VERSUCHSANSTALT DER HEFEINDUSTRIE E.V.

Test Report

VH Berlin Standard Operating Procedure SOP H 04 dough raising Comparison of VH Berlin standard equipment with the ANKOM^{RF} Gas Production System

Test Dates: **21.03.2011 - 15.04.2011**

Scope

The Versuchsanstalt der Hefeindustrie (VH, Research Institute for baker's yeast) ran a test to see if the ANKOM^{RF} Gas Production System can be used for the dough raising capacity determination of baker's yeast *Saccharomyces cerevisiae* (SOP H 04). The results were compared to the standard VH equipment SJA Fermentograph.

The SOP H 04 procedure is certified by DAkkS, Deutsche Akkreditierungsstelle (national accreditation body of the Federal Republic of Germany) according to DIN EN ISO/IEC 17025:2005.
Dough raising tests are standard for all baker's yeast producing companies, as it is the main quality parameter for baker's yeast. The baker's yeast industry is an old industry with internal corporate standards that have often been established for decades. The VH chose to perform the tests according to the Brabender Method [2] on the SJA Fermentograph. Along with the Risograph™, the SJA is one of the most widely used pieces of equipment for doing dough raising tests within yeast companies. The ANKOM^{RF} Gas Production System has already been compared to the Risograph™ by the VH for other methods.

1 Material and methods

General consideration

Because the pressure does not rise during fermentation, the SJA is considered to be an open system. Figure 1 shows the schematic design of the Fermentograph.

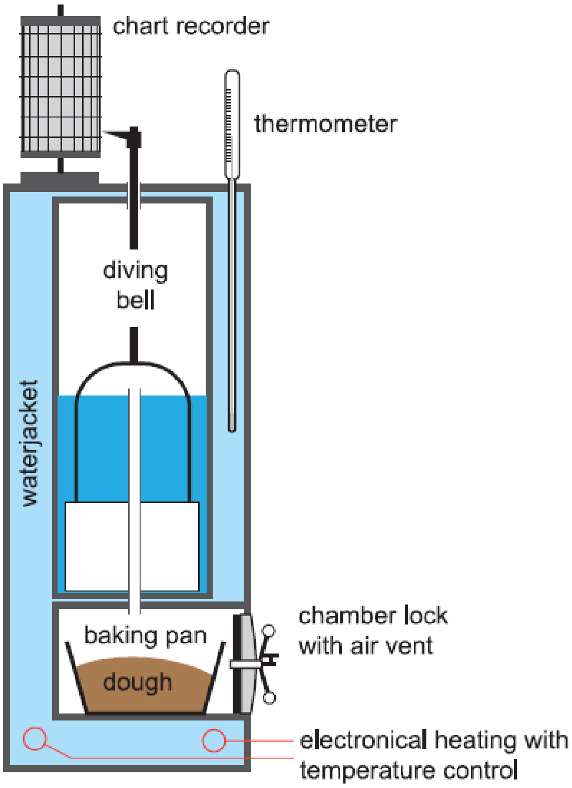

Fig. 1: SJA Fermentograph in principle

The dough is filled into a baking pan and the fermentation chamber is locked tight. The evolving gas lifts up the diving bell and records the gas production in ml over the fermentation time using a rotating chart recorder.

To compare the results from the different testing systems, it is necessary to use the ideal gas equation for the conversion between pressure rise (as measured by the ANKOM system) and ml CO_2 (as measured by the SJA Fermentograph).

$$p \times V = n \times R \times T \qquad \textbf{[Ideal gas equation]}$$

p = pressure [Pa]
V = volume [l]
n = amount of substance [mol]
T = temperature [°K]
R = gas constant [8,314472 J/(mol*K)]
Molar gas volume CO_2= 24,87 l / mol (V = (T x R)/p; T=303°K, p= 101,3kPa)

As a model, the dough density was set as 1 [g/cm³] → $\mathbf{V_{Headspace} = V_{total} - V_{dough} = constant}$

The ANKOM[RF] Gas Production System has an adjustable pressure release level that can be configured through the software. For our comparison with the SJA the ANKOM pressure measurement module was adjusted to a pressure release of 138 mbar above atmospheric pressure (see settings Tab. 1). During a previous test, we were able to verify that this pressure level has no influence on the gas production of the dough.

