Advanced Oxidative Decontamination of Flaxseed and the Effects of Storage on Decontaminated Flaxseed Techno-functionality

Guwanth Wanigasuriya[1], Muhammad Mudassir Arif Chaudhry[2], Claudia Narvaez[1], Jitendra Paliwal[2,3], Filiz Koksel[1]

[1]Department of Food and Human Nutritional Sciences, University of Manitoba, Winnipeg, MB, Canada

[2]Department of Biosystems Engineering, University of Manitoba, Winnipeg, MB, Canada

[3]Department of Applied Computer Science, The University of Winnipeg, Winnipeg, Canada

University of Manitoba

Introduction

- Flaxseed is Canada's third-largest oilseed crop, accounting for about 40% of global production.
- Microbial contamination during storage and processing poses a major threat to food safety and quality of agricultural commodities like flaxseed.
- Advanced Oxidative Processes (AOP) using ozone (O_3), hydrogen peroxide (H_2O_2), and ultraviolet (UV) radiation offer innovative and effective decontamination solutions.
- The combination of O_3, H_2O_2, and UV radiation synergistically generates more hydroxyl radicals (·OH) than individual treatments.
- Hydroxyl radicals possess a very high oxidation potential (~2.8 V), exceeding that of O_3 and H_2O_2, enabling rapid and irreversible damage to microbial cell components, and leading to effective microbial reduction.

Figure 1. Brown flaxseed

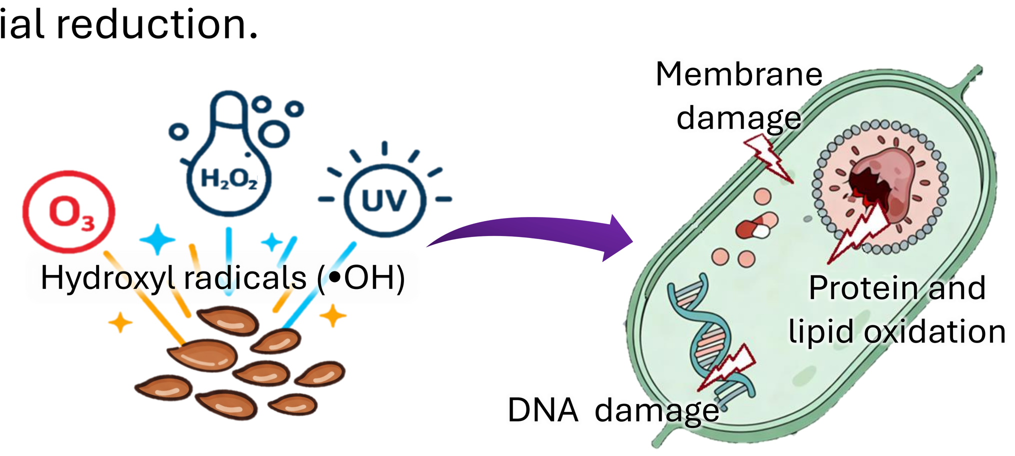

Figure 2. Microbial inactivation by hydroxyl radicals

Objective

To quantify the changes in techno-functional properties including water holding capacity (WHC), oil holding capacity (OHC), emulsifying capacity (EC) and emulsifying stability (ES) of AOP treated flaxseed before and during storage.

Materials & Methods

- Brown flaxseed (AAC Bravo) conditioned to 9% moisture content was spread over plastic trays in monolayers. AOP decontamination was performed using a Clean Flow Healthcare Mini (Cleanworks corp., St. Catharines, ON, Canada).
- Decontamination parameters were UV-C intensity of 10 mW/cm^2 and O_3 concentration of 5 - 9 ppm. Two different flow rates (20 & 30 ml/min) of 3% v/v H_2O_2 were used with 30- and 40-seconds exposure times.
- AOP treated flaxseed were ground (≤ 500 μm) and techno-functional properties were analyzed before storage, and monthly during a 3-months storage period.

