Involvement of Keratinolytic Fungi Derived from Rookery Soils in the Management of Poultry Industry Post-Production Waste for Practical Use

Justyna Bohacz[1], Michał Możejko[1], Ignacy Kitowski[2], Joanna Bednarz[1]

[1]University of Life Sciences in Lublin, Faculty of Agrobioengineering, Department of Environmental Microbiology, Leszczyńskiego 7 Street, 20-069 Lublin, Poland
[2]State School of Higher Education in Chełm, Institute of Agricultural Science, Pocztowa 54 Street, 22-100 Chełm, Poland
***Corresponding author:** justyna.bohacz@up.lublin.pl*

Introduction

As reported by FAO, the global consumption of poultry meat reaches 86 million tons. According to the data of the Central Statistical Office from 2017, over 2 million tons are consumed in Poland per year. The level of the generation of feather waste during poultry processing in Poland ranges from approximately 77,000 to 90,000 tons. Globally, this value reaches 2 million tons per year. Feather waste contain about 90% of protein, chiefly keratin, and from ~ 15-18% of nitrogen and from 2 to 5% of sulfur. Keratin waste also contain 1.27% of fat and 3.20% of minerals. The physical and chemical treatment of feather waste keratin and other native keratins are energy-intensive and environmentally unfriendly. During uncontrolled decomposition, large amounts of poisonous gases are released, i.e. ammonia and hydrogen sulfide. Therefore, there is a growing interest in microbiological methods of transforming keratin-rich waste.

The aim

The aim of the study was to propose a method for improvement of the recovery of valuable organic matter, i.e. post-production feather waste from poultry processing and proposition of use obtained bioproducts.

Material and methods

5 strains of *Arthroderma insingulare* signed XI, XII, XIII, XVI, XVII were used to determination of keratinolytic activity. The nucleotide sequences of these fungi are included in GenBank with the accession numbers, respectively: MZ 461974, MZ468049, MZ468048, MZ468051, MZ468050.

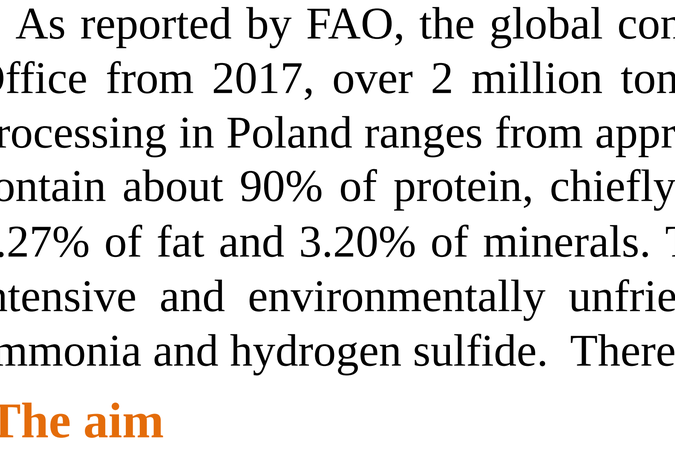
The fungi *Arthroderma insingulare* were isolated from soil with a constant supply of keratin matter from bird nests, especially those with a large breeding range, such as the rook *Corvus frugilegus*.

In order to determine the keratinolytic activity of fungi, liquid cultures were set up on mineral medium with chicken feathers as a sole source of N,S,C and energy and the activity of keratinase, protease, concentration of soluble proteins and peptides, ammonium and sulfate ions, pH and feather mass loss were periodically determined.

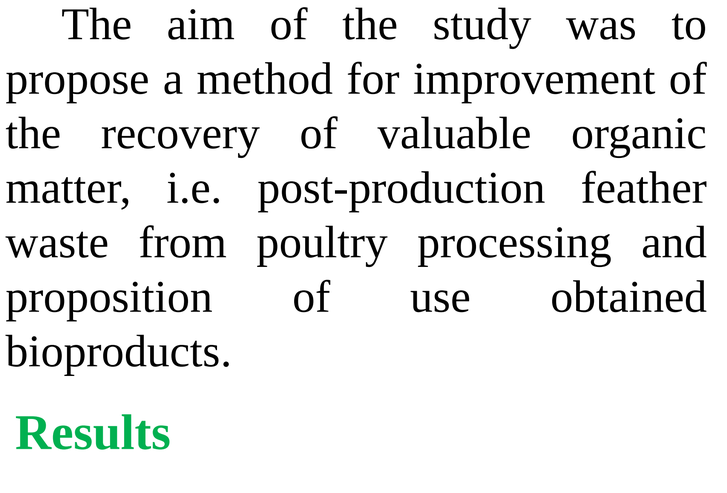
In order to determine the effect of the obtained keratin hydrolysates on germination and early plant growth, a phytoxicity test was performed using the Tigret Phytotoxkit kit. The phytoxicity test was carried out on rendzina and podzolic soil against the reference soil using *Lepidium sativum* L., and *Brassica napus* L. spp. *napus*. following the procedure provided in the Phytotoxkit.

