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Development of a new highly-sensitive method for predicting gushing potentials in beer products.

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【 Introduction 】

"Beer gushing" is an undesirable phenomenon that occurs when beer and foam forcefully erupt from a beer bottle immediately after it is opened. The majority of gushing problems are attributable to secondary metabolites of fungi that occur in malt and therefore evaluating the malt-related gushing potential is important.

Asahi Breweries, Ltd. has developed a new method for predicting malt gushing potentials, which entails a small scale (200ml) trial, mimicking actual beer manufacturing process. As a consequence, this new method was shown to detect not only the gushing determinants present in malt itself, but also the gushing risks that become apparent during the beer manufacturing process. The comparative analysis also demonstrated that Asahi's method is three times as sensitive as the modified Carlsberg method.

Our new method is useful for the highly-sensitive and comprehensive detection of malt crops with gushing potentials. Through the monitoring for each lot of malt crops, Asahi Breweries has successfully introduced a system in place that prevents the use of malt that may cause gushing in the beer manufacturing.

【 Methods 】

[Features]

・Our new method can accurately assess the risk of malt gushing despite the complex effects exerted by beer production processes.
⇒This is because the developed method simulates the actual brewing process.
・The risk of malt gushing can be detected with high sensitivity.

Table 1: Method of analysis

	Operation	Asahi method	Carlsberg method[1)]
Mashing	Milling	Fine	Coarse
	Saccharification	Congress mashing	None
	Boiling	Autoclave at 105℃ for 60 min	Boiling on a hot plate for 20-25 min
Fermentation	Fermentation	25℃ for 24 hours	None
Filtration	Cooling	Overnight at 0℃	≤20℃ for 30 min
	Filtration	**Diatomaceous earth with iron level control**＋filtration by filter paper	None
	Carbonation	Pressurized shaking	Substitution with carbonated water
Gushing potential analysis	Shaking	24 hours	72 hours
	Opening	Rest 15 min, Opening	Position for 10 min, Rotate three times within 10 s, Rest 30 s, Opening

[Points for setting the conditions of the Asahi method]

・Metal ions are well recognized as causal factors of gushing[1)].
・Metal ions are known to elute from diatomaceous earth.
⇒ In the Asahi method, diatomaceous earth is used when performing the tests, therefore the proper control of metal (iron) ions is necessary.

【 Results 】

[Effects of iron elution on gushing in our method]

・We examined the effects of iron eluted from diatomaceous earth on gushing.

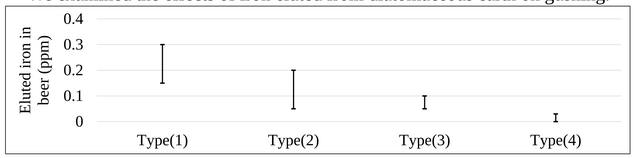

Figure 1: Differences in beer concentrations of iron eluted from each type of diatomaceous earth.

Table 2: Assessment results on iron concentration and gushing potential based on malt type differences.

	Risk of gushing	High-level iron eluting diatomaceous earth (type (1))		Low-level iron eluting diatomaceous earth (type (4))	
		Gushing (ml)	Iron (ppm)	Gushing (ml)	Iron (ppm)
Positive control	High	74	0.55	67	0.05
Malt A	High	45	—	25	—
Malt B	High	29	0.53	3	0.03
Malt C	High	10	0.39	10	0.04
Malt D	**Low**	**31**	0.45	**0**	0.05
Malt E	Low	Trace	0.44	0	0.04
Malt F	**Low**	**16**	0.45	**0**	0.04
Malt G	Low	4	0.53	Trace	0.03

Malt with iron sensitivity regarding gushing.

Table 3: Induction tests of gushing by iron addition

	Iron standard solution not added		Iron standard solution added *	
	Gushing (ml)	Added iron (ppm)	Gushing (ml)	Added iron (ppm)
Malt with metal sensitivity	0	0	10	0.80
	0	0	11	0.80
	0	0	19	0.80

* Using metal-sensitive malt (Malt D), experiments on low-level iron eluting diatomaceous earth (type (4)) was set up. At the last minute of carbonation, iron standard solution was added at the iron concentration of 0.80ppm.

As a result, the addition of iron was shown to induce gushing.

[Control of iron concentration in the Asahi method]

・To predict the gushing potential of metal-sensitive malt, diatomaceous earth was blended in a particular manner to control the concentration of iron elution from the diatomaceous earth.
・Considering the gushing risk of metal-sensitive malt, the iron concentration eluting from diatomaceous earth was adjusted at 0.05-0.10 ppm based on the iron concentrations of beers produced in various countries[2),3)].