1.1 Experimental set up

A standard ANKOM[RF] Gas Production System consists of up to 50 pressure measuring modules that connect to narrow mouth glass bottles with volumes between 250 ml and 1000 ml. For easier handling of large dough portions, VH developed a prototype adapter that allowed the ANKOM pressure measuring modules to connect to 1.85 L glass jars with a wide mouth opening of 8.5 cm. Figure 2 shows a picture of the prototype system used in a water bath at 30°C (at least 1 h before start and during measurement the bath was covered with a Styrofoam lid to ensure temperature consistency). The dough temperature was checked during the fermentation with a thermometer directly in the dough. The pressure measurement modules are also equipped with temperature sensors.

Fig. 2: Experimental set up for dough testing at the VH Berlin using ANKOM pressure measurement modules with prototype adapters connected to 1.85 L glass jars.

The prototypes were tested on gas tightness at a pressure range up to 500 mbar (7.25 PSI) overpressure.

1.2 ANKOM^{RF} Gas Production System settings

One of the features of the ANKOM RF Gas Production System is the ability to configure system settings for specific tests. For our testing we used different system settings to determine which ones were best for the dough raising method. The settings shown in Tab. 1 were used for most of the tests. Tests comparing the influence of different pressure release levels and valve opening times were presented at a lecture and on a poster at the 2011 VH Yeast Conference in Potsdam, Germany [1].

Tab. 1: Settings for the ANKOM system for high gas production rates

Parameter Name	Value	Units
Live Interval	1	[s]
Pressure Release	138	[mbar]
Recording Interval	15	[s]
Valve Open Time	1000	[ms]

1.3 SOP H 04 Determination of the baker's yeast raising power by using the Brabender method on the SJA Fermentograph

The SOP H 04 is used to determine the CO_2 that is produced over a period of 120 min in standardized dough. The dough is prepared according to the VH SOP H 04. In order to obtain comparable results between two doughs from identical yeasts, doughs are prepared and kneaded with a Brabender Farinograph to a viscosity of 500 +/- 50 FU (Farinograph units).

Standard dough:
300g tempered all-purpose wheat flour
4.5g common salt (solved in water)
7.5g fresh yeast with 30% dry substance (re- suspended in tempered water)

Sugar dough:
300g tempered all-purpose wheat flour
4.5g common salt (solved in water)
45g sucrose (solved in water)
7.5g fresh yeast with 30% dry substance (re-suspended in tempered water)

For both dough types: All solutions are prepared with tap water. Addition of potable water until a dough viscosity of 500FU (+/- 50 FU) is reached.

By using the standard recipe, dough with a mass of approx. 470g was obtained. For single run experiments, 350g of dough was used. Further tests were run with 100g dough portions (SJA and ANKOM, 2 portions each).

For comparative tests, several doughs were prepared. Table 2 gives a test overview. In order to cover a broad range of CO_2 production levels, standard commercial yeasts from different suppliers and dry substances and instant active dry yeasts (IADY) were tested as a fresh sample and after a storage time of 1 week at 25 °C for fresh yeast (1 week at 43 °C for dry yeast). These storage times simulate the end of the freshness date range.

Tab. 2: Table of experiments with different dough portion sizes and yeast storage time.

Yeast	Dough portion	Dough type	Fresh / stored	Number of runs	
				SJA	Ankom
H 12162	350g	Standard	Fresh	1	1
H 12161	100g	Standard	Fresh	2	2
H 12167	350g	Standard	Fresh	1	1
H 12167	100g	Standard	Fresh	2	2
ADY 1682	350g	Standard	Fresh	1	1
ADY 1682	100g	Standard	Fresh	2	2
H 12162	350g	Standard	Stored	1	1
H 12161	100g	Standard	Stored	2	2
H 12167	350g	Standard	Stored	1	1
H 12167	100g	Standard	Stored	2	2
ADY 1682	350g	Standard	Stored	1	1
ADY 1682	100g	Standard	Stored	2	2

Tab. 3: Table of experiments: Comparison between 350g SJA and 60g ANKOM[RF] Gas Production System

Yeast	Dough portion	Dough type	Fresh / stored	Number of runs	
				SJA	Ankom
H12097	60g	Standard	Stored	2	1
H12098	60g	Standard	Stored	2	1
H12098	60g	Sugar	Stored	1	1

2 Results

2.1 Reproducibility

The dough portions with a mass of 100 g were run in duplicates in the SJA and the ANKOM instruments. Figure 3 shows the reproducibility of the ANKOM[RF] Gas Production System (readings every 60 s) and Figure 4 shows error bars for the SJA tests (readings manually every 30min).