Results

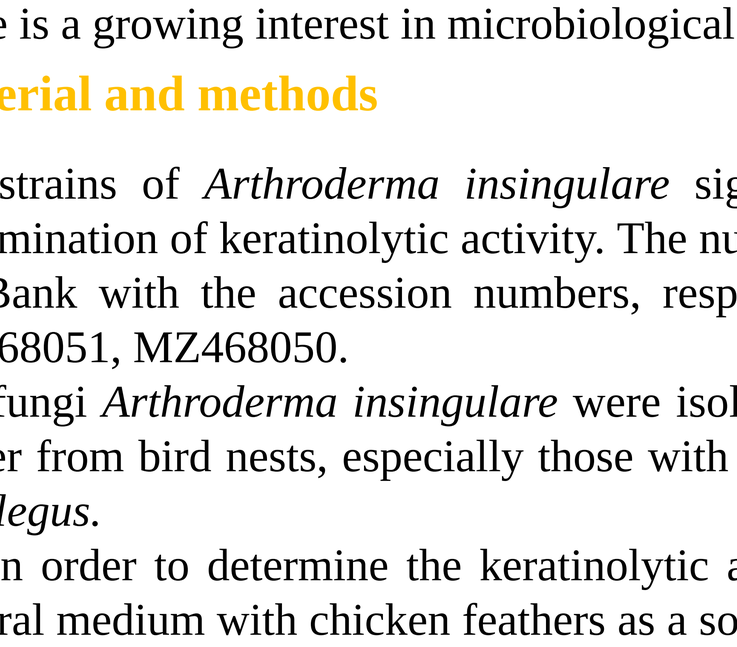
keratinase activity



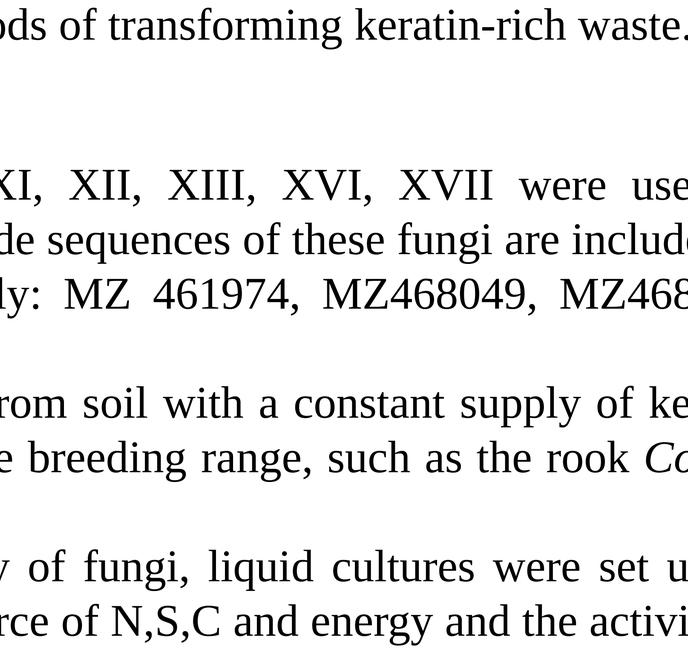
protease activity



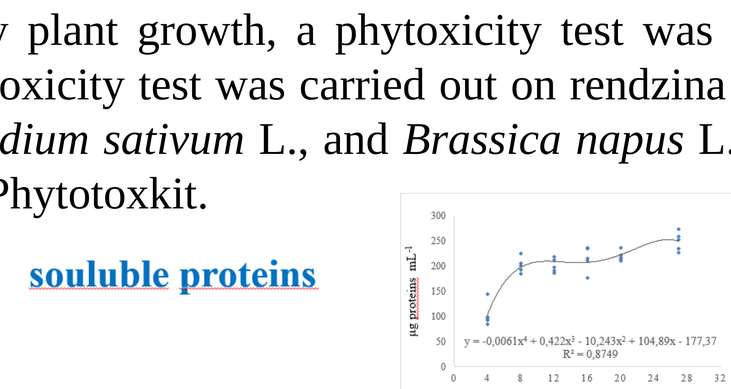
souluble proteins



ammonium ions



sulfate ions

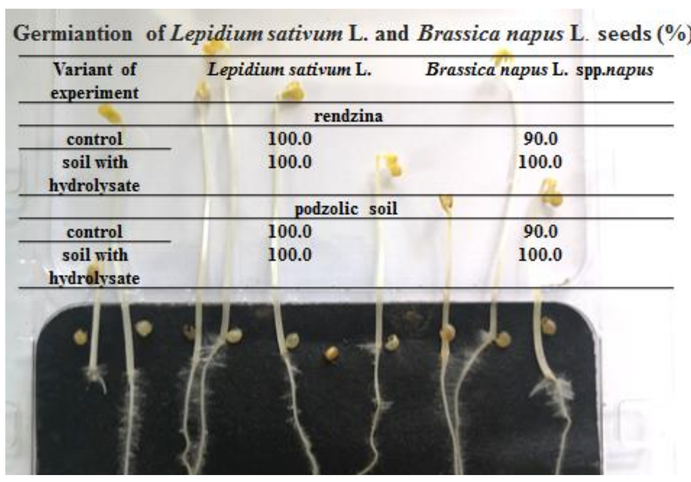


feather mass loss

No.	Numer of strains	species	%
1.	XI	*Arthroderma insingulare* A.A. Padhye & J.W. Carmich.	25,00 ±3,00
2.	XII	*Arthroderma insingulare* A.A. Padhye & J.W. Carmich.	24,00 ±4,00
3.	XIII	*Arthroderma insingulare* A.A. Padhye & J.W. Carmich.	25,67 ±2,08
4.	XVI	*Arthroderma insingulare* A.A. Padhye & J.W. Carmich.	22,67 ±1,53
5.	XVII	*Arthroderma insingulare* A.A. Padhye & J.W. Carmich.	**28,67** ±1,53

Germiantion of *Lepidium sativum* L. and *Brassica napus* L. seeds (%)

Variant of experiment	*Lepidium sativum* L.	*Brassica napus* L. spp.*napus*
	rendzina	
control	100.0	90.0
soil with hydrolysate	100.0	100.0
	podzolic soil	
control	100.0	90.0
soil with hydrolysate	100.0	100.0



pH of post-culture liquid

Strain/ Term (days)	4	8	12	16	20	27
XI	7.01±0.031^{b}	8.21±0.031^{c}	8.64±0.022^{e}	**8,73±0,021**^{a}	8,70±0,031^{a}	8,65±0,059^{d}
XII	7.25±0.037^{b}	8.28±0.016^{c}	8.67±0.018^{e}	**8,76±0,026**^{a}	8,71±0,041^{a}	8,63±0,074^{d}