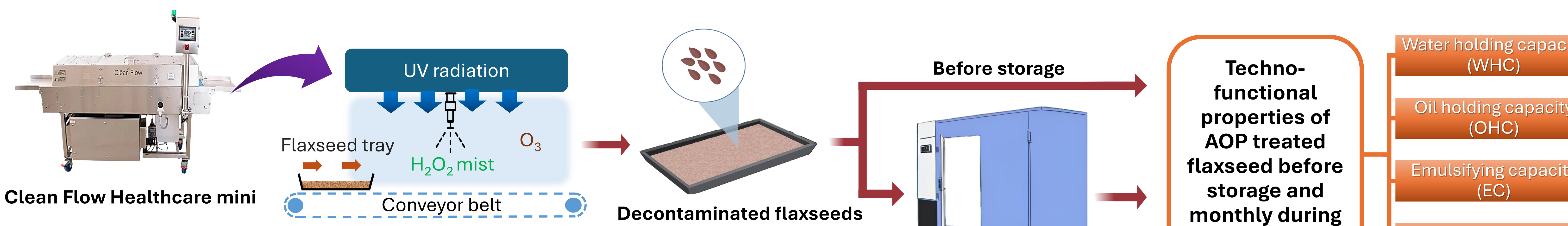

Figure 3. Process for flaxseed AOP decontamination, storage and testing

Table 1. Decontamination conditions for treatments

Treatments	H_2O_2 Flow Rate (mL/min)	Exposure Time (s)
Control	-	-
T1	20	30
T2	20	40
T3	30	30
T4	30	40

Storage in a growth chamber at 20°C and 75% RH

- Control and AOP treated samples were stored in separate pails for 3 months. Samples were drawn monthly and analyzed for techno-functional properties.

