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in conjunction with

INTERNATIONAL ASSOCIATION FOR CEREAL CHEMISTRY: GROUP 30†

AN EVALUATION OF TWO SIMPLE METHODS FOR THE MEASUREMENT OF FERMENTING POWER OF BAKER'S YEAST

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Report prepared for publication by Prof. F. Parisi

INTRODUCTION

IUPAC Information Bulletin No. 37 recorded the work done by this Commission (at that time the Fermentation Industries Section) during 1965-1968 on the evaluation of active dry baker's yeast.

The progress report recommended continuing the evaluation which was of interest to the manufacturers of the baker's yeast, to large and small bakers and also to the national and supernational authorities. In addition the International Association for Cereal Chemistry (ICC) created a Working Group (No. 30, now 'yeast properties'), which dealt with the methods of analysis for baker's yeast. As the first project, they chose to develop a simple method for determining the fermentation power of baker's yeast and the limits for its use in baking.

The Working Group of ICC took into consideration the work previously done by IUPAC, and the two associations decided that they would cooperate in the execution of the work. Close cooperation was accomplished as some members of the IUPAC Fermentation Section were also members of Group 30 of the ICC.

ICC dealt with the development of a second investigation, two simple methods: one was based on the use of flour and the amount of gas developed (from now onwards called method 1) prepared by Ir. Greup of the Gist-Brocades nv. Delft., the second was based on the increasing volume of a semi-synthetic dough made of starch, carob flour and a pure sugar (sucrose or maltose), from now onwards called method 2, studied by Schulz and Coll.

Comparisons of the two methods were made by laboratories in many countries.

A sample of dried yeast supplied by Gist-Brocades nv was distributed after a draw among the available dried yeasts, as a standard yeast sample. Each laboratory was asked to carry out 5 tests each of these methods with the standard yeast sample. 53 laboratories were asked to take part in the research; the 34 that sent their results in time are listed in Appendix 3. The results obtained were statistically evaluated according to the recommendations of Group No. 29 of the ICC ('Statistical evaluation of Collaborative Tests'). The data were examined and discussed by Group 30 of the ICC and by the Fermentation Commission of the IUPAC.

RESULTS AND CONCLUSIONS

The statistical analysis of the data is summarised in Appendix 4. Although the results exhibit a high degree of variation, in the absence of more precise methods we recommended that the methods and results be published to demonstrate the present state of the art. Further experimental work is required to improve the methods. Nevertheless they may be used, in spite of the high degree of variation, to compare the performance of a sample with a predetermined limit for baking. The methods are described in Appendices 1 and 2. For method 2 the use of sucrose for 150 minutes is preferred (Appendix 4).

A limited test showed that the variability of results of method 2 were not affected if an identical sample of carob flour was used by different laboratories.

A second interesting result was obtained by a French and by two Italian laboratories: instead of dried yeast they used a sample of fresh yeast which was carried by plane from Paris to Milan. The coefficient of variation fell to less than 10%, suggesting that part of the errors were due to some variability in the rehydration of the dried yeast.

The Group will continue research to confirm and improve these results.

APPENDIX 1. Determination of gas produced during the fermentation of a wheat flour dough by Baker's yeast

Method 1

1. Apparatus

1.1 Mixer: Conventional experimental dough mixer designed to mix a quantity of dough between 100 and 500g flour.

1.2 Thermostatically controlled water bath capable of maintaining a temperature of $30^{\circ}C \pm 0.1^{\circ}C$.

1.3 Standard gas burette of 100 ml connected to an expansion vessel.

1.4.1 Round-bottomed and wide-mouthed flask of 250 ml , or

1.4.2 Cylindrical reactor with a round-bottom and a plane joint of 250 ml.

1.5.1 Rubber stopper with an opening for outlet and rubber or plastic hose for connecting the round-bottomed flask (1.4.1) to the gas burette (1.3).

1.5.2 Cover of reactor with a plane joint and a Torion 8 mm, with outlet and rubber or plastic hose for connecting the reactor (1.4.2) to the gas burette (1.3) and closing device.

