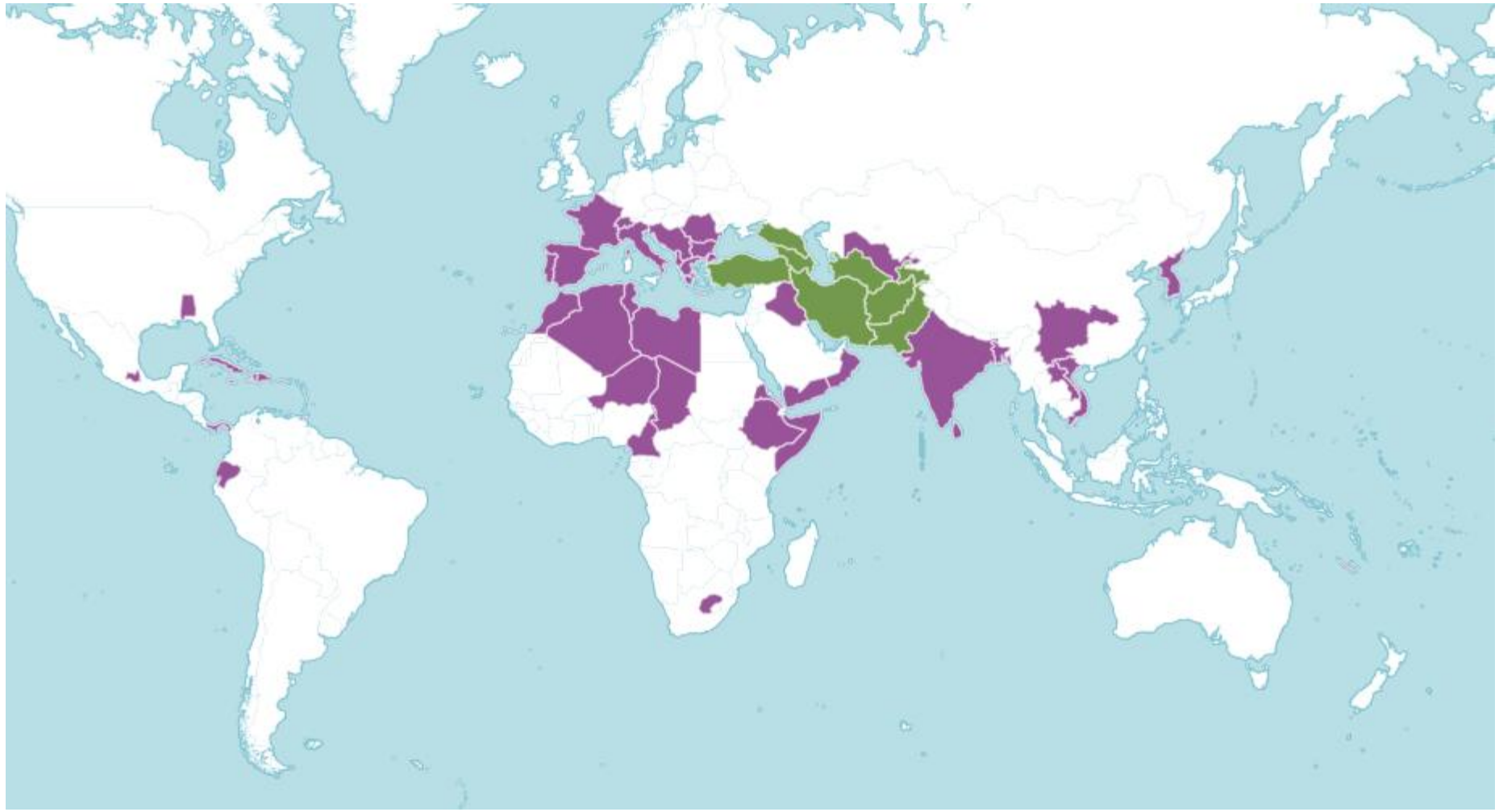
Turning Pomegranate By-Products into Sustainable Protein Sources