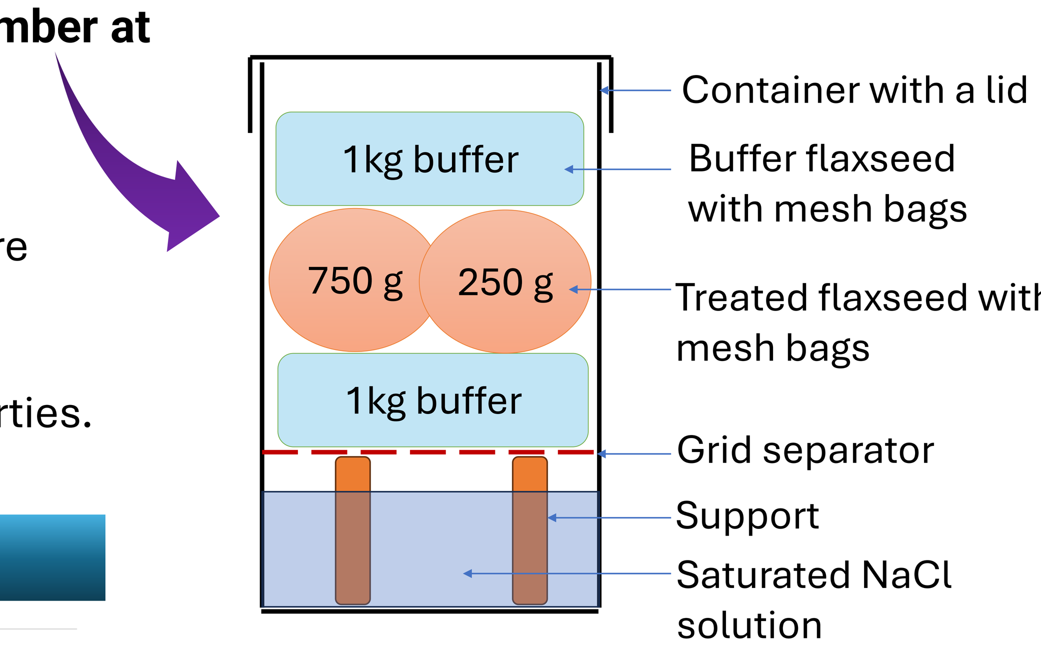

Figure 4. A setup of a pail

Results & Discussion

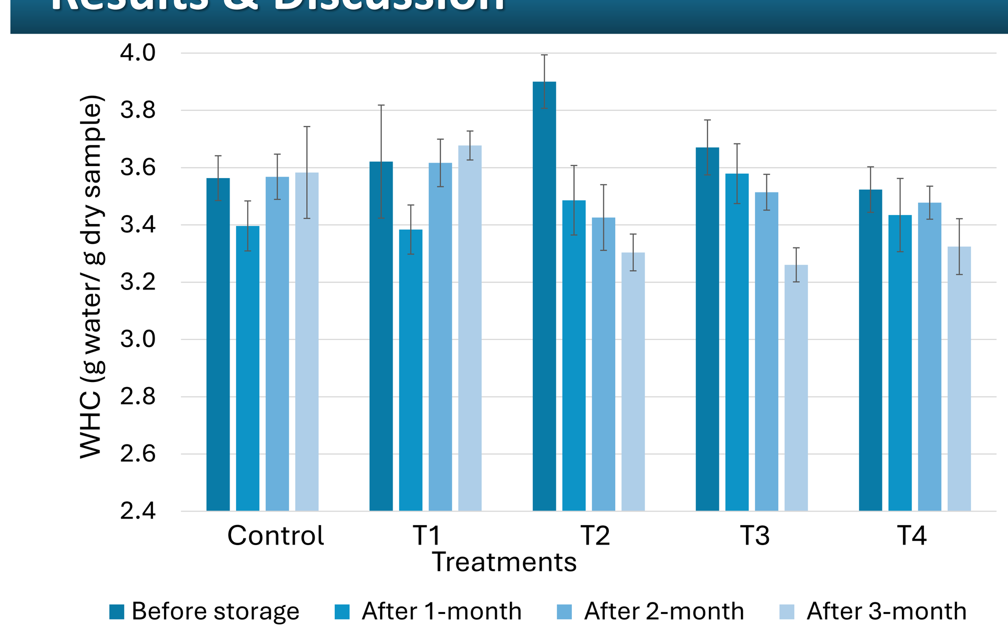

Figure 5. Water Holding Capacity (WHC) of ground flaxseed samples

Overall, WHC ranged from ~3.2–3.9 g water/ g dry sample, with slight declines during storage of T2, T3 and T4. T2 showed the largest decrease, while the control and T1 remained stable.

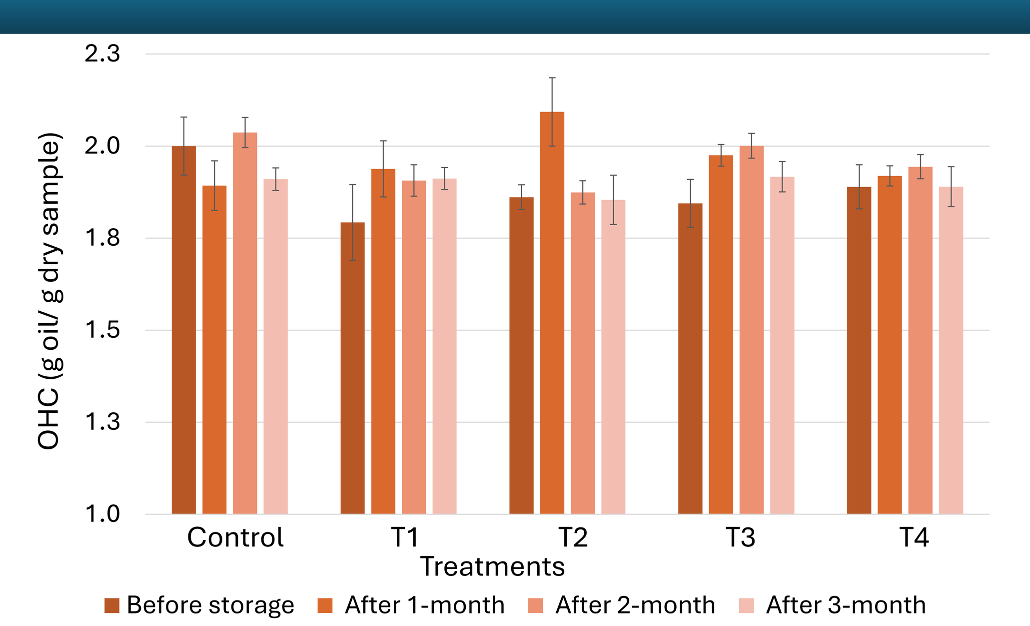

Figure 6. Oil Holding Capacity (OHC) of ground flaxseed samples

OHC ranged from ~1.8 to 2.1 g oil/ g dry sample, with minor fluctuations during storage. Initial values were consistent, with the control having slightly higher OHC than AOP-treated samples. Temporary increases were noted in T2 (one month), T3 and control (two months), but by three months all treatments stabilized near ~1.9 g/g.

