Surface disinfection of wheat kernels using a gas phase hydroxyl-radical process: How does it affect the germination characteristics, microbial load, and functional properties of wheat kernels?

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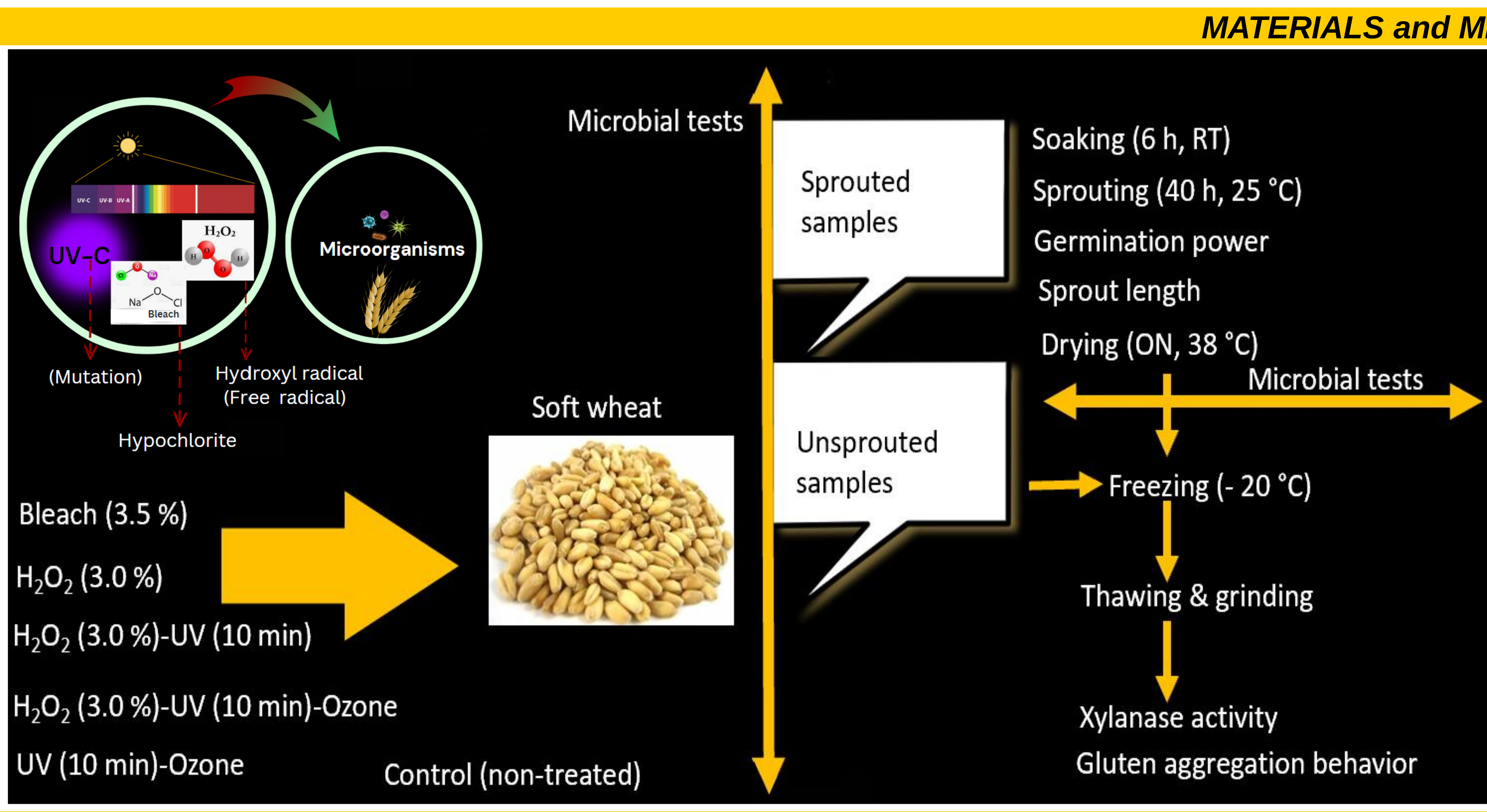
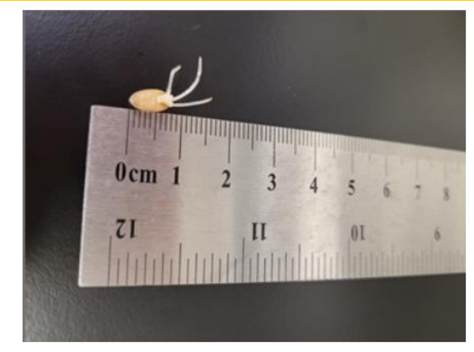
INTRODUCTION and OBJECTIVE

