BIOCATALYTIC ACTIVATORS SPECIFIC FOR THE YEAST FERMENTATION OF MALTOSE*

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(Received for publication, February 20, 1937)

It has long been the generally prevailing belief that maltose is fermentable by yeast only after hydrolytic conversion to glucose by the enzyme maltase present either in the yeast or in the substrate, or both. This viewpoint has, however, been challenged by certain workers, including Willstätter and Stiebelt (1), Willstätter and Bamann (2), and Sobotka and Holzman (3), whose observations indicate that preliminary hydrolysis to glucose is not necessarily an essential requirement in maltose fermentation.

Yeasts show a wide range of maltase activity, and maltase is considered to be extremely unstable. Harding and Nicholson (4) reported that bakers' yeast loses its maltase activity almost completely after standing a few days at room temperature. Sandstedt and Blish (5) found bakers' compressed yeast frequently deficient in its ability to ferment pure maltose, and that this ability decreased with age and with elevation of storage temperature. They also found, however, that the lack or the loss of the yeast's power to ferment pure maltose, alone, did not significantly impair its ability to ferment maltose as produced by diastasis in wheat flour paste or dough.

Using a special manometric technique, Sandstedt and Blish (5) showed repeatedly that in a diastatically active flour-water paste containing 3 to 5 per cent of yeast the rate of gas production was the same for 15 to 20 day-old samples of yeast as for a fresh sample.

* Published with the approval of the Director as Paper No. 197, Journal Series, Nebraska Agricultural Experiment Station, Lincoln.
The deficiency frequently shown by bakers' yeast in fermenting pure maltose, when acting upon it alone, in contrast to its ability to ferment maltose without difficulty when in contact with a diastatically active flour paste or dough, permits only one reasonable conclusion. The flour must have furnished a factor or combination of factors without which the yeast could not ferment maltose effectively. Tests for maltase activity in the flour, alone, gave negative results. A sample of flour was then rendered enzymatically inert by suspension for 1 hour in dilute HCl, followed by washing with strong alcohol, neutralization, and drying. This flour, when doughed with an old yeast, showed completely negative fermentation. Fermentation was, moreover, so slight as to be almost negligible in the case of pure maltose alone, in contact with the yeast. Nevertheless, an active fermentation occurred when the same yeast was added to a mixture of the inactivated flour and pure maltose.

It was concluded by Sandstedt and Blish (5) that flour contains a yeast maltase stimulant or activator that is non-enzymic. However, it would seem equally plausible to consider that the activator is not necessarily a maltase stimulant, but that it is possibly, if not probably, a factor that induces yeast to ferment maltose directly, and without any preliminary hydrolysis to glucose. Regardless of how it functions, it serves effectively as a maltose fermentation activator or accelerator.

More recently, Genevois and Pavloff (6) also have reported the existence of a maltose fermentation catalyst in flours. They find that the amount varies with different flours, and conclude that the catalyst is probably identical with Factor Z of von Euler and Swartz (7).

The literature of recent years has recorded an enormous volume of research on yeast fermentation as influenced by a variety of catalytic factors including enzymes, coenzymes, non-enzymic accelerators, and inhibitors, among which are salts and other specific substances, some of which have not been identified. In most instances the effects of these factors have been measured and recorded in terms of CO₂ produced in the fermentation of glucose or sucrose.

The chief purpose of this communication is to report our further experiences and observations as to the occurrence and properties
of biocatalysts that are seemingly distinctive for their stimulating influence on maltose fermentation.

EXPERIMENTAL

The method used in these experiments for studying rate and degree of fermentation is essentially a manometric procedure in which the fermentations were conducted in aluminum cups of definite volume, submerged in a water bath at 30°. Each cup is fitted with a gas-tight lid carrying a mercury manometer, and fermentation rate is recorded in terms of mm. of pressure read at definite time intervals. Conditions and specifications for securing trustworthy results by this convenient procedure have been described by Sandstedt and Blish (5).

The usual practice in these studies was to use 0.3 to 0.5 gm. of bakers' compressed yeast and 0.3 gm. of maltose,¹ and all experiments involved these amounts unless otherwise specifically stated. The substance or preparation suspected of containing activator was superimposed on this mixture, the total volume of which was seldom more than 5 to 6 cc. This small volume reduces to a negligible amount the error arising from the solubility of CO₂ in the liquid medium under pressure.