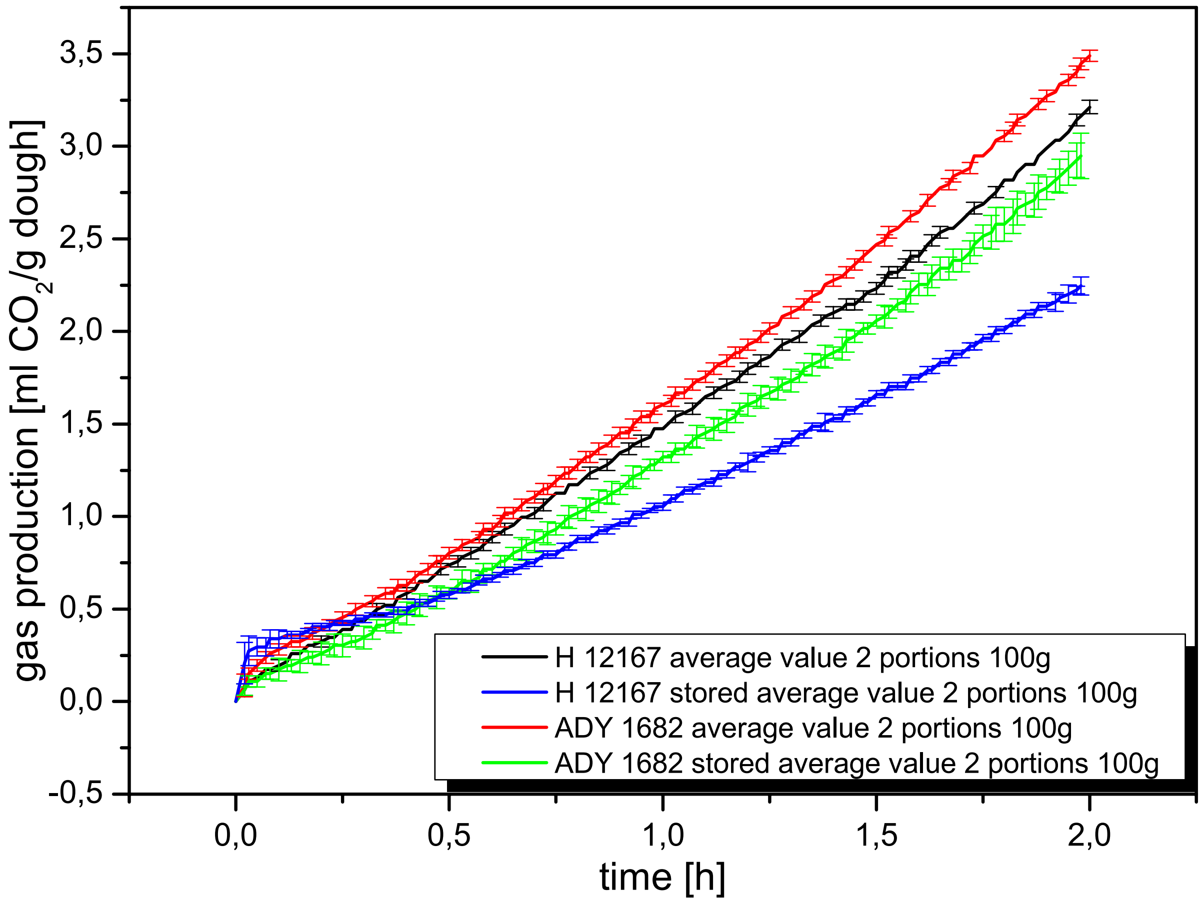

Fig. 3: Gas production [ml CO_2 / g dough] over time for different yeast-dough-systems. Dough portion sizes 100 g with doughs run in duplicates. The ANKOM[RF] Gas Production System was used as the measuring system.