Like any seed, wheat kernels can harbor microorganisms on the surface which becomes an issue when applying as a functional food ingredient. To reduce the risk derived from human pathogens and spoilage microbes there is a need for an effective kernel disinfection method that inactivate microbes without negatively affecting the functionality of the grain. The objective of the following study was to undertake a comparative study of kernel disinfection methods based on hydroxyl-radical process vs the commonly applied bleach method. The hydroxyl-radical process is based on the UV-C mediated degradation of hydrogen peroxide vapor and ozone gas. The process has been applied for decontamination of low moisture foods, fresh produce and other surfaces but has yet to be evaluated for kernel disinfection. Here, we focused on wheat functionality by studying gluten aggregation behaviour and the xylanase activity of wheat kernels. Xylanase activity can originate from either the kernel itself, or the native microbiome of the kernel.

MATERIALS and METHODS





UV-C treatment → Gas-phase hydroxyl-radical process (Clean Works Inc., Canada)

Microbial test → Total Aerobic Count: Trypticase Soy Agar -30 ºC, 3 days

Microbial test → Fungal count on Potato Dextrose Agar 25 ºC, 3-5 days

Xylanase activity→ Megazyme kit (Neogen, Canada)

Gluten aggregation behavior→ GlutoPeak tester (Brabender, Germany)

Statistic analysis → One-way ANOVA and the t-test (IBM SPSS 27 (IBM corp))