Fermentation of Pure Maltose, Alone, by Bakers' Yeast—The rate and the completeness of fermentation of pure maltose, alone, by a well known brand of bakers' compressed yeast have been found to vary with different lots of yeast. With some lots there was only a negligible fermentation of the maltose, while others fermented it more completely. In nearly all instances a state of active fermentation was never reached until after an induction period of many hours. With all lots the fermentation efficiency was very low as compared with the action of the same yeasts on either glucose or sucrose. A typical instance of this is shown in Fig. 1.

Fig. 1 shows that the fresh compressed bakers' yeast was very deficient in its ability to ferment pure maltose, alone, as compared to sucrose.

Occurrence of Activator in Flour—That wheat flour contains a non-enzymic maltose fermentation catalyst has been indicated,

¹ C.P. maltose hydrate was supplied by the Pfanstiehl Chemical Company.
Activators for Maltose Fermentation

and it is of interest to know whether different flours contain the factor in equal or varying amounts. Accordingly four flours were selected, including two bakers' flours milled from hard winter wheat, one soft wheat flour, and one malt flour milled from germinated wheat. In each case the flour was extracted for 10 minutes with 3 parts of water (preliminary tests having clearly shown the flour activator to be water-soluble). In 25 cc. of extract 1 gm. of yeast was suspended, and the mixture was allowed to ferment overnight at 30° to eliminate fermentable sugars present as such in the extract. Next morning a 7.5 cc. aliquot of the sus-

![Graph](http://www.jbc.org)

Fig. 1. Comparative fermentabilities of pure maltose and sucrose by fresh bakers' yeast.

pension (equivalent to 2.5 gm. of flour and 0.3 gm. of yeast) was added to 0.2 gm. of pure maltose, and the rate of fermentation was studied by the usual manometric procedure. Blank determinations without maltose gave negligible values. The results are shown graphically in Fig. 2.

From the comparative fermentation rates shown in Fig. 2, it is apparent that flours vary appreciably as to the quantity or potency of activator, as also reported by Genevois and Pavloff (6), and it is evident that malted wheat flour contains much more of it than ordinary flour. In the case of the malted flour activator
the maltose was completely fermented in 5.5 hours, whereas in all other instances fermentation was incomplete even after 8 hours.

**Some Properties of Activator As Found in Malted Wheat Flour**—Some difficulties were experienced in attempts to prepare the malt flour activator in highly concentrated form, reasonably free from contaminating substances, for the purpose of determining its properties. The best preparation was one obtained by extracting malted wheat flour with dilute HCl at pH 2 (the purpose in using acid was to destroy enzymic activity), neutralizing the acid, centrifuging, and adding alcohol to about 75 per cent concentra-

![Diagram](image)

**Fig. 2.** Comparative amounts of activator in different flours

tion. The filtrate from the alcohol precipitation was evaporated under reduced pressure, taken up with a little water, and treated with a large excess of acetone. The precipitate, after drying with acetone and ether, contained a large amount of activator, together with a considerable quantity of fermentable substance. No convenient method of separating the activator from these and other contaminating materials was found, although we have made no serious or systematic effort to isolate and identify the active substance.

Results of a few experiments intended to disclose some of the
more important properties of the activator, as found in wheat flour, can be briefly summarized as follows: It is soluble in water. It is not effectively extracted by alcohol, although in water solution alcohol does not precipitate it until an alcoholic concentration of approximately 90 per cent by volume is reached. It is readily precipitated by acetone. It was found to be completely stable to exposure for 20 minutes in an autoclave at 15 pounds of steam pressure. After dialysis overnight in tap water the activity was greatly reduced, indicating that the factor is dialyzable and therefore presumably of relatively small molecular size. The activator, in water solution, showed evidence of being strongly adsorbed by colloidal ferric hydroxide. These properties are indeed suggestive of Factor Z of von Euler and Swartz (7), as noted by Genevois and Pavloff (6).

**Occurrence of Activators in Yeasts and Yeast Preparations**—We have made no serious effort to determine the extent to which maltose fermentation activators occur in biological materials of widely different type and origin. We did find appreciable amounts in navy beans, in young wheat leaves, in horse serum, and in eggs. Of the materials thus far studied, certain dried yeast and zymin preparations have afforded the most convenient and effective sources of the activating factor or combination of factors. Several commercial samples of dried yeasts were tried (two were brewers' yeasts and another supposedly dried bakers' yeast) and all were found to be effective, but in varying degrees.

