

ON THE ADMIXTURE OF STARCH WITH YEAST.

By W. F. K. STOCK, F.C.S., F.I.C.

Read at the Meeting, April, 1887.

I HAVE to confess to a considerable feeling of diffidence in bringing before this Society the subject which forms the title of my paper. As a provincial, meeting but seldom with

public analysts, it may be that I shall stand in the unfortunate position of one repeating an oft told tale. If that should unhappily be the case, please bear in mind that you owe the infliction to our honoured President, at whose invitation I stand before you.

In fairness to myself, I may say that had this request come to me two years ago I should have found it exceedingly difficult to respond, for, owing chiefly to the scattered and fragmentary nature of the literature of yeast, what I know has simply grown upon me in the pursuit of business. Looking back through twenty years of the issue of the *Chemical News* I can find but one short notice of yeast manufacture and perhaps eighteen biological references, nearly all, if not all, of which are from foreign sources.

Since it is my intention to-night to treat the addition of starch to yeast as an offence against the "Food and Drugs Act," and since my utterances will probably be made public, it will be well, at the outset, to draw particular attention to the conflicting nature of statements which have from time to time been made respecting this matter. On the one hand, I have it from manufacturers and merchants that *occasionally* starch is added to yeast to the extent of from 10 to 15 per cent. On the other hand, I have heard it declared upon oath by a member of this Society that he had analysed "thousands of samples," and had sometimes found even 75 per cent. of starch present (1) but had seldom met with pure yeast.

My own experience is that out of 120 samples recently analysed 54 contained starch varying in proportion from 5 to 40 per cent. Some samples were absolutely free from starch, whilst others contained a trace, which was proved by microscopic examination to be manufacturing residuum.

Looking at the subject from a public analyst's point of view, three questions naturally present themselves for solution. We must ask ourselves:—

- 1st. Is the addition of starch to yeast a necessity?
- 2nd. If necessary, what end does it serve?
- 3rd. What is the quantitative limit?

And these questions lead directly to a fourth, which is—Does this addition come within the meaning of the Food and Drugs Act?

I do not intend to weary you with a detailed account of how I solved these problems for myself. All I need say is that I looked in vain for help from the pages of our own excellent journal. All I met with was an exceedingly great discouragement in that the only case I could find was a prosecution for yeast adulteration, which had been quietly put to rest by words of wisdom from the magistrates' clerk, who appeared to know all about it.

However, I was fortunate in being the possessor of a translation of Pasteur's admirable "Studies on Fermentation," and by diligent reading and pretty extensive microscopic observation I arrived at a certain amount of facts which emboldened me to dare the superior knowledge of magistrates' clerks. I asked for a test case to be taken. I appeared as a witness, and a conviction was obtained. Other cases followed rapidly. In one week I travelled nearly 300 miles on yeast cases alone, and the "learned brethren" made a "rough time" for me. How it all ended is plain, when I say that the justices of the county of Durham will not now tolerate adulterated yeast.

Now let me get back to my four questions:—

Is the addition of starch to yeast a necessity? My answer to this is yes and no. Yes, if the yeast is of questionable character—that is, if it be infested with ferments other than the true *torula*. No, if it be an honest, healthy crop.

What end does the added starch serve? Well, in my experience, it serves the very pious end of making bad yeast look like good, and it probably impedes the movements and development of the lactic bacterium and kindred organisms. Unhappily, it does but lay them by the heels for a time. If it killed them outright, we should have cause to be thankful.

What is the quantitative limit? I feel unwilling to answer this question, for, after hearing sworn testimony to the finding of 75 per cent., it might prove erroneous to put it anywhere within 100 per cent.

The fourth question, as to the capacity of the Act to deal with this fraud, is squarely answered by a long and growing list of convictions in my own county.

Before proceeding to speak of the methods I have adopted for the analysis of starched yeast, permit me, for a moment, to deal with the social bearings of my subject. There are here involved questions of health which are in importance far superior to that of the petty fraud committed in the substitution of cheap starch for the more expensive yeast. So far as my experience goes, starch has the effect of making yeast presentable to the eye when it is absolutely unfit for use. Good bread cannot be made from bad yeast, and whatever deteriorates the staple food of a people deteriorates also the social condition of that people.

I come now to the analysis of yeast under the "Food and Drugs Act, 1875." I think I am safe in saying that methods hitherto published are not entirely satisfactory, but in presence of a company of trained analysts I am clearly open to correction. But I believe I may say, without fear of contradiction, that a trustworthy, *direct* method is still a desideratum among analysts.

