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A new lease of life for oat hulls - fermentation-based lifeline for disruptive food innovations

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INTRODUCTION & AIM

- Oat production in Canada – 3.42 million metric tonnes in 2024 (Statistics Canada, 2025, https://doi.org/10.25318/3210035901-eng, Date accessed Oct. 22, 2025).
- During milling 25-30% by-product generated consists of oat hulls. Crosbie et al., 1985, Crop Science, 25(4):678-680, https://doi.org/10.2135/cropsci1985.0011183X002500040023x).
- Hulls general use - in animal feed, for combustion for electricity generation, as an absorbent in bedding material for poultry or simply discarded
- Oat hulls composition: 30 – 35% crude fibre, 30 – 35% pentosans, 10 – 15% lignin, about 5% protein and about 5% ash (3 – 4% silicic acid) (Welch et al., 1983, https://doi.org/10.1002/jsfa.2740340502; González-Alvarado et al., 2010, https://doi.org/10.1016/j.anifeedsci.2010.08.010).
- Limited reports on the use of oat hulls for human consumption:
  - Alkaline H_2O_2-treated oat hulls were extruded and used in cookies as a 20% replacement for wheat flour (Galdenano et al., 2006, Food Sci. Tech., https://doi.org/10.1590/S0101-20612006000100021).

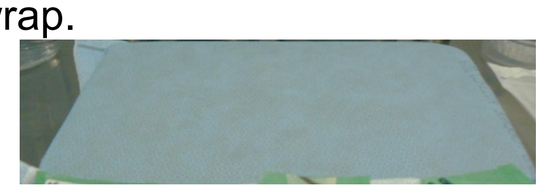
OBJECTIVE

To use static solid-state fermentation (sSSF) and agitated solid-state fermentation (aSSF) to texturize the oat hulls for incorporation into food products and create added value for oat hulls utilization

METHOD

Fig.1. Oat hulls used as substrate for solid state fermentation

- Oat hulls were milled in a blender for the small-scale solid-state fermentation experiments.
- **Static SSF set up:** Stainless steel trays were used and kept sterile using Biowrap.



- **Agitated SSF set up:** Spinner flask (2 L) was customized with impeller

- **Silica quantification** – Inductively-coupled mass spectrometry

RESULTS & DISCUSSION

Table 1. Si percentage determined in untreated and treated oat hulls. ND – Not determined

Samples	Si (%) - ICP-MS
Untreated oat hulls	6
Milled oat hulls fermented with *Rhizopus oligopsorous*	2
Cellulase treated autoclaved oat hulls	1
Viscozyme and cellulase treated autoclaved oat hulls	2
Viscozyme treated autoclaved oat hulls	1
50% Hydrogen peroxide bleached oat hulls	< 1
25% Hydrogen peroxide + 2M NaOH treated oat hulls	< 1
Alkaline Hydrogen peroxide treated oat hulls	< 1
Rhizopus oligosporous mycelia	< 1

Fig.3. Alkaline H_2O_2 treated oat hulls for Si reduction

Fig.4. Agitated SSF. CFU = 2.98 E+10 – 1.35 E+11. Also, better texturization of the hulls and better growth compared to static SSF

Fig.5. Static SSF on milled oat hulls. (a). Pre-inoculation, (b). Post-inoculation with inoculum density at CFU = 1 E+07 per 100 g substrate with moisture adjusted to 50%, (c). Mycelial growth on surface of substrate after three days, (d). Mycelial growth on surface of substrate after seven days, (e). Inoculated with *A. oryzae*, (f). Inoculated with *R. oligosporous*

Fig. 6. Milled fermented oat hulls

Fig.7. Incorporation in products at 10% w/w

CONCLUSION

- Oat hulls were milled, alkaline H_2O_2 bleached, and Si reduced to < 1%
- SSF with *Rhizopus oligosporus* and *Aspergillus oryzae* allowed texturization of hulls and ready for use in baked products

FUTURE WORK

- Detailed nutritional composition analyses
- Scale up testing at 10 Kg
- Pilot scale testing at 300 Kg
- Incorporation at into breads and cakes and at higher percentages and evaluation by tasting panel

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