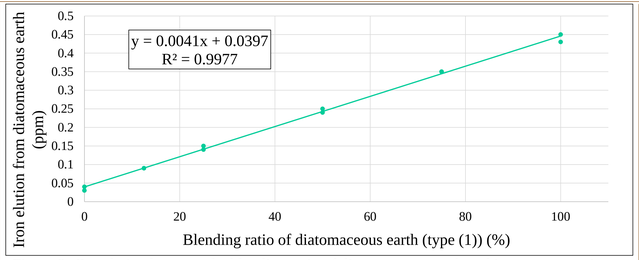

Figure 2: Correlation between the blending ratio of diatomaceous earth and iron concentration

It is possible to control the concentration of iron by blending high-level iron eluting diatomaceous earth (type (1)) with low-level iron eluting diatomaceous earth (type (4)).

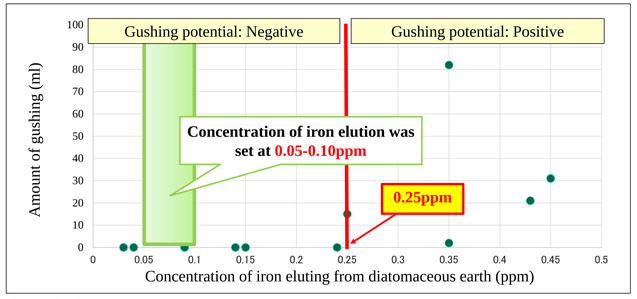

Figure 3: Correlation between iron concentration and the level of gushing.

* The correlation between iron concentration and gushing potential was examined using metal-sensitive malt (Malt D).

Gushing potentials of metal-sensitive malt differed significantly, bordering on the iron concentration of 0.25ppm.

[Sensitivity comparison of the gushing risk detection between Asahi and Carlsberg method]

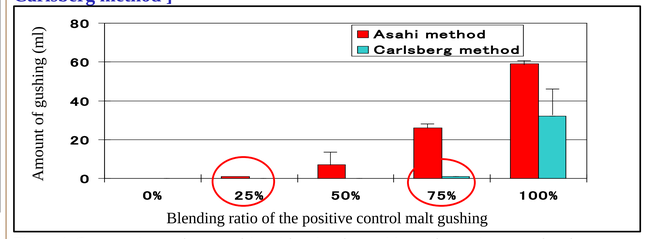

Figure 4: Comparative study on gushing risk using the positive and negative control malts.

* Blending ratios of the positive and negative controls were adjusted to perform the comparative gushing tests of the Asahi method and Carlsberg method [4)].

In the Asahi method, “gushing was detected” with a positive control malt blending ratio of 25%, Our method was three times as sensitive as the Carlsberg method that required 75% blending ratio.

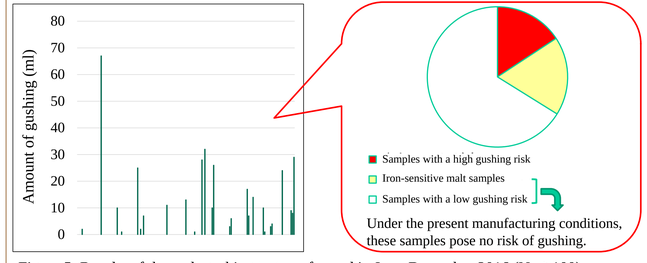

Figure 5: Results of the malt gushing test performed in June-December 2016 (N= ≥100)

*The shipping samples and positive control malt were included in the gushing test results.

Incidents of gushing problems with Asahi products: 0 case

【 Conclusions 】

•The existence of a gushing risk of metal (iron) sensitive malt was revealed.
•The concentration of eluting iron can be controlled by blending different types of diatomaceous earth.
•By controlling the concentration of iron elution from diatomaceous earth, the gushing risk of metal sensitive malt can be more accurately predicted.
•A highly sensitive gushing prediction test was successfully constructed at Asahi.
•We are now able to maintain a system whereby malt gushing risk is predicted in advance to prevent gushing incidents of products in the market.

【 References 】

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2) A. PIENDL : Brauindustrie,75 1083(1990)
3) A. PIENDL : Brauindustrie,69 1269(1984)
4) “Modified Carlsberg Test”Interlaboratory Test-February 2009,VLB

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