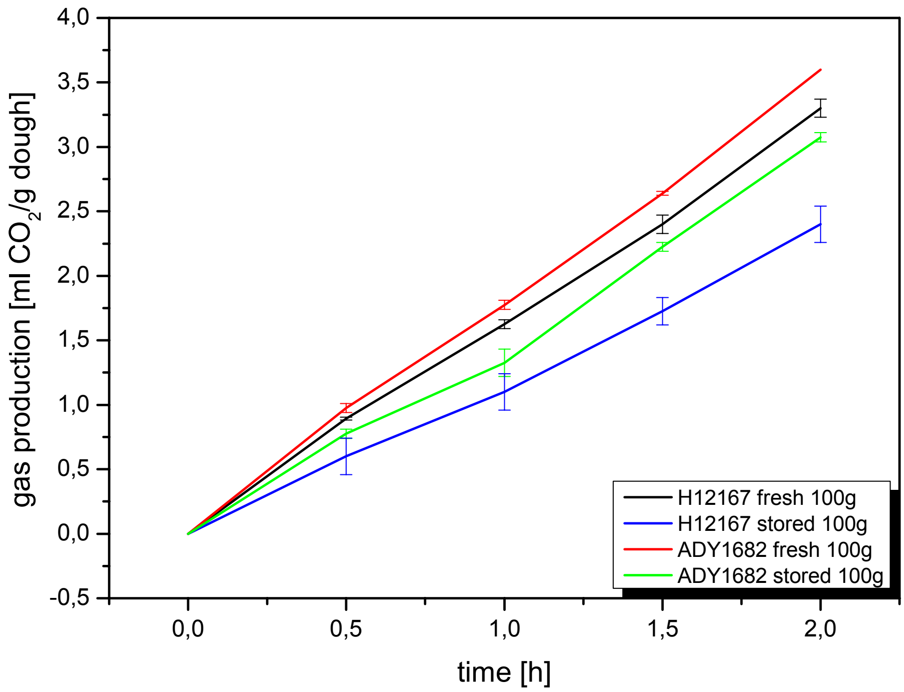

Fig. 4: Gas production [ml CO_2 / g dough] over time for different yeast-dough-systems. Dough portion sizes of 100 g with doughs run in duplicates. The SJA Fermentograph was used as the measuring system.

Tab. 4: Reproducibility for the ANKOM and the SJA System.

Yeast	ANKOM				SJA			
	ml CO2 / g dough in 2h	standard deviation	Srel [%]	Δ CO_2 [ml]	ml CO2 / g dough in 2h	standard deviation	Srel [%]	Δ CO_2 [ml]
H12167 fresh	3,21	0,04	1,12	3,59	3,30	0,07	2,14	10,00
H12167 stored	2,25	0,05	2,20	12,20	2,40	0,14	5,89	20,00
ADY 1682 fresh	3,49	0,03	0,88	4,50	3,60	0,00	0,00	0,00
ADY 1682 stored	2,95	0,12	4,16	13,00	3,08	0,04	1,15	5,00

Table 4 indicates that the ANKOM and SJA systems both show a high reproducibility between two samples from the same origin. For the ANKOM^{RF} Gas Production System the maximum deviation between samples run as duplicates was 13 ml. For the SJA the maximum deviation between two channels was 20 ml.

2.2 Direct comparison of the dough raising systems

As indicated in Tab. 2 and Tab. 3 different dough portion sizes were prepared and compared.

60g samples in ANKOM glass bottles vs. 350g samples in SJA

For the 60g dough samples a glass bottle with a total volume of 305 ml was used. Three doughs were run in parallel and compared to a 350g dough sample in the SJA.

Tab. 5: Direct comparison 60g dough portions in a standard ANKOM glass bottle with a 350g dough portion in the SJA System.

Time [h]	SJA H12097 std wdh	Ankom H12097 std wdh	SJA H12098 std wdh	Ankom H12098 std wdh	SJA H12098 sugar wdh	Ankom H12098 sugar wdh
	ml CO_2 / g dough	ml CO_2 / g dough	ml CO_2 / g dough	ml CO_2 / g dough	ml CO_2 / g dough	ml CO_2 / g dough
0,0	0,00	0,00	0,00	0,00	0,00	0,00
0,5	0,80	0,52	0,24	0,10	0,13	0,08
1,0	1,79	1,29	0,63	0,38	0,20	0,15
1,5	3,23	2,13	1,21	0,87	0,34	0,28
2,0	4,07	3,12	1,94	1,48	0,54	0,46

