The Effect of Ultradisperse Humic Sapropel Suspensions on Grain α-Amylase Activity in Germination

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INTRODUCTION

- An ultradisperse humic sapropel suspension (UDHSS) is a colloid solution of complex composition with 86...89 nm particle size obtained by alkaline extraction and ultrasonic treatment of sapropel. The treated suspension primarily consists of humic substances, natural organic compounds that include humates, humic acids and fulvic acids, the latter being the most active among all fractions of UDHSS.
- The germination of grain is accompanied by α-amylase activation by the phytohormone gibberellin. α-Amylase breaks down stored starch into dextrins and maltose, supplying nutrition to the embryo plant.
- The effect on germination may be unstable due to differences in the structure of humic substances and the grains tested, as well as experimental conditions, including: germination in natural or artificial soil or in air with the so-called steeping water.
- Air germination with artificial humidification is mainly used for malting, which aims, among other things, to increase the activity of amylolytic enzymes. The activity of α-amylase and other malt amylases determines the speed and the degree of mash saccharification in brewing. Consequently, the earliest possible achievement of peak α-amylase activity and malting intensification are important for both the malting and brewing industries.
- This reason makes relevant a study that aims to examine the effect of humic substances contained in ultradisperse humic sapropel suspensions on the α-amylase activity dynamics and the malting process of various cereal grains.

MATERIALS AND METHODS

- Barley and wheat Leningradskaya 6 were used for malting. The steeping solution was prepared from UDHSS obtained at the Limnology Institute, Russian Academy of Science, by alkaline extraction at 40°C under the action of 35 kHz ultrasound at 2 $W \cdot cm^{-2}$pressure. The suspension was sterilized, after which its humic substances content was 30% dry matter, and the pH value was 4.50 ± 0.02.
- Both types of grains were germinated in Petri dishes at 18...20°C under natural light on filter paper wetted with UDHSS diluted to a calculated humic substance content of 1 dm^3 per 1 ton of grain, or with water for the control lots.
- Enzymatic activity was determined in aqueous extracts, for which 2.5 g crushed grains were kept in 20 ml water for 16 h at 4...5° C, and then the optical density was measured at 670 nm with a CFC-2 photometer which is the measure of intact starch, hence the lower the optical density, the deeper the starch hydrolysis due to α-amylase activity.

RESULTS AND DISCUSSION

- The measured values for barley and wheat grains are given in Tables 1 and 2, respectively.

TABLE 1. Average optical density of barley grain extracts

Sample Name	Day 1	Day 2	Day 3	Day 4
UDHSS Treated	0.059	0.068	0.069	0.018
Control	0.061	0.058	0.084	0.050

TABLE 2. Average optical density of wheat grain extracts

Sample Name	Day 1	Day 2	Day 3	Day 4
UDHSS Treated	0.089	0.093	0.093	0.091
Control	0.089	0.088	0.089	0.090

- While in barley grains the amylolytic activity obviously rises at the fourth day of germination and dissolves a significant portion of starch, in wheat grains the enzymatic activity unexpectedly remains stagnant as evidenced by the same amount of unhydrolyzed starch.
- After treating wheat and barley grains with a UDHSS solution calculated humic substances content of 1 dm3 per 1 ton, a slightly more intense germination was noted relative to the control. The difference in the germinated treated and untreated grains percentage is most noticeable in barley (Figure 1) on the second day of the experiment (7%), in wheat (Figure 2) on the third day (6%).

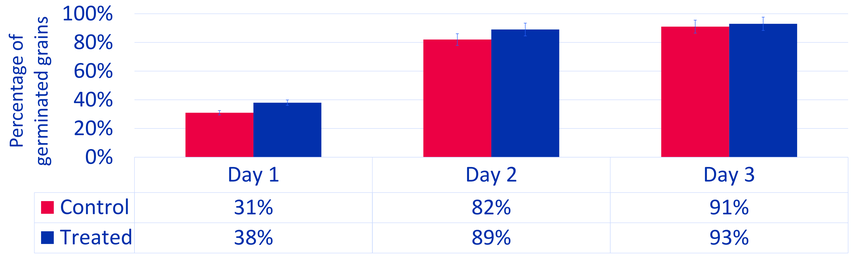

FIGURE 1. The percentage of germinated barley grains

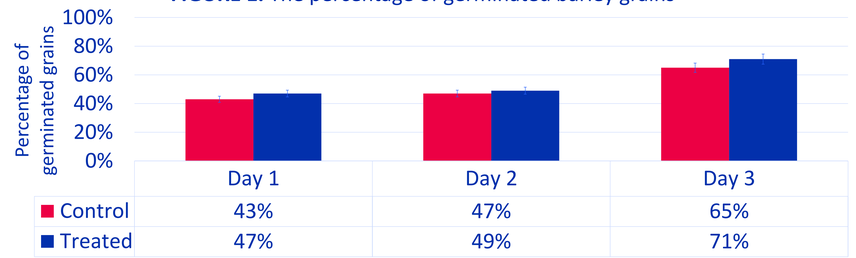

FIGURE 2. The percentage of germinated wheat grains

CONCLUSIONS

- The growth dynamic of germinated barley and wheat grains percentage shows that the suspension's effect manifests itself the clearest when the grains germination accelerates: on the second or third day. This allows to assume the relation between the suspension's action and its accumulation inside the grain, hence the uptake rate of steeping water in which the suspension is dissolved.
- Since the intensity of water absorption and germination processes are related through amylolytic activity as stated above, it can be concluded that the correlation between the presence of UDHSS in steeping water and an increase in the germinated grains percentage signifies an actual dependence of the latter on the former. In this case, seeing how the wheat grains germination is also more lax, steeping water uptake in wheat grains in this experiment was too slow for the suspension's effect on α-amylase activity to become noticeable like in the case of barley.

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