1.6 Balance sensitive to 0.1g.

1.7 Balance sensitive to 0.01g.

1.8 Thermometer ranging from 0-50°C, calibrated in °C.

1.9 Minute timer.

2. Ingredients

2.1 Commercially available white wheat flour with an ash content of 0.50-0.55% plus compulsory mineral addition (to specify).

2.2 Salt: Fine granulated NaCl.

2.3 Baker's Yeast: pressed or active dry.

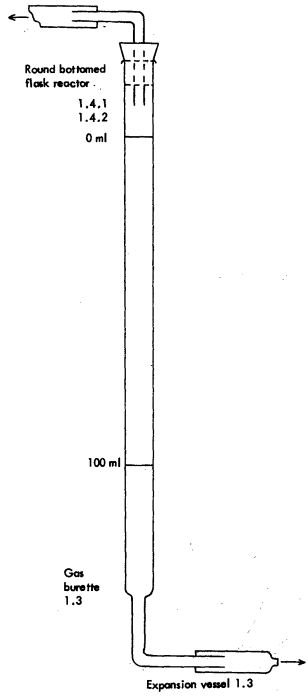
2.4 Water: from the tap.

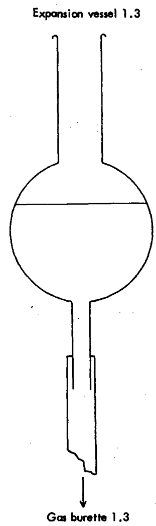
2.5 Saturated solution of NaCl for the gas burette.

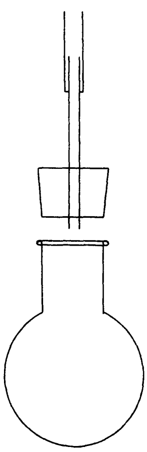
3. Method

3.1 Dough formula:

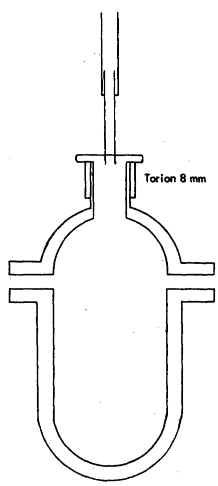
Flour	100.0g
Salt	2.0g
Pressed yeast	1.5g
Water	variable (from 50 to 60 ml)







Round bottomed and wide mouthed flask of 250 ml with one hole rubber stopper (1.4.1 and 1.5.1)



Round bottomed reactor vessel of 250 ml with plane joint end and its cover

DETERMINATION OF GAS PRODUCED DURING THE FERMENTATION OF A WHEAT FLOUR DOUGH BY BAKER'S YEAST

3.2 Method:

Final dough temperature should be 30°C, so adjust initial temperature of flour and water, taking into account room temperature and heat generated during mixing.

3.2.1 With pressed yeast:

Take care that yeast weighed on balance (1.7) to an accuracy of 0.01g be transferred totally in the kneader together with the other ingredients.

Mix ingredients, adding a sufficient, measured, amount of water to bring the dough to the desired consistency.

Carefully note the time of commencement of mixing or use the minute timer.

Mixing time depends upon the type of mixer used but should not exceed 10 minutes.

Immediately after mixing is completed, remove dough from the mixer, weigh out 50g and transfer this dough piece on a sheet of aluminium.

With the help of this sheet work the weighed dough in order to be able to introduce it easily in the round-bottomed flask or in the reactor (1.4.1 or 1.4.2) held in the water thermostatically set at 30°C ± 0.1°C.

Exactly 15 minutes after commencement of mixing connect the flask or the reactor to the gas burette with the appropriate device (1.5.1 or 1.5.2), the gas being filled with a saturated solution of salt. The level of the burette solution must be exactly adjusted to 0.

After 60 minutes, viz 75 minutes after the commencement of mixing, read the total volume of gas released by bringing to the same height the level of the saturated solution in the gas burette and that in the expansion vessel.

3.2.2 With active dry yeast:

Weigh out 0.8g of active dry yeast to an accuracy of 0.01g.

Proceed with the rehydration of active dry yeast according to the instructions given by the producer.