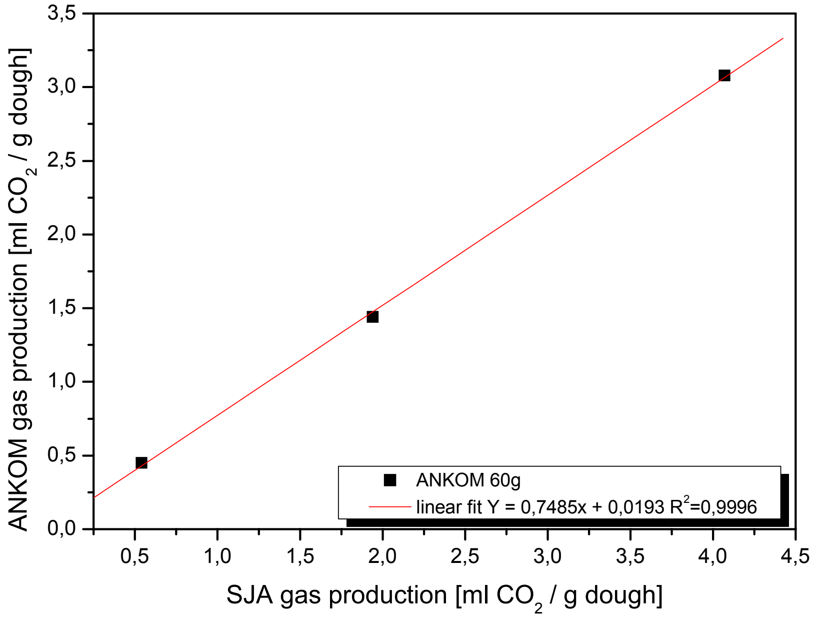

Fig. 5: Gas production [ml CO_2 / g dough] for a 60 g dough portion in the ANKOM^{RF} Gas Production System [ml CO_2 / g dough] and for a 350g dough portion in the SJA. Doughs for ANKOM and SJA were from the same portion.

The comparison between the SJA machine with 350g dough portions and the ANKOM system with 60 g dough portions gave a very good correlation. The final values of the ANKOM results set in the equation of the linear fit and matched the SJA values exactly.

Data correlations

For this comparison different dough portions were prepared and run on the ANKOM and SJA systems. The correlation of the 100g dough portions were taken from a single dough piece (best reproducibility). For the comparison of 100 g dough versus 350 g dough it was necessary to produce 2 dough pieces. These tests were run on VH prototypes for dough testing as described in section 2.1.

As seen in Tab. 6 and Fig. 6, the correlation is dependent on the dough portion size.

Tab. 6: Linear correlations for the different experimental set-ups (dough portion sizes) and linear equation for all doughs tested (see Fig. 6 and Fig. 7).

SJA [g dough]	ANKOM [g dough]	Head Space ANKOM [ml]	Correlation	
350	350	1500	y = 0,888x - 0,0532	R^2 = 0,9923
350	100	1750	y = 0,9481x + 0,0595	R^2 = 0,9895
100	100	1750	y = 1,0882x - 0,4083	R^2 = 0,9983
100	350	1500	y = 0,8989x - 0,2892	R^2 = 0,9881
350	60	245	y = 0,7485x + 0,0193	R^2 = 0,9996
all	all		y = 0,8826x - 0,0034	R^2 = 0,9062