One of the most potent sources of activator was afforded by drying some ordinary bakers' compressed yeast which in its fresh condition was conspicuously lacking in ability to ferment pure maltose. The addition of a small quantity of the dried yeast enabled the fresh yeast to ferment pure maltose rapidly and almost completely. Within certain limitations the method of drying the yeast was not a factor of critical importance.

A commercial sample of zymin (Eimer and Amend) was found to be highly potent. Among the less effective of the yeast preparations were those made by autolysis processes, including treatments, respectively, with toluene, chloroform, acetone, ethyl acetate, etc.

Fig. 3 shows comparative stimulating effects of several dried yeast preparations. In each case the fermenting medium con-
sisted of 0.3 gm. of maltose, 0.3 gm. of fresh yeast, and 0.3 gm. of the activator substance, with 5 to 6 cc. of water. The fermentations were conducted in a 30° water thermostat. It was, of course, necessary to run a blank determination on each preparation, with maltose left out of the mixture.

![Activator Supplements Graph](image)

**Fig. 3.** Acceleration of maltose fermentation by dried yeast preparations

A value of 225 mm. of mercury (after subtraction of the blank) is the highest obtained from 0.3 gm. of maltose in any of these experiments, and this value may be conveniently designated as the optimum yield of carbon dioxide.

From an inspection of Fig. 3 it is evident that the fresh yeast was able to ferment pure maltose actively and readily only when supplemented by some stimulating substance contained in the
dried yeast preparations. When corrections for the blank values are applied, all combinations gave the optimum yield in 5 to 6 hours with the single exception of Supplement A, which fell only slightly short.

The significant variable among the different dried yeast products is the induction period, or the time interval elapsing before active fermentation begins. With Supplements A, B, and C (Fig. 3) fermentation did not reach the active stage until approximately 1.5 hours had passed, whereas with Supplements D, E, and F active

The significant variable among the different dried yeast products is the induction period, or the time interval elapsing before active fermentation begins. With Supplements A, B, and C (Fig. 3) fermentation did not reach the active stage until approximately 1.5 hours had passed, whereas with Supplements D, E, and F active fermentation began without appreciable delay. Once active fermentation had started, the fermentation rates of Supplements B and C were not significantly different from those of Supplements D, E, and F. This suggests the probable existence of more than one stimulating factor, one of which is effective in eliminating or greatly reducing the induction period, while the other is concerned with the maintenance of a reasonably rapid rate of fermentation after the process is once initiated.

The blank values, with the exception of the laboratory-dried bakers' yeast, were small. That the high blank value for the laboratory-dried bakers' yeast was due to the filler ordinarily

<table>
<thead>
<tr>
<th>Preparation</th>
<th>CO$_2$ pressures at successive time intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 hrs.</td>
</tr>
<tr>
<td>A. Fresh yeast alone</td>
<td>9</td>
</tr>
<tr>
<td>B. Brewers' Yeast-Harris</td>
<td>2</td>
</tr>
<tr>
<td>C. Mead's brewers' yeast powder</td>
<td>1</td>
</tr>
<tr>
<td>D. Dried bakers' yeast (filler-free)</td>
<td>2</td>
</tr>
<tr>
<td>E. Commercial zymin</td>
<td>3</td>
</tr>
<tr>
<td>F. Zymin 1*</td>
<td>3</td>
</tr>
<tr>
<td>&quot; 2*</td>
<td>4</td>
</tr>
<tr>
<td>A+D. Fresh yeast supplemented by dried yeast</td>
<td>203</td>
</tr>
</tbody>
</table>

* The acetone-dried preparations were kindly furnished by Dr. E. I. Fulmer, Iowa State College, Ames.
contained therein is evidenced by the fact that a much smaller blank was obtained in the case of some specially purchased filler-free bakers' yeast.

Is the stimulating effect of the dried yeast preparations distinctly a supplementary effect, or will these preparations, by themselves, actively ferment pure maltose? In Table I are presented data showing typical observations of the rates at which several of these preparations, respectively, ferment pure maltose by themselves, as compared with their activities when used in conjunction with fresh yeast.