Add the rehydrated yeast suspension to flour in the mixer and proceed as in 3.2.

3.3 Remarks:

3.3.1 As the dough contains a limited amount of baker's yeast and is allowed to ferment for only 60 minutes the limiting factors for optional fermentation are avoided.

3.3.2 When active dry yeast is used it is necessary to take into account the water quantity used for rehydrating the latter in order to determine the amount necessary for obtaining a desired consistency of dough.

3.3.3 If fresh baker's yeast and active dry yeast are to be compared one with another with the above method, it is necessary to introduce in the dough of fresh yeasts the same amount of sugar as that used for rehydrating the active dry yeast according to the producer's instructions.

3.4 Expression of results:

3.4.1 From the measured volume (V ml) of gas released by 50g of dough in the presence of pressed yeast, calculate the gas amount released by 1g of pressed yeast in taking into account the total dough weight (P g = the sum of quantities of ingredients used).

Amount of gas released during 1 hour by 1g of pressed baker's yeast:

$$\frac{V \times P}{75} \quad \text{ml}$$

3.4.2 From the measured volume (V ml) of gas released by 50g of dough in the presence of active dry yeast, calculate the gas amount released by 1g of active dry yeast in taking into account the total dough weight (P g = the sum of quantities of ingredients used).

Amount of gas released during 1 hour by 1g of active dry yeast:

$$\frac{V \times P}{40} \text{ ml}$$

APPENDIX 2. Determination of gas produced by Baker's yeast from the fermentation of sucrose or maltose added to a starch dough and retained in the latter

Method 2

1. Apparatus

1.1 Laboratory kneader.

1.2 Calibrated cylinders of 2 litres graduated in 20 ml, with the following approximate sizes: inner Ø : 82 mm - outer Ø : 85 mm - height (for 2 litres) : 405 mm.

1.3 Water bath set at $30^{\circ}C \pm 1^{\circ}C$.

1.4 Technical balance (1 kg, graduated in 0.1g).

1.5 Graduated balance sensitive to 0.01g.

1.6 Thermometer ranging from 20 to $50^{\circ}C$ (graduated in $^{\circ}C$).

1.7 Minute timer.

2. Ingredients

2.1 Corn starch.

2.2 Carob flour.

2.3 Sucrose (or food grade white sugar), maltose (analytical grade).

2.4 Water.

2.5 Yeast sample.

3. Method

3.1 Fresh yeast:

Mix (200 impulses) 500g of corn starch with 400 ml water at about $40^{\circ}C$ to obtain a dough to which are added:

15.0g of carob flour
25.0g of sucrose or maltose
12.5g of pressed fresh yeast

The water temperature must be adjusted so that once dough is mixed its temperature is $30^{\circ}C \pm 1^{\circ}C$.

Weigh this dough and part it into two equal pieces of 400g and place them in graduated cylinders preheated to $30^{\circ}C$ in the water bath (assays in duplicate).

The dough surface is smoothed by hand and cylinders are immersed in water bath. Mark the time or start a minute timer.

Every 15 minutes read the dough heights on the graduated scale (avoiding parallax errors). The volume increases are carefully noted for a 2½ hour period. They give the amount of gas produced and retained under the defined experimental conditions.

3.2 Active dry yeast:

Weigh out 6g of active dry yeast and put in a starch dough after they have undergone the appropriate rehydration treatment described by the producer.

3.2.1 The amount of water used for the rehydration of active dry yeast must be taken off the 400 ml water intended for making dough.

3.2.2 If the rehydration is done in the presence of a sugar, this sugar must be the same as that put in the starch dough for measuring the fermentative power. The sugar amount used for rehydrating must be taken off the sugar amount to be added to the starch dough.

4. Expression of results

Results may be expressed graphically for each yeast sample. For a given yeast, results are to be summed up in a chart or in a diagram on scale paper.

If wished the results may be referred to 1g of fresh or dry yeast dividing the values respectively by 5.25 or 2.25. It is not recommended however to use 1g of yeast and correspondingly smaller amounts of ingredients for the test, this may give rise to further errors.