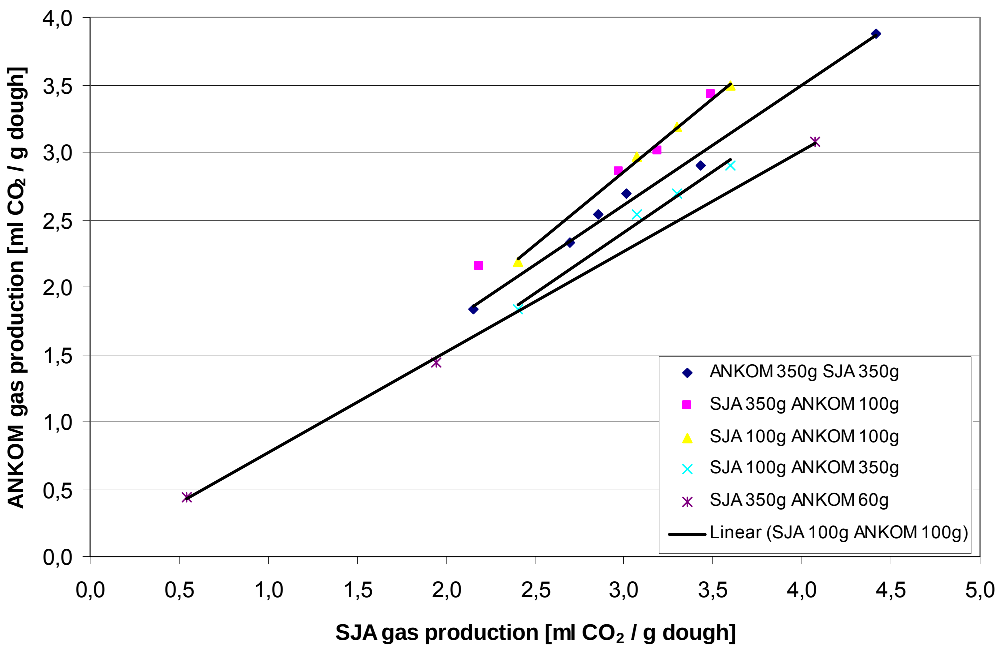

Fig. 6: Gas production [ml CO_2 / g dough] in the ANKOM^{RF} Gas Production System over gas production [ml CO_2 / g dough] and in the SJA. Dough portion sizes were grouped and the linear fit was calculated. Values are displayed in Tab. 6

There is a linear correlation between the two different measuring systems. Figure 7 shows the overall correlation for all doughs measured. Although the coefficient of determination (R^2) is not as good as the ones for specific test setups, the results are sufficient.

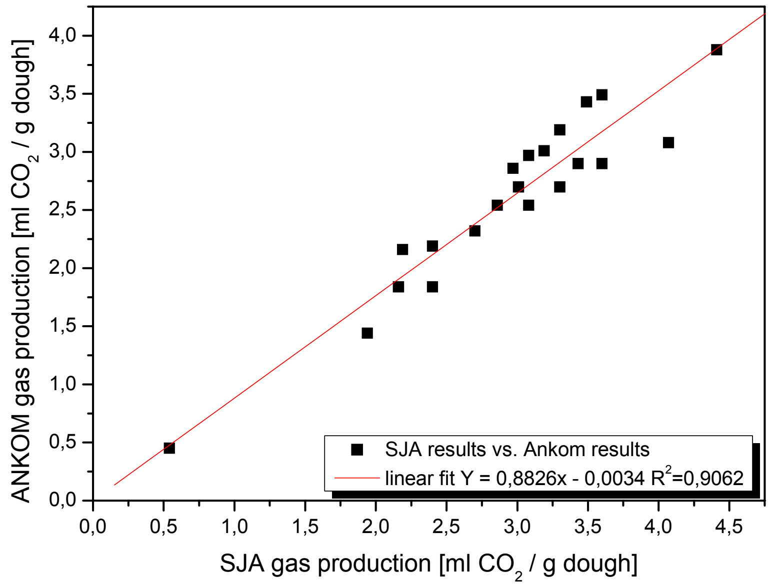

Fig. 7: Overall correlation for all doughs measured with both systems.

2.3 Influencing parameters

During testing the following two parameters were detected that can influence the dough raising measurement independently of the testing system.

1. Dough kneading between two measuring cycles (necessary in the SJA for yeasts with a gas production >1000ml in a 2 h period) increased the gas production.
2. The dough portion size had an effect on the gas production (both for the ANKOM and the SJA-systems).

Results regarding these effects can be found on the poster presented at the 2011 VH Yeast conference in Potsdam, Germany [1].

Conclusion

There is a direct linear correlation between the ANKOM[RF] Gas Production System and the SJA. The correlation is strongest when comparing specific dough sizes as opposed to comparing multiple dough sizes together in an overall correlation. Therefore it is recommended to correlate the systems using a direct dough size comparison.

The dough raising test is affected by various factors including kneading the dough half way through the test and dough portion size. These factors should be studied further.

The VH Berlin can recommend the ANKOM^{RF} Gas Production System as a tool to determine the dough raising power. The tests were mainly performed with prototype wide mouth bottles, because some of the dough portion sizes we used fit better in larger wide-mouth bottles.

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Appendix: List of tables and figures

Literature

[1] C. Decker, Dr. M. Quantz, B. Stadler, C. Kelley; VH Berlin standard operating procedure H 04: Dough raising power comparison between SJA and ANKOM RF Gas Production System (Poster 2011 VH Yeast conference, Potsdam, Germany)

[2] VH-Berlin Standard Operating Procedure for the determination of Yeast Raising Power, SOP H04