In my own practice I have met with only four or five varieties of starch in yeast, which I now mention to you in the order of the frequency of their occurrence, namely:—Potato starch, maize starch, rice starch, arrowroot and buckwheat starch. The two last named are rare, and, indeed, I have some doubt about the buckwheat. It is difficult to differentiate this starch from rice starch.

Perhaps the simplest method that ever suggested itself for the separation of starch from yeast is that of deposition from a dilute aqueous diffusion, and if carried out in a special manner, it leaves, with potato and arrowroot starches, nothing to be desired. But with maize starch, rice starch, or buckwheat starch, it is quite impracticable, owing to the fact that the rates of deposition of these three are more or less coincident with the deposition rate of yeast itself. Numerous experiments have shown this to be beyond question.

The matter stands quite differently with potato starch and arrowroot, and since potato starch is at present the commonest adulterant of yeast, I have been led to adopt the following method for its determination. The sample is broken down and well mixed; 25 grammes are weighed on a pair of fine scales; the weighed portion is transferred to a glazed mortar, and gently rubbed down with 50 c.c. of cold water to a smooth cream, then washed carefully into a *clean* 30 oz. beaker. Next 5 grammes of pure potato farina are treated in exactly the same way, and transferred to a second

clean 30 oz. beaker. The contents of both beakers are now diluted rapidly, with a strong stream of water from the town supply (which is made to issue through a $\frac{1}{4}$ -inch glass nozzle attached by I-R. tubing to the tap) until the column of liquid in each is four or five inches in height, which height must be constant for both, and is best marked for guidance. The beakers are now allowed to stand at perfect rest until the one containing the P. starch only has suffered complete deposition. Both are now carefully decanted, and the water quickly rushed up again to the mark. This is repeated until the rate of deposition for each is alike when it is only necessary to decant the perfectly clean water from the beaker which contained the sample, wash out the starch on to a filter, allow to drain, wash twice with strong alcohol, once with ether, and dry gradually, finishing at 100° C. When dry the starch is swept off the filter paper into a counterpoised watch-glass, and weighed. Yeast mixed with arrowroot is dealt with exactly as above, with the precaution only of using arrowroot starch for a standard of deposition. After weighing, the only further step to be taken in the case of unmixed starch residues is to correct for loss on drying at 100° C. I have found, by two concordant experiments, that air dried potato starch loses 16·50 per cent. of its weight, when heated for two hours in the water-bath, and two concordant experiments gave 15·04 per cent. loss for arrowroot. If it be found that the dried residues are contaminated with matters not starch, such as malt dust, rye awns, or mineral matters, the necessary corrections must be made. The *modus operandi* of these corrections is obvious.

I have here the details of two experiments made by this method with mixtures of pure yeast, and potato starch and arrowroot respectively in known proportion.

	Potato Starch.	Arrowroot.
Grammes of yeast taken	20·00	20·00
„ starch	5·00	5·00
Percentage of starch	<u>20·00</u>	<u>20·00</u>
	Potato Starch.	Arrowroot.
Grammes of dry starch recovered ..	4·126	4·181
Add, for loss in drying at 100° C. ..	·815	·737
Grammes of air dried starch recovered	<u>4·941</u>	<u>4·918</u>
Percentage of starch found in mixture	19·764	19·672
Percentage of total starch recovered	98·82	98·36

As before stated, maize, rice, or buckwheat starches are not amenable to treatment by deposition. After many trials I have been compelled to resort to micro-methods for their quantitative estimation. A preliminary micro-examination having indicated the presence of one of these starches I proceed as follows :—

Five grammes of the sample are weighed out, brought to a smooth paste in a glazed mortar with the addition of a little water. The mixture is now gradually diluted until it measures 200 c.c. A drop of the well-stirred mixture is transferred by aid of a glass rod to a micro-slide having a glass slip cemented along one edge. A minute drop of solution of iodine in aqueous—not alcoholic—solution of potassic iodide is next added,