The data in Table I show that the efficiencies of the dried yeast products, respectively, in fermenting pure maltose were similar to that of fresh yeast, and that in every case an induction period of many hours elapsed before active fermentation occurred. With the combination of fresh and dried yeast, however, (see Preparation of A + D) fermentation started without delay and was nearly complete in 2 hours.

Effect of Varying Quantity of Activator—The effect upon rate of maltose fermentation of varying quantity of activator was noted in the case of the commercial zymin and of dried bakers' compressed yeast, these preparations, respectively, being superimposed in varying amounts upon mixtures containing 0.3 gm. of fresh yeast and 0.3 gm. of maltose. Comparative fermentation rates are indicated in Table II.

### Table II

**Maltose Fermentation Rates As Influenced by Varying Amounts of Activator**

<table>
<thead>
<tr>
<th>Activator</th>
<th>CO₂ pressures at successive time intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>½ hr.</td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>A. Commercial zymin</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>B. Commercial dried yeast</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
</tr>
</tbody>
</table>
It is apparent from the values given in Table II that for Activator A, within wide limits, the stimulating effect on fermentation is not proportional to the amount used, although the larger quantities do significantly increase the initial fermentation rate. In the case of Activator B, which had a much longer induction period than A, quantity variations from 0.3 to 1 gm. were without significant effect.

Properties and Identities of Maltose Fermentation Activators in Dried Yeast Preparations—From the foregoing experiments the obvious conclusion is that the drying of yeast induces the formation of one or more factors that stimulate to a remarkable degree the maltose-fermenting capabilities of fresh bakers' yeast. The likelihood that there is more than one of these factors has been suggested in the discussion of data presented in Fig. 3.

It has been indicated that the maltose fermentation activator found in wheat flour might be identical with von Euler's Factor Z, and the same should reasonably be assumed for at least one of the dried yeast factors. Assuming two types of activators in dried yeast preparations, one type conspicuous for its ability to eliminate the induction period, experiments were designed to disclose, if possible, any distinctive differences in the properties of the two types.

Stability toward heat (boiling in water) and dialyzability were properties suggestive of the likelihood that the wheat flour activator is identical with Factor Z, but with dried yeast preparations, however, boiling in water—in fact, moist heat at a temperature far below 100°—rapidly destroyed much of their effectiveness as accelerators of maltose fermentation. Especially prominent was the destructive effect upon the particular factor that is responsible for the elimination of the induction period. This seems to show that dried yeast contains an active maltose-fermenting accelerator that is distinct from Factor Z, since the latter is known to be resistant to boiling water temperature. A means for the identification and measurement of Factor Z is to observe the extent to which the substance in question, after boiling, is capable of accelerating the fermentation of glucose or sucrose, by fresh yeast. It was therefore considered of interest to compare the accelerating effects of the dried yeast activator, both before and after boiling, on sucrose and maltose fermentation, respectively. Typical data obtained from this series of studies are given in Table III.
Both dried yeast preparations showed marked ability to accelerate the fermentation of sucrose by fresh yeast, but this stimulation of sucrose fermentation is by no means as striking as the effect upon maltose fermentation.

Boiling treatment of the dried yeast preparations strongly inhibited their power to accelerate maltose fermentation, this effect being far more drastic for the zymin than for the dried compressed yeast. It is highly significant, however, that the boiling treatment did not appreciably impair the ability of either of the activator substances to accelerate sucrose fermentation. This, seemingly, is conclusive evidence that, in addition to von Euler's Factor Z, the dried yeast preparations contained a catalyst that is specific for maltose fermentation. The latter, in contrast to Factor Z, is destroyed by boiling. It may, for convenience, be tentatively designated as Factor M.

