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23. Effect of the Composition of Steep Liquor upon Barley Malting

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There are so many works about malting. However, any remarkable studies are not pointed out on the relation between the composition of steep liquor and the nature of the malt, therefore the effect of the composition of steep liquor on barley-malting was investigated.

1. Effect of NaCl

With two volumes of water containing various concentrations of NaCl (0.0005 *m* to 0.2 *m*), barley (var. Siga Zairai) was steeped for 33 hours, and after the germination for 7 days at room temperature (20° to 22° C), green malt was dried and then ground. For determination of various enzymes, aqueous extract of the dried malt obtained was used.

Percentage of germination, amount of K_2SO_4 soluble nitrogen and albumin nitrogen in the malt, and activity of dextrinogen amylase of the malt were found to be reduced at higher concentrations of NaCl, while they were increased with 0.0005 *m* NaCl, when they were compared with the control without NaCl.

It was found that water soluble reducing sugars, total sugars, activities of invertase and maltase of the malt were reduced with the increase in NaCl concentration. Any remarkable decreasing was not pointed out at lower concentrations of NaCl on the formation of saccharifying enzyme until NaCl attained to 0.005 *m*.

Protease of the malt obtained by steeping with 0.005 *m* NaCl revealed the maximum activity, while any systematic relations were not observed between the concentrations of NaCl and catalase formation.

2. Any remarkable effect on the properties of the malt was never found by the addition of $CaCl_2$ or $Ca(OH)_2$ to the steep water to the concentrations of 0.001 *m* to 0.2 *M*.

It is interesting to note that the formation of protease was selectively decreased according to the increasing concentration of $NaNO_3$ from the experiments steeped with $NaNO_3$ (concentrations are 0.01 to 0.2 *m*), while any other properties of the malt were not altered.

3. So remarkable effect was observed on the treatment of $(NH_4)_2HPO_4$, as shown in the following table, in which activities of various enzymes of barley, steeped barley (period of germination is zero), green malts (periods of germination are 3 to 10 days) and dried malt (10 days' green malt was dried on $CaCl_2$ at reduced pressure for 7 days) were compared.

Oxygen consumption was observed by Warburg manometer at 30°C for 30 minutes with 10 corns, and the enzymatic activities in the table is also represented by the values with 10 corns.

Enzymatic activities of malts.

Barley and malt	Period of germination (day)	Oxygen consumption (μ l.)	Dextrinogen amylase (D)	Saccharogen amylase (mg. of maltose)	Maltase (mg. of reduced Cu)	Invertase (mg. of invert suger)	Catalase (mg. of H_2O_2)	Protease (mg. of Amino-N)	
Barley	—	26.3	±	179	±	±	1.5	0.14	
Steeped by	water	0	146.6	7.8	1204	±	±	9.9	0.18
		3	189.5	56.9	1473	4.4	1.5	24.5	2.80
		6	216.3	107.7	2169	6.4	14.2	156.3	2.39
		10	270.3	97.5	2208	12.6	20.9	67.5	2.79
		10 (dried)	35.1	120.8	787	5.2	6.8	52.6	4.04
	0.1 M phosphate	0	70.8	±	890	±	±	26.5	0.17
		3	161.6	55.5	1400	5.5	±	75.7	2.09
		6	175.7	120.9	2313	7.2	5.2	143.2	2.05
		10	299.3	116.7	3780	17.1	15.1	149.5	2.72
		10 (dried)	43.4	272.4	1280	8.1	8.3	13.8	4.23
	0.01 M phosphate	0	164.6	3.9	923	3.9	2.3	8.8	0.26
		3	176.1	55.5	1648	10.6	5.5	22.0	1.68
		6	237.9	88.0	2328	14.4	10.6	132.9	2.40
		10	261.3	110.0	3648	16.8	15.6	56.7	2.73
		10 (dried)	28.3	193.0	1155	6.9	5.0	20.4	4.17

A noticeable activities of dextrinizing and saccharifying powers (225% and 163% respectively) compared with ordinary dried malt steeped by water were observed with dried malt obtained by steeping with 0.1 m phosphate, while the amount of starch in the malt (20.241 g. starch in 1000 corns) was found to be superior to the ordinary malt (15.160 g. starch in the same number of corns).

Therefore ammonium phosphate would produce a favorable effect on malting, since the formation of amylase was increasing while the consumption of starch was decreasing during the malting.