and the whole is now evenly mixed with the rod by strokes alternating at right angles, taking care not to carry the liquid beyond the limits of the cover glass, which I prefer of an inch square in size. The cover glass is now placed in position, and lifted rapidly four or five times with a mounted needle, after which the slide is examined with a quarter inch object, and B eyepiece giving 360 or so diams. The iodised granules stand out in fine relief, and in the case of maize are easily counted. Rice is more difficult to manage owing to the greater number of granules, but I have had a special eyepiece prepared, which has two fine lines crossing at right angles in the centre of the field-lens, thus dividing the field into four equal segments. This little modification has been a great comfort in counting. This counting I perform over ten distinct fields, and thus get a fair average. I then repeat the whole of these very simple operations with a mixture of genuine yeast, and the same variety of starch, which starch I add to the extent of 20 per cent. It is only necessary to do this once for all, if fixed conditions as to weight of sample, bulk of liquid, size of rod, and area of cover glass, along with degree of amplification, are observed. The standard once established serves for all proportions. I state this as the result of experiment, in proof of which take the following:—Two mixtures of rice starch with yeast were made; one contained 20 per cent. starch; the other was made with yeast, already known to contain about $1\frac{1}{2}$ per cent. of starch, to which 10 per cent. further was added. On counting by the foregoing method, 1502 granules were found in ten fields of the 20 per cent. mixture, and 844 granules for ten fields of the 11.3 per cent. mixture—giving in round numbers an average respectively of 150 and 84 per field. Then if $150 = 20$ per cent., $84 = 11.2$ per cent.—a result which, considering all things, is sufficiently gratifying.

There is just one other point I should like to touch upon in conclusion, and I mention it to put analysts upon their guard in cross-examination. I have found sometimes that samples of yeast taken from the same consignment, and out of the same batch, will vary in their content of starch by perhaps 5 per cent., giving rise apparently to serious discrepancies in analyses. This occurs chiefly with potato starch, and it is due to the fact that in the manufacture of mixed yeast, the starch and yeast are pumped into the filter press simultaneously from the mixing box, and, as we have seen, the starch deposits, and so the tail end of the batch is apt to get an accumulated dose of starch.

DISCUSSION.

The PRESIDENT said this was just an instance of the advantages afforded by the Society. They here had a member who had had special experience in his district of an article which had been neglected in others, and it was very important that his special experience should be laid before the Society, in the form of a paper, as had been done. He would ask any other gentleman who had had any experience with it to express his opinion on the plan adopted by Mr. Stock, and to make any comments on the amount of starch, if any, which could be tolerated.

Mr. HEHNER said: I would like to have seen some information as to the reasons which induce Mr. Stock to say that there is no use or necessity for the presence of starch in yeast, and why he asserts it to be only required in yeast of bad quality. I may state that my experience is diametrically opposed to that of Mr. Stock. Some

years ago I made many practical experiments with yeast, and found that with some yeasts, and those the most active and powerful, it was impossible to bake a good loaf of bread, until a large proportion of starch had been added, with a view to dilute the yeast and diminish its activity. Indeed the better the yeast and the quicker its action, the greater was found the necessity of the addition of a neutral body. The bakers are accustomed to add a certain quantity of yeast to a given amount of flour, and they cannot be induced to diminish the quantity of yeast in proportion to its activity; it is not reasonable to expect them to have an analysis of the yeast before their mind's eye. With yeast we expect to get a certain effect; the effect only is aimed at; I should say, if a sample containing 90 per cent. of starch did its work properly and well, it should be permitted in preference to a pure but weak article. I would of course oppose any deception in this matter, but analysts, as such, are not, in my opinion, in a position to judge of the requirements of the baker. The activity of a yeast in breadmaking depends greatly upon the temperature at which the yeast has been cultivated. As these temperatures vary in the case of brewers or distillers' yeast, or that specially bred for the purpose, the activity must be controlled by the addition of judicious quantities of starch.

Mr. HARVEY said that in Canterbury yeast was sent out perfectly pure, and with no starch added. He apprehended that the consistency of it had something to do with what Mr. Hehner had said. The yeast goes out in a massive state, requiring a knife to cut it. He was not aware where it went to, nor whether bakers did anything with it.

Mr. STOCK, in reply, said that Mr. Hehner had really touched the gist of the whole matter when he said that brewers' yeast could not be used without some intermediate cultivation, but he thought Mr. Hehner had missed the object of his paper.

If any analyst were not to oppose this sort of thing he did not quite see where they were getting to. Mr. Hehner had stated that if 90 per cent. of starch were necessary it was a fair thing to add that quantity, but he differed from Mr. Hehner.

Some which he examined contained no starch whatever, but the question was how were they to prevent the unnecessary addition of starch, unless the Sale of Food Act could take knowledge of it?

There was another point from the bacteriological point of view. In samples of yeast containing starch that merchants had sent him he found that the bacteria had multiplied by thousands, and the yeast was absolutely unfit for use. How far was that sort of thing to be allowed to go on?

Of course he did not say that starch was injurious in yeast.