RESULTS and DISCUSSION

Figure 1: Fungal counts of unsprouted wheat kernel

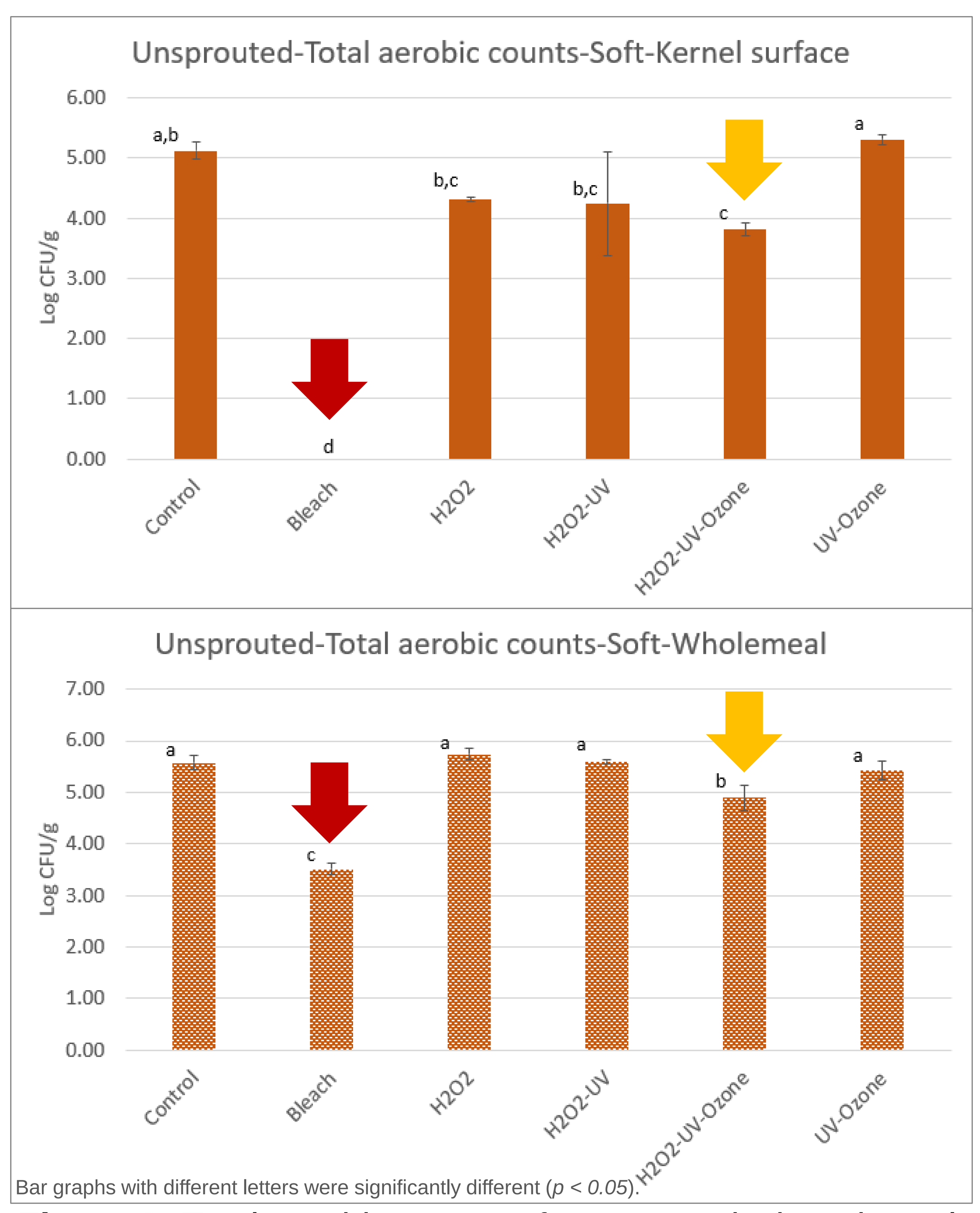


Figure 2: Total aerobic counts of unsprouted wheat kernel

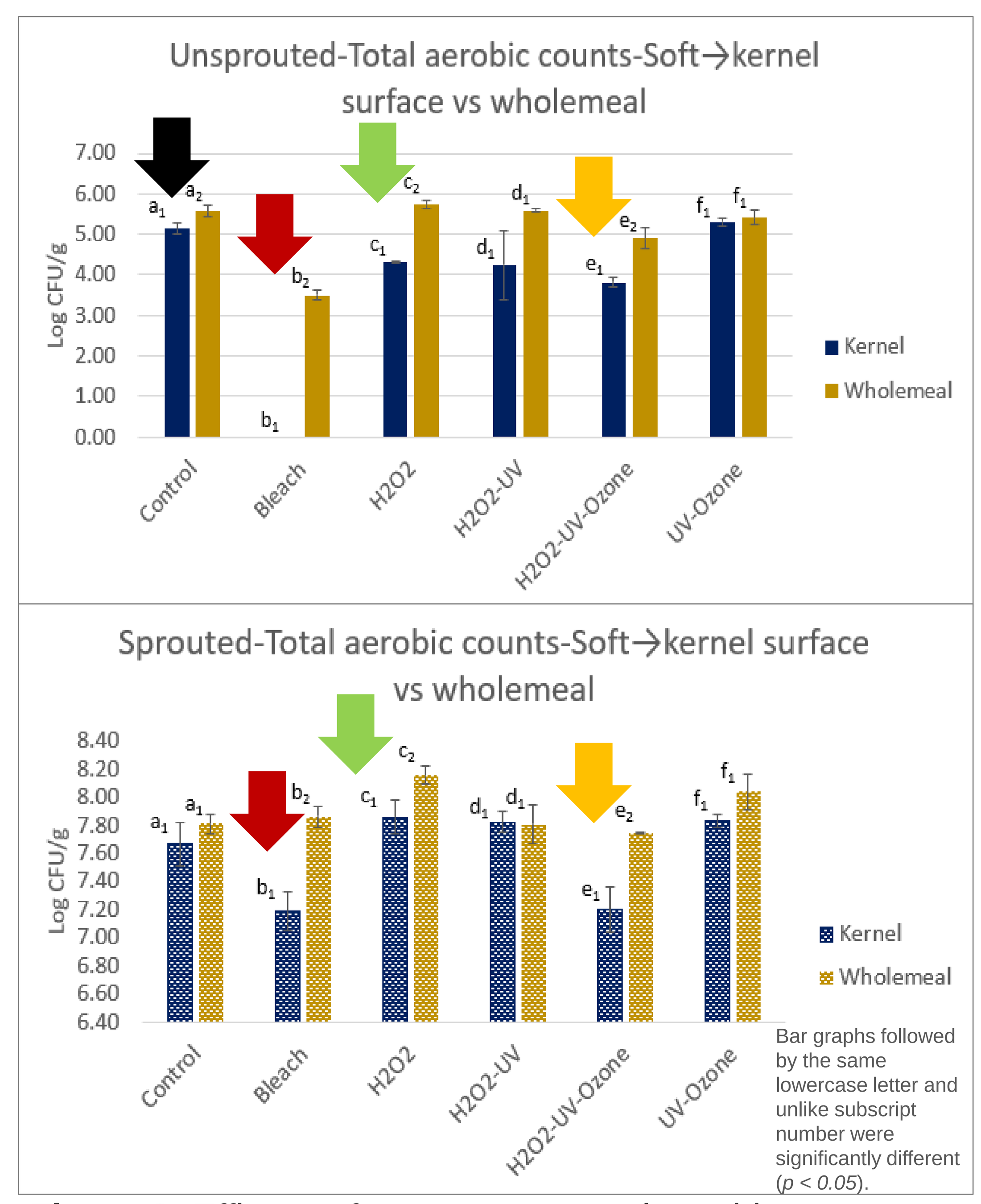


Figure 3: Efficacy of treatment on total aerobic count

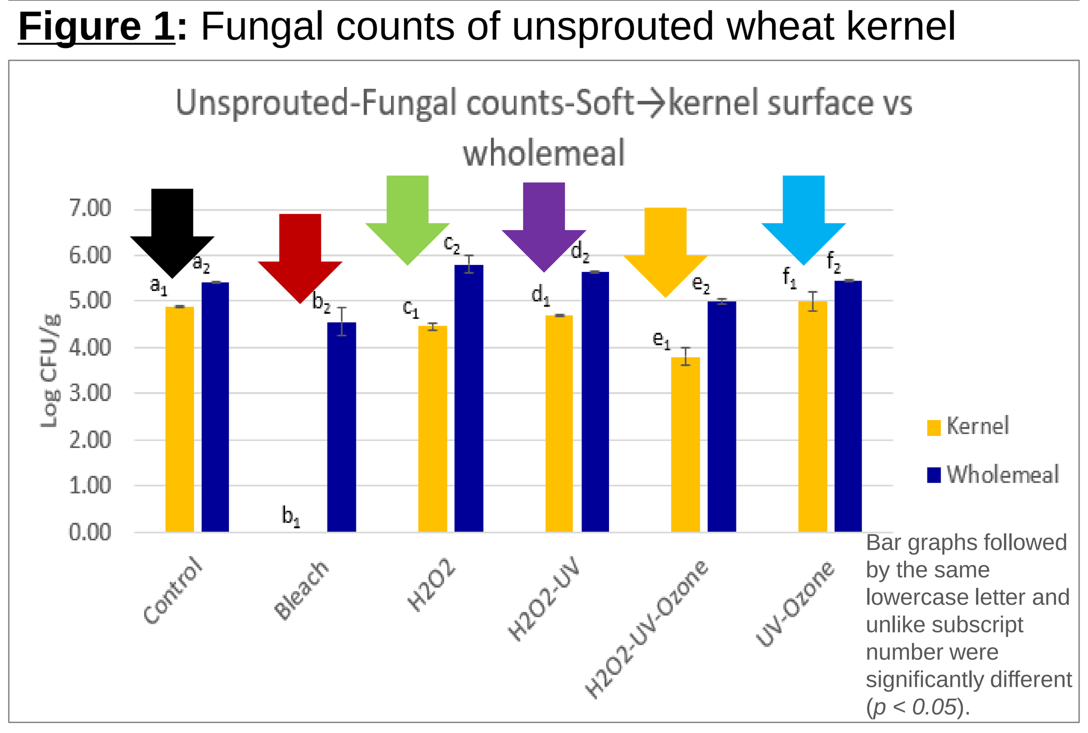


Figure 4: Efficacy of treatment on fungal load

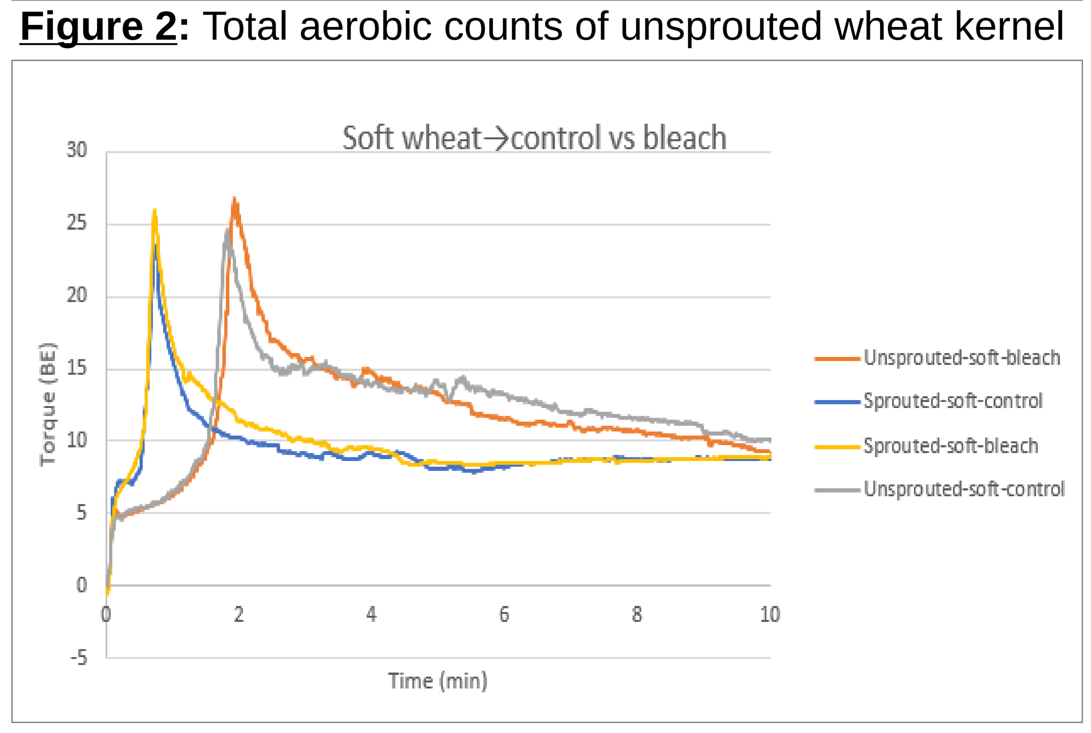


Figure 5: Gluten aggregation behavior of wheat kernel

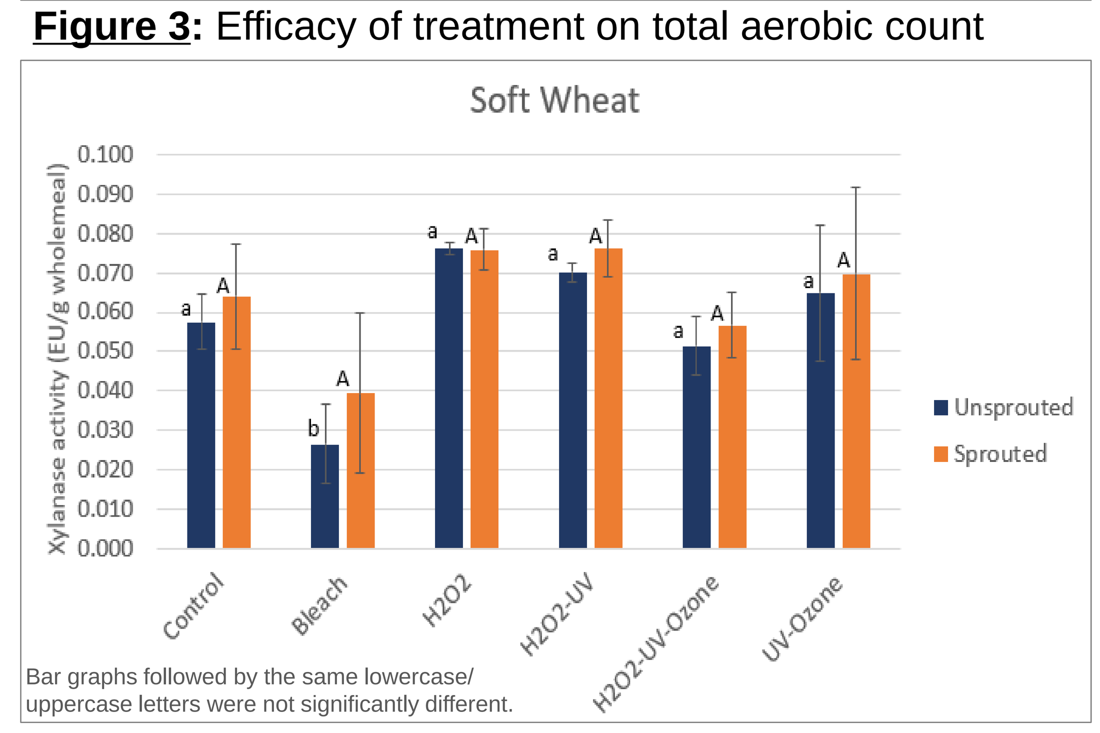


Figure 6: Xylanase activity of wheat kernel