That Factor M is not a definite and exclusive chemical entity, having constant properties irrespective of origin or source, is

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**Table III**

*Acceleration of Maltose and Sucrose Fermentation by Boiled and Unboiled Dried Yeast Preparations*

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Substrate</th>
<th>CO₂ pressures at successive time intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>½ hr.</td>
</tr>
<tr>
<td>A</td>
<td>Maltose</td>
<td>5</td>
</tr>
<tr>
<td>&quot;</td>
<td>Sucrose</td>
<td>23</td>
</tr>
<tr>
<td>B</td>
<td>Maltose</td>
<td>33</td>
</tr>
<tr>
<td>&quot;</td>
<td>Sucrose</td>
<td>51</td>
</tr>
<tr>
<td>C</td>
<td>Maltose</td>
<td>43</td>
</tr>
<tr>
<td>&quot;</td>
<td>Sucrose</td>
<td>44</td>
</tr>
<tr>
<td>B₁</td>
<td>Maltose</td>
<td>6</td>
</tr>
<tr>
<td>C₁</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>B₂</td>
<td>Sucrose</td>
<td>49</td>
</tr>
<tr>
<td>C₂</td>
<td>&quot;</td>
<td>48</td>
</tr>
</tbody>
</table>
Activators for Maltose Fermentation

evidenced by the fact that the activator found in malted wheat flour is far more stable toward heat, as well as toward other treatments, than the one present in certain dried yeast preparations. The latter is injured not only by boiling, but also by exposure to alcohol. It is only partially dialyzable, and only partially extractable with water. When a portion of the commercial zymin was electrodialyzed, much of the Factor M was destroyed, although the liquid in the cathode compartment was found to contain considerable activity.

It is, of course, possible that the presence of certain unrecognized inhibitors may have played a prominent part in some of the phenomena herein discussed, and that this has led to some misinterpretation. Several attempts to inquire into this possibility gave negative results, however. Control of hydrogen ion concentration did not appear to be an issue of serious consequence.

Only a few pure chemical substances were investigated as to their possible stimulating effects upon maltose fermentation by fresh yeast. These included varying quantities of cysteine, cystine, glutathione, and monobasic ammonium phosphate, respectively. None gave significantly positive results.

Effect of Dried Yeast Activator on Completeness of Sugar Fermentation—The calculated theoretical yield of CO₂ from a specified quantity of sugar is usually not realized in ordinary yeast fermentation. In experiments with pure glucose and sucrose it was consistently observed that the addition of activator to the fresh yeast and sugar accomplished more than a mere acceleration of fermentation rate. There was also a very substantial reduction of the "fermentation deficit," i.e. the difference between theoretical and actual yields of CO₂. For sucrose our calculations—based upon volume and temperature considerations—indicated that 0.3 gm. should give a pressure of about 282 mm. of mercury, assuming complete conversion to CO₂ and alcohol by fermentation. With 0.3 gm. of fresh compressed yeast, together with the activator supplement, final pressures averaging 253 mm. were reached, indicating approximately 90 per cent of the maximum theoretical yield. This value was consistently obtained, within a small factor of error, with amounts of dried yeast preparations varying from 0.2 to 2.0 gm. With 0.3 gm. of fresh yeast alone, and the same quantity of sucrose, closely agreeing values averaging 214
mm. were obtained, indicating that alcoholic fermentation was only 76 per cent complete. From these values of 90 and 76 per cent it may be calculated that without the activator the fermentation of sucrose was only 85 per cent as efficient as with the activator. It must be presumed from the data given in Table III that for sucrose fermentation Factor Z, not Factor M, is the activator responsible for the increased total CO₂ production, because this particular potentiality was not impaired by the boiling treatment which was highly destructive to Factor M.

Convenient Method for Preparation and Use of Sugar Fermentation Activators—Several readily available sources of Factor M have been discussed. It is perhaps safe to expect that all dried or autolyzed yeast preparations containing Factor M will also contain Z, but the reverse of this is certainly not true, as in the case of boiled zymin. Accordingly, since Factor Z of yeast is much more stable than Factor M, the production and preservation of Factor M is the critical feature of any procedure in which both types of biocatalysts are desired.

To obtain highly active preparations of Factor M from fresh yeast, the yeast must be dried but not overheated while moist. Any method in which the fresh yeast is autolyzed, i.e. putting it on a steam bath or in a hot air oven, must be avoided. If dried in the vacuum oven, fairly high temperatures may be used. A highly satisfactory and simple procedure is to crumble up a quantity of compressed filler-free yeast, spread it over a flat surface, and use an overhead heater, with a current of air supplied by a fan. If stirred occasionally, complete drying is accomplished in 3 or 4 hours. This dried yeast need not be finely ground, because it readily disintegrates in water suspension.

