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Effects of L-Cysteine on the malt quality during germination

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PURPOSE

Barley (*Hordeum vulgare L.*) is a major raw material for malting and subsequently production of beer. Malting includes the controlled germination of barley in which hydrolytic enzymes are synthesized and the cell walls, protein and starch of the endosperm are largely digested, making the grain more friable.

The main objective of this research was to investigate the effect of L-Cysteine (L-Cys) as the food additive on malt quality during germination. Barley was laboratory-germinated from 0 to 5 days with different levels of L-Cys (0 mM, 2.5 mM, 5 mM, 10 mM), and then malt quality were determined.

MATERIAL AND METHODS

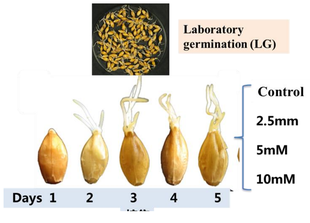

Fig. 1 The procedure of research

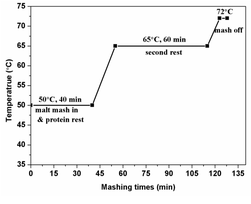

Fig. 2 Process flow diagram in mashing

- The domestic Gan 3 barley was used for both germination (Table 1).
- Grains were placed on germination paper in a Petri. Water or water with different L-Cys concentration was added to each Petri dish. Grains were germination for 5 days at 20°C (Fig. 1). Mashing was conducted as shown in Fig. 2.
- α-Amylase, β-amylase and limit dextriane (LD) were measured on a small-scale with Megazyme Cerelpha, Betamy1-5, and Limit DextriZyme (Megazyme), respectively.
- Protein molecular weight distribution analysis was determined using the Capillary Gel Electrophoresis.
- Wort sugar profile (maltotriose, maltose, glucose, fructose and sucrose) were separated using HPLC.
- Filterability performance was determined as the volume of filtered wort after 10 minutes.

Table 1. the characteristics of barley used in this study

Barley	Moisture%	Protein %	1000kernel weight g	Plump kernel ≥2.5mm %	Thin Kernel < 2.2mm %	germination rate %	water sensitivity %
Gan 3	11.8	13	41.2	89	2.2	98	4

RESULTS

The effect of L-Cys on the activities of starch-degrading enzymes

- The activities for β-amylase and LD with the addition of L-Cys were higher than control, while the activity of α-amylase was decreased compared to control (Fig. 3).
- The activity of β-amylase and LD reached the peak on the 3 day and 4 day of germination time with L-Cys addition, respectively. The germination time was shorted 2 days and 1 day for β-amylase and LD, respectively.

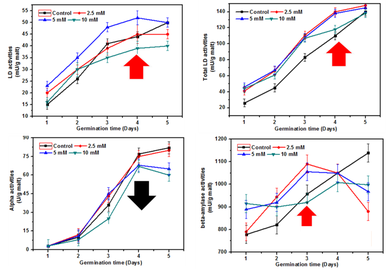

Fig.3 The effect of L-Cys on the malt amylase activities

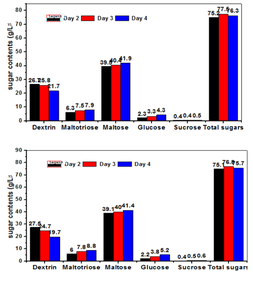

Fig.4 The wort sugar profile of malt with L-Cys addition (below)or not (Up)

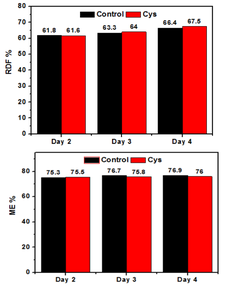

Fig.5 The wort RDF (Up) and ME (Below)

The effect of L-Cys on the wort parameters

- **Wort sugar**: Because of higher enzyme activities, the ratio of fermentable sugars of malt malted with the L-Cys was higher than the control, resulting in higher real degree fermentability (RDF). The malt extract had a slightly decrease compared to the control (Fig 4, Fig 5).
- **Wort protein and Protein molecular weight distribution** : Protein content had no difference between the malt with L-Cys or not. However, the low molecular weight (<20KDa) protein ratio and 50-100KDa protein ratio was increased and 20-35KDa protein ratio was decreased compared to the control, indicating that L-Cys activated the protein degradation and enzyme synthesis (Fig.6, Fig.7).
- **Wort filterability**: Wort Filterability performance was improved with the germination time. The malt with L-Cys showed a better filterability performance compared to the control (Table 2).

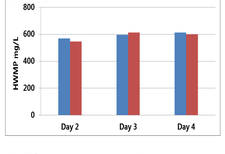

Fig.6 The wort protein content.

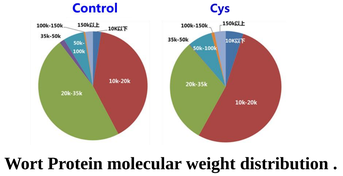

Fig.7 Wort Protein molecular weight distribution .

Table 2. The filtration volume of wort

	Control	Cys
Day 2	25 ml	35 ml
Day 3	50 ml	100 ml
Day 4	75 ml	135 ml

CONCLUSIONS

- During malting, barley seeds are germinated to promote the mobilisation of storage compounds. However, barley and malt both contain endogenous proteins (limit dextrinase inhibitor, trypsin/alpha-amylase inhibitor protein family), that inhibit the enzymatic activities, leading to low activities of enzymes. More inhibitor has disulfide bonds, the reduction of disulfide bonds can change the activities of inhibitor.
- L-Cys, can interact with proteins by splitting the disulfide bonds. From our results, L-Cys prompt the starch, protein, glucan or xylan degradation, suggesting that the reduction of disulfide bonds affects the malting process and the resultant malt quality.
- In conclusion, the reduction of disulfide bonds was important to malting quality.

FURTHER WORK

- Thioredoxin system, which was widely found in various plant species, can break the intramolecular disulfide bonds, changing the activities of enzymes either directly by reduction or indirectly by counteracting the effect of the inhibitor proteins.
- In the next, the correlation of thioredoxin content and malt quality, the change of thioredoxin content among barley varieties, the effect of malting protocol on reduction of disulfide bond, were studied further.

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