An updated method for pico malting of barley, improving throughput and congruency with typical micro scale malting

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137

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Introduction

Malt quality is of high importance for variety success and dictates the need for effective screening. Earlier testing and more data points could empower breeding programs for production of higher quality malt varieties. A 2011 paper written by Schmitt and Budde [1] outlined a novel approach for increasing throughput of malt quality data via pico scale maltings. Despite advantages of this method, which includes evaluation of malting lines at earlier stages in the program and across more environments, the pico method has not been adopted by most breeders. Here we present a 2020 update to the pico scale (5.6g) malting method with improved potential for throughput, reduced usage of resources, and better congruency with the methods utilized for micro scale malting (120g). Malts were produced with Custom Laboratory Prouducts (CLP) micro malters. Pico scale malts contained in loose leaf tea ball cages and ASBC methods were utilized for all malt quality evaluation. The two scales were found to have similar moisture uptake during steeping, and high correlations for each of the individual malt quality measures. This work offers updates to the previous method providing breeding programs more manageable high throughput options for evaluation.

Methodology

30 malt lines, including named and experimental lines, representing significant range for the malt parameters tested were subjected in replicate to micro (120g) and pico (5.6g) malting scales. Malting was conducted utilizing a CLP malting system. Pico scale malts were individually housed in 2" diameter loose leaf tea balls. No carrier grain was used. The micro and pico malting regimes were identical but for the kiln profile, which was slightly adjusted to dry more gently for the pico scale malts.

Variation in grain hydration causes major differences in malt quality. To ensure that the methods were well matched moisture was evaluated on replicates of all lines at steep out (48 hours into process), with a goal of reaching 45% moisture. The micro scale malts had an average moisture of 44.3% while the pico scale malts had 45.6%, a difference of 1.3%. Variation across reps was similar with the micro samples having average standard deviations of 0.003 and the pico scale samples measuring at 0.004. There was not a significant difference in moisture between the two malting scales (two-tailed, paired T-test p= 8.47), data not shown.

Malt quality analysis was performed following ASBC methods with minor modifications to accommodate the pico scale samples, and results compared for the two malting scales.

Table 1: Sample setup and malt regime comparison between pico and micro scale maltings

	Pico	Micro
Seed cleaning	Seed plumped over 6/64 sieve, Broken/badly skinned kernels removed	Seed plumped over 6/64 sieve
Sample weight	5.60g	120.00g
Steep Regime	10 h steep – 15°C 18 h rest – 15°C 6 h steep – 15°C 10 h rest – 15°C 4 h steep – 15°C	10 h steep – 15°C 18 h rest – 15°C 6 h steep – 15°C 10 h rest – 15°C 4 h steep – 15°C
Germination	96 h – 15°C	96 h – 15°C
Kilning	12 h – 60°C 6 h – 65°C 2 h – 75°C 3 h – 85°C	6 h – 45°C 6 h – 55°C 3 h – 60°C 3 h – 68°C 2 h – 80°C 2 h – 85°C

Table 2: Comparison of extraction and testing methods between the pico and micro methods

Process/Parameter	Pico	Micro
Moisture	2mL tubes, forced air drying oven	Standard tins, forced air drying oven
Enzyme Extraction	50mL tubes in IEC mash bath, filter plate filtration in centrifuge	IEC mash bath, Standard filtration
α-amylase	Same as micro	Gallery discrete analyzer
Diastatic Power	Same as micro	Gallery discrete analyzer
Wort Extraction	50mL tubes in IEC mash bath, Vacuum filtration	IEC mash bath, Standard filtration
Extract	Same as micro	AP DMA 5000 densitometer
β-glucan	Same as micro	Gallery discrete analyzer
FAN	Same as micro	Gallery discrete analyzer
Soluble Protein	Same as micro	Gallery discrete analyzer
pH	Same as micro	Accumet AB150 pH meter

Results

Malts were found to have a considerable range for each of the parameters and measured values were consistent across between the two malting scales with R2 correlation values ranging from 0.62 to 0.92.

Table 3: Malt quality evaluation of pico and micro scale malts including variance and correlation of the two methods

	Moisture %		Extract FGDB %		S. Protein %		FAN mg/L		β-Glucan mg/L		pH		α-amylase D.U.		Diastatic Power °ASBC	
	micro	pico	micro	pico	micro	pico	micro	pico	micro	pico	micro	pico	micro	pico	micro	pico
Ave	4.49	4.80	80.9	80.1	4.98	5.37	214	217	148	123	5.86	5.90	79.3	87	150	155
Range	4.19 - 5.06	4.50 - 5.29	77.1 - 84.7	76.8 - 83.6	3.72 - 6.11	4.39 - 6.18	136 - 274	162 - 279	19 - 877	20 - 545	5.67 - 6.00	5.73 - 6.00	45 - 107	54 - 121	76 - 186	81 - 200
CV	0.04	0.05	0.00	0.02	0.02	0.04	0.04	0.06	0.13	0.27	0.00	0.00	0.04	0.06	0.04	0.09
r^2	0.04		0.62		0.84		0.90		0.77		0.79		0.92		0.75	

Conclusions

The current pico method shows good consistency with micro scale maltings yet employs several time and resource saving advantages over the previously published method:

- No carrier grain utilized – a savings of time and resource.
- No handling of samples needed during malting regime to match moistures.
- Larger extractions allow reduced need for replicates, significantly cutting prep time.
- Malt moisture was evaluated here but was found to be very stable and could be skipped to further save resources.
- Extractions performed in standard lab mash bath (50mL tubes utilized for pico) – improving congruency between scales and reducing handling time.
- Utilization of a discrete analyzer allows small volume testing allowing identical testing methods between scales, rather than modified methods for pico.

These advantages make utilization of pico scale maltings much more realistic for established breeding programs and could offer key advantages in the early selection of malting quality.

Future work to incorporate even more improvements to this method include trialing different filtration procedures for the wort extracts which could improve correlation of the extract measure (r^2 = 0.62 currently), even greater time efficiency of the filtration process, and may allow the capture of greater sample volume allowing incorporation of an automated density sampler.

References

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