Dried yeast thus prepared contains an appreciable amount of fermentable substance, which may either be fermented out or corrected for by blank determinations. If made into a paste or batter with water and allowed to stand a few hours, the small quantity of fermentable substance is disposed of and the yeast is redried by the method already described. When maximum accuracy is desired, it is advisable to run blank determinations with fresh yeast and activator, alone, with each series of tests.

Detection of Activators in Biological Material—The simple and obvious method for identification of fermentation activators in
biological substance is to ferment, under comparable and controlled conditions, two samples of the material, one in the presence and the other in the absence of activator substance, i.e. the dried yeast preparation. If the material under consideration is deficient in activator, we can expect the added dried yeast preparation significantly to increase both the speed and completeness of fermentation, the degree of response indicating the extent of the deficiency in the material itself. If, on the other hand, the material itself contains activator, this should be indicated by either a negative or an insignificant response in the test in which the dried yeast activator preparation was added.

As illustrative of two types of biological products, one containing fermentation activators while the other is lacking or deficient in this respect, we may consider carrots on the one hand and molasses on the other. Under comparable conditions, when tested both with and without the dried yeast supplement, fermentation tests on these two materials gave, respectively, the results typified in Table IV.

In Table IV it is seen that in the case of the carrot sample the supplementary effect of added activator on both rate and completeness of fermentation was insignificant as compared with the effect upon the molasses. This is interpreted to mean that the carrot material, itself, contained sufficient activator to render unnecessary any addition of the dried yeast preparation.

On the other hand the molasses was highly deficient in this

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**TABLE IV**

**Comparative Effects of Activator on Fermentation of Different Types of Biological Material**

0.5 gm. of yeast was used.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Weight of sample</th>
<th>Activator</th>
<th>CO₂ pressures at successive time intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gm.</td>
<td>mm. mm. mm. mm. mm. mm. mm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gm.</td>
<td>Hg Hg Hg Hg Hg Hg</td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td>1</td>
<td>0.5</td>
<td>168 278 288 291 291 291</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>166 286 295 295 296 296</td>
</tr>
<tr>
<td>Molasses</td>
<td>5</td>
<td>0</td>
<td>97 140 151 160 165 168</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.5</td>
<td>135 176 181 180 192 192</td>
</tr>
</tbody>
</table>
respect, for without added activator its rate of fermentation was much slower, and the final yield of carbon dioxide was about 87 per cent of the yield when supplemented by the dried yeast activator. This value of 87 per cent assumes added significance when it is recalled that the final carbon dioxide yield for pure sucrose without added activator was approximately 85 per cent of the yield obtained in the presence of the activator substance.

Findings of this character indicate the importance of insuring the presence of an adequate amount of these biocatalytic factors in technological studies involving the quantitative estimation of sugars by fermentation methods. A knowledge and appreciation of the properties, use, and control of these biocatalysts should prove of value in the further improvement and establishment of such fermentation methods. From the standpoint of convenience and simplicity, alone, the tremendous advantages of the type of fermentation procedure used in these studies justifies every effort to establish the conditions and limitations under which such methods are applicable and trustworthy. Suggested possibilities for the use of this type of method in studying amylase activity appear in papers, respectively, by Schultz and Landis (8), Schultz and Kirby (9), Sandstedt and Blish (5), and Sandstedt, Blish, Mecham, and Bode (10). Further studies are in progress.

SUMMARY

Fresh bakers' compressed yeast is usually strikingly deficient in its ability to ferment pure maltose, alone, as compared with maltose in the presence of other biological substances.

Flour (especially from malted wheat) and dried yeast preparations, respectively, contain accelerators that are specific for maltose fermentation and that are distinctive for the ability to (1) eliminate or greatly shorten the induction period, (2) increase fermentation rate, and (3) reduce the "fermentation deficit."

The maltose fermentation accelerator (Factor M) in dried yeast preparations is sharply distinguishable from Factor Z of von Euler by its great instability toward heat and toward alcohol.

An understanding of the properties and the capabilities of fermentation activators is highly important in the development and use of fermentation methods for the quantitative estimation of sugars, and for the study of phenomena associated with amylase.
Activators for Maltose Fermentation
activity. The manometric yeast fermentation technique affords an extraordinarily simple and convenient procedure for technological studies of this character.

BIBLIOGRAPHY

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