APPENDIX 3. List of participating laboratories

1. The Agricultural Institute, Kinsealy Research Centre, Dublin (Ireland).
2. Bread Research Institute of Australia, North Ryde (Australia).
3. Bundesforschungsanstalt fur Getreideverarbeitung, Detmold (German Federal Republic).
4. De Danske Spritfabrikker, Kobenhagn (Denmark).
5. Deutsche Hefewerke GmbH, Hamburg (German Federal Republic).
6. Prof. ir. A.R. Deschreider, Laboratoire Central-Adn. de l'Industrie, Bruxelles (Belgium).
7. The Distillers Co. (Yeast) Ltd., Morden, Surrey (Great Britain).
8. Ecole national superieure de meunerie et des industries cerealieres, Paris (France).
9. Eridania Zuccherifici Nazionali, Genova (Italy).
10. Prof. R.J. Ertola, La Plata (Argentine)
11. Etablissements Fould-Springer, Maisons-Alfort, Val de Marne (France).
12. Fachschule Richemont, Luzern (Switzerland).
13. Finnish State Alcohol Monopoly, Helsinki (Finland).
14. Flour Milling and Baking Research Association, Herefordshire (Great Britain).
15. Gist-Brocades N.V., Yeast Division, Delft (Netherland).
16. Jugoslovenski Institut Za Prehrambenu Industriju, Novi Sad (Yugoslavia).
17. JYDSK Teknologisk Institut, Arhus (Denmark).
18. Institute for cereals, flour and bread TNO, Wageningen (Netherland).
19. Institut fur Getreideverarbeitung, Bergholz-Rehbrucke (German Democratic Republic).
20. Institut fur Lebensmitteltechnologie-Getreidetechnologie, Berlin (German Federal Republic).
21. Istituto dos Cerais, Lisboa (Portugal).
22. Laboratory of the Government Chemist, London (Great Britain).
23. Prof. R. Lambion, Bruxelles (Belgium).
24. Migros-Genossenschaftsbund, Zurich (Switzerland).
25. "Mlinpek", OOUR "Hleb", Laboratorija, Novi Sad (Yugoslavia).
26. Mlinsko-pekarska industrija-Laboratorija, Beograd (Yugoslavia).
27. Norsk Cerealinstitutt-ved Statens Teknologiske Institutt, Oslo (Norway).
28. Research Institute for Alcohol Inudstry, Budapest (Hungary).
29. Societe Industrielle Lesaffre, Marcq-En-Baroeul (France).
30. Statens Kornforretuing, Oslo (Norway).
31. University of Galatz-Faculty of Food Industries, Galatz (Romania).
32. Versuchsanstalt der Hefeindustrie e.v., Berlin (German Federal Republic).
33. Vinal SpA, Casteggio, Pavia (Italy).
34. Zitoprodukt, Laboratorija, Zrenjanin (Yugoslavia).

APPENDIX 4. Statistical Analysis of Interlaboratory Comparisons of Methods 1 and 2

method	no. of labs involved	coeff. of variation in each lab		test for homogeneity no. of labs passing the test (*)		max. coeff. of variation reached in the labs of the 1st group	min. coeff. of variation reached in the labs of the 2nd group	mean	real value of standard deviation at 5% prob. of error	coeff. of variation among labs	conf. limits of coeff. of variation
		min	max	1st group	2nd group						
1	31	±0.63%	±13.69%	16	14	±4.67%	±7.36%	176 193	35 0 25 49 0 35	±16.5% ±21.6%	19.9÷14.2% 25.4÷18.1%
2 sucrose 60min	22	±0.62%	±18.54%	18	4	±5.39%	±5.47%	578	167 0 119	±24.1%	28.9÷20.5%
2 sucrose 150min	22	±0.47%	±12.24%	21	1	±7.25%	±12.24%	1188	183 0 135	±13.0%	15.4÷11.4%
3 maltose 150min	11	±0.68%	±5.42%	9	2	±2.15%	±2.81%	1288	349 0 219	±21.0%	27.1÷17.0%

(*) The results were divided into two groups on the basis of the Cochran variances homogeneity test. Any possible difference between the sum of the results and the number of labs involved is caused by a non-homogeneous result.