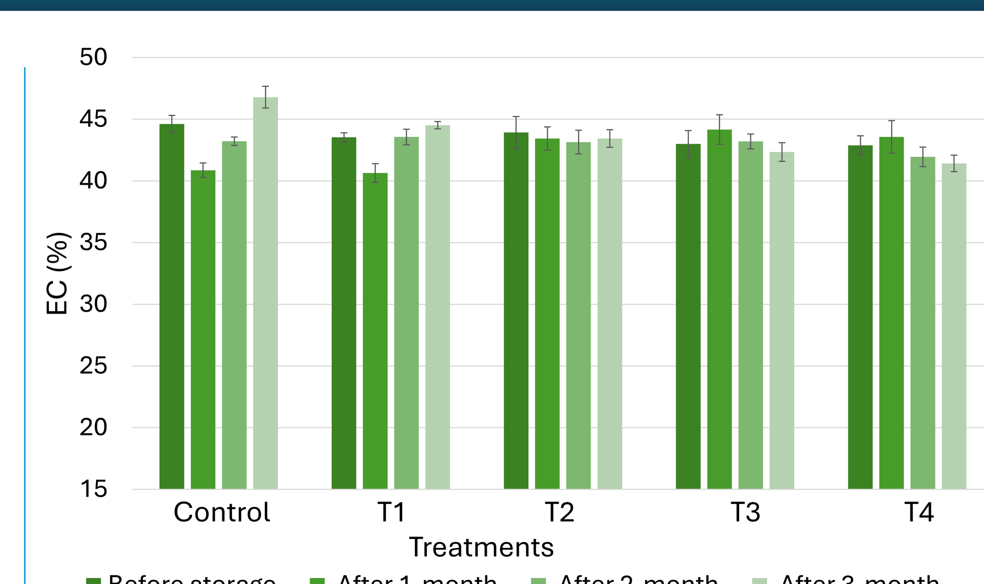

Figure 7. Emulsifying Capacity (EC) of ground flaxseed samples

EC ranged between 40 and 46%. Overall, AOP treatment and storage caused only minor changes, showing that flaxseed maintained good emulsifying ability under the tested conditions.

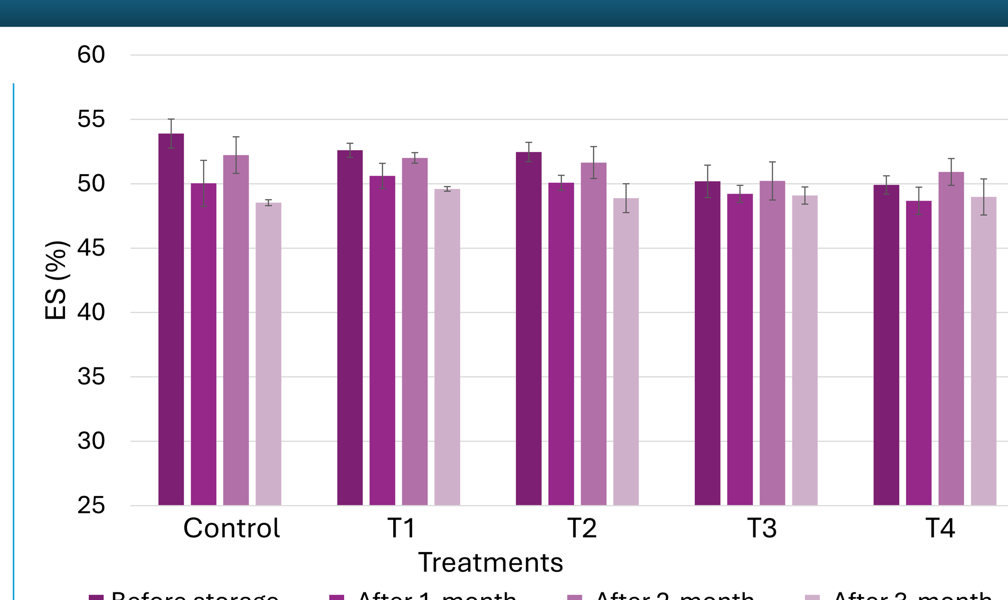

Figure 8. Emulsifying Stability (ES) of ground flaxseed samples

ES decreased modestly during three months of storage with ES values stabilizing around 48-50%. ES of the control samples declined more sharply compared to those of AOP-treated samples. AOP did not negatively affect ES suggesting that the stability of the emulsions remained uncompromised.

Conclusion

AOP shows potential as a decontamination method that maintains flaxseed techno-functionality during storage. Further validation is ongoing with the storage study.

Acknowledgements

MANITOBA CROP ALLIANCE
Sustainable Canadian Agricultural Partnership
NSERC CRSNG

Industry Relevance & Application of AOP

- **Food Safety & Decontamination**

AOP reduces microbial loads without chemically intensive treatments or heat, ensuring safe flaxseed for processing.

- **Functional Food Production & New Product Development**

Maintains key techno-functional properties for use in health foods and plant-based nutritional supplements.

- **Clean Label Processing**

Non-thermal, chemical residue-free AOP supports clean label, and additive-free claims.

Ideal for: organic brands and export-focused companies.

- **Regulatory & Standard Development**

Supports setting safe AOP treatment protocols to meet CFIA, FDA, and EU standards.

Relevant to: food safety regulators and R&D labs.

References