XIII	7.27±0.054^{b}	8.31±0.039^{c}	8.67±0.036^{e}	**8,75±0,012**^{a}	8,70±0,008^{a}	8,60±0,017^{d}
XVI	6.99±0.041^{b}	8.18±0.029^{c}	8.61±0.057^{e}	**8,71±0,008**^{a}	8,71±0,012^{a}	8,62±0,017^{d}
XVII	7.38±0.017^{b}	8.35±0.016^{c}	8.72±0.017^{e}	**8,79±0,017**^{a}	8,72±0,042^{a}	8,56±0,052^{d}

Conclusions

✓The tested fungi have ability to biodegradation of feather waste keratin. This is supported by numerical values of coefficients of keratinolytic activity, i.e. the loss of keratin substrate mass, the release of soluble proteins and peptides, N–NH_4^+, S–SO_4^{2-}, changes in the pH and keratinase and protease activity.

✓The obtained bioproduct-hydrolysate stimulated of germination of *Lepidium sativum* L. and *Brassica napus* L. spp. *napus* seeds.

✓The tested fungi, during the decomposition of feather waste keratin, released mineral and organic products important from the agricultural practice point of view. Among the tested strains, *Arthroderma insingulare* strain designated XVII was the most active.

This reserach were funded by the Provincial Fund for Environmental Protection and Water Management in Lublin, Poland, grant number 8/2020/D/IN