None of the treatments significantly ($p < 0.05$) influenced the germination ability of the wheat kernels. The hydroxyl-radical process significantly increased the sprout length of the selected kernels. Besides the bleach treatment, also the hydroxyl-radical process was able to reduce the fungal and total aerobic counts on the kernel surface and in wholemeal of unsprouted samples (Figure 1 and 2). The total aerobic load was significantly lower on the kernel surface than in the wholemeal for the unsprouted and sprouted samples treated with bleach, H_2O_2, and hydroxyl-radical process (Figure 3). The fungal load was significantly lower on the kernel surface than in the wholemeal of unsprouted samples for all treatments (Figure 4). None of the treatments affected the gluten aggregation behavior of unsprouted and sprouted samples. Only the bleach and control samples are shown here but the same results were obtained with the other treatments (Figure 5). The bleach treatment reduced the xylanase activity significantly for the unsprouted samples, this difference did not persist through sprouting (Figure 6). The other treatments did not affect the xylanase activity of the sprouted and unsprouted samples.

CONCLUSIONS

Five different treatments were selected to reduce the microbial load on the wheat kernels. In conclusion, the hydroxyl-radical process based on using a combination of hydrogen peroxide, ozone and UV-C decreased microbial levels on kernels compared to the individual treatment components; although it was not as effective as the currently applied bleach treatment. The findings suggest that there is benefit of the hydroxyl-radical process in being a dry-process but would require further optimization to increase the antimicrobial efficacy.

REFERENCES

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Acknowledgments

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