vessel proves a pretty active ferment to sugar. The acidity of the liquid is but trifling, and its smell is somewhat disagreeable. These differences in the behaviour of boiled wort may also depend upon the quantity of hops added and the length of time during which the ebullition had been continued.

The effect produced in a spontaneously fermentable liquid by vegetable acids, or acid salts, such as cream of tartar, is a curious subject of inquiry. From an experiment made upon some wort, it appeared not improbable that the result of such addition showed an interference in the formation of lactic acid. We know that when the juice of grapes, or currants and gooseberries, is exposed to the air, the vinous fermentation is set up apparently at once; whereas in an unboiled infusion of malt, which is destitute of these substances, lactic acid seems to be first formed, although ultimately the two fermentations go on together.

I stated, when speaking of the spontaneous decomposition of wheaten dough, that an acid state preceded that in which it became an alcoholic ferment; and if in this condition it be mixed with a dilute solution of common sugar, and the whole kept warm for several days, it furnishes a sour liquid which is rich in lactic acid, and from which white crystallized lactate of zinc is easily prepared. There is a tendency in the liquid to run into the alcoholic fermentation, and to produce vinegar by a subsequent change, but still the quantity of lactic acid so formed is very considerable.

Common wheat-gluten then in its mode of decomposition

succession through two different dynamic conditions; it is successively a lactic acid and an alcohol ferment; is it too much to expect that it might by proper means be detected in a third condition, namely, as a "sugar ferment," like diastase itself in the state in which it exists in malt? Is it not possible that diastase, as a definite proximate principle, has no more existence than yeast; that its powers are purely dynamic, and that it is, in short, nothing more than the gluten of the seed in one of its earliest stages of decomposition? This is an interesting inquiry, but its prosecution will be somewhat difficult from the rapidity with which these changes succeed each other; it must be remembered that no one has yet succeeded in getting diastase in a state fit for analysis.