Taner Sar



https://www.kew.org/plants/pomegranate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100%
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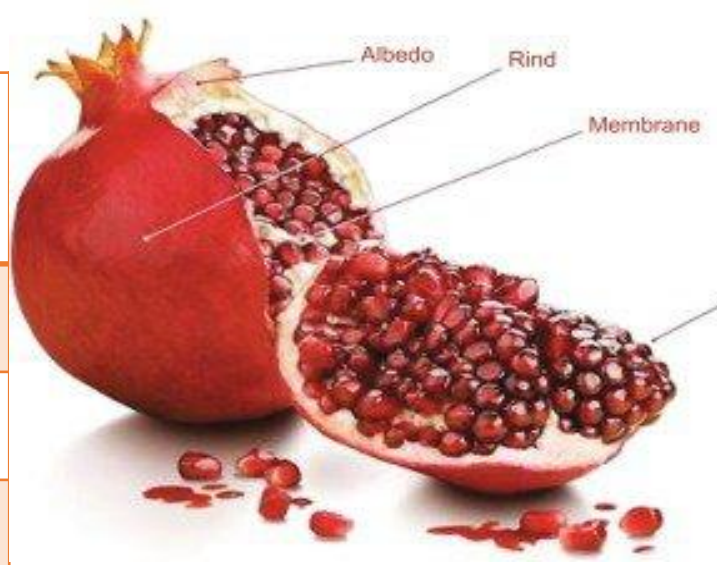
석류
900 ml

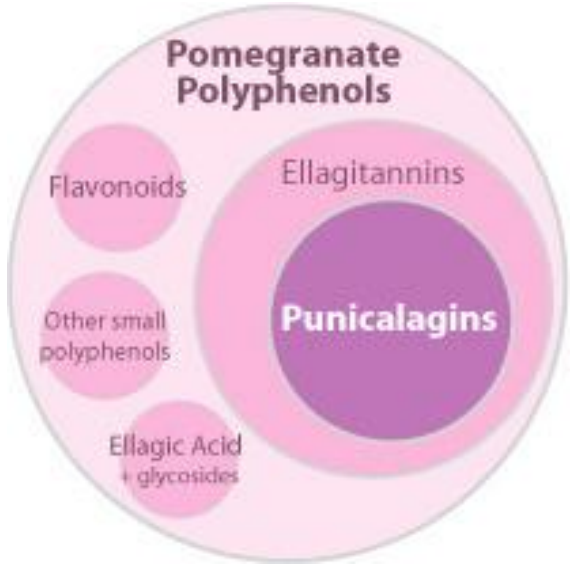

BRETTENBACH
WINE CELLARS
POMEGRANATE WINE
Amish Country Wines

Pomegranat rization

Dried at 50 °C

	Unit	Pomegranate Peel	Pomegranate Juice	Pomegranate Aril
pH		3.22 ± 0.01	2.91 ± 0.01	2.96 ± 0.01
TS	(g/kg)	903.69 ± 0.15	156.95 ± 0.53	215.85 ± 4.59
Volatile solid	(g/kg)	864.38 ± 0.08	132.46 ± 0.18	176.06 ± 1.57
Ash	(g/kg)	39.31 ± 0.07	30.20 ± 1.51	39.79 ± 3.02
Protein (*5.8)	(g/kg)	**30.89 ± 4.05**	3.78 ± 0.33	19.97 ± 1.84
Nitrogen	(g/kg)	5.36 ± 0.69	0.65 ± 0.06	3.44 ± 0.32
Glucose	(g/kg)	**114.57 ± 1.95**	71.38 ± 0.34	79.21 ± 0.04
Other sugars	(g/kg)	**153.74 ± 5.64**	78.67 ± 0.38	91.98 ± 0.02





Filamentous fungi used

- ***Aspergillus oryzae*** var. *oryzae* CBS 819.72, isolated from **tané koji** used for sake making,

- ***Neurospora intermedia*** CBS 131.92, isolated from **oncom**

- ***Rhizopus oligosporus*** NRRL 2710 is related with soybean **tempeh** fermentation

Neurospora

Oncom

Aspergillus

Miso

Rhizopus

Tofu

Tempe

Experiment design

Stage 1

Shake flask experiments

❖Screening of Pomegranate by-products.

- **Peel**
- **Juice**
- **Aril**

❖Screening of different fungal strains.

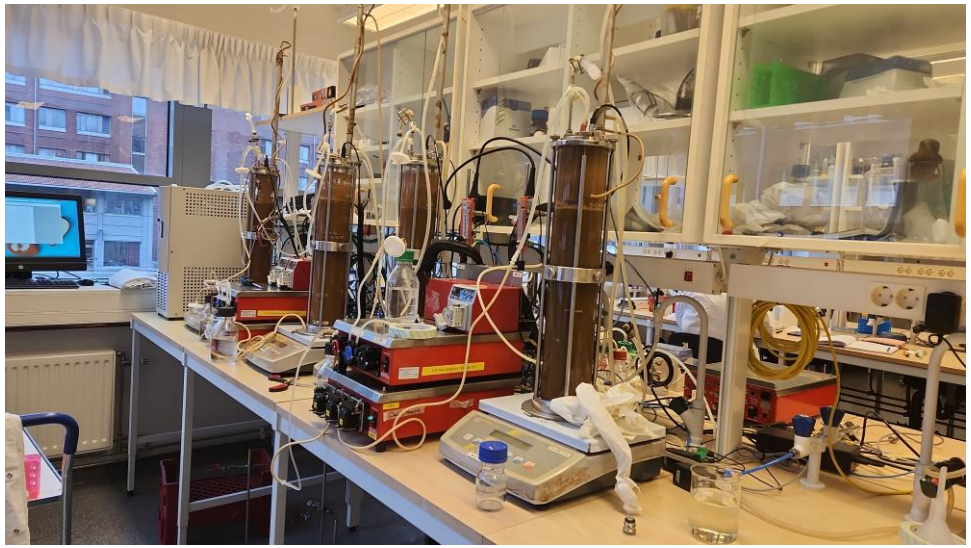
- ***A.oryzae***
- ***R.oligosporus***
- ***N.intermedia***

Stage 2

Bubble-column reactor

❖Scaling up

❖Biomass characterization



Phase 1

Shake flask cultivation.

3 days in 35 °C

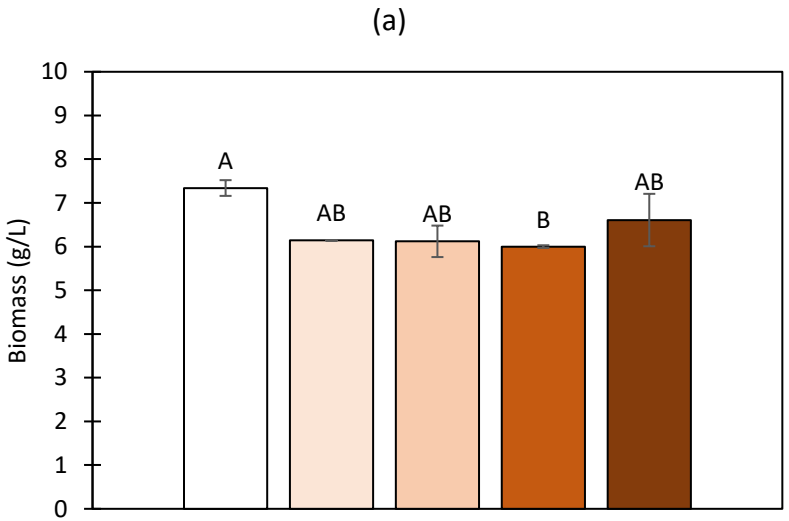
pH 5.5

Submerged fermentation

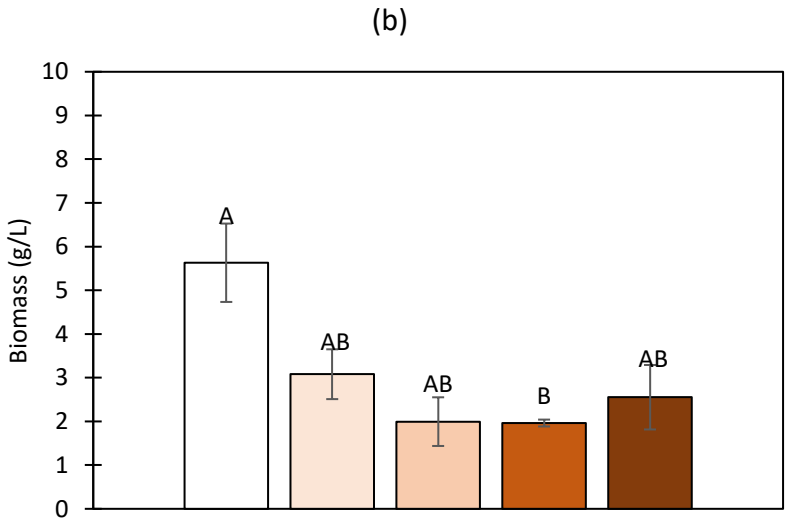
Fungal strain	Glucose g/L	Yeast g/L	Pomegranate gr peel/100 ml substrate	Pomegranate ml juice /100 ml substrate
Ao, Ro, Ni	30	5	0.5	0.5
Ao, Ro, Ni	30	5	1	1
Ao, Ro, Ni	30	5	2	2
Ao, Ro, Ni	30	5	4	3

Effects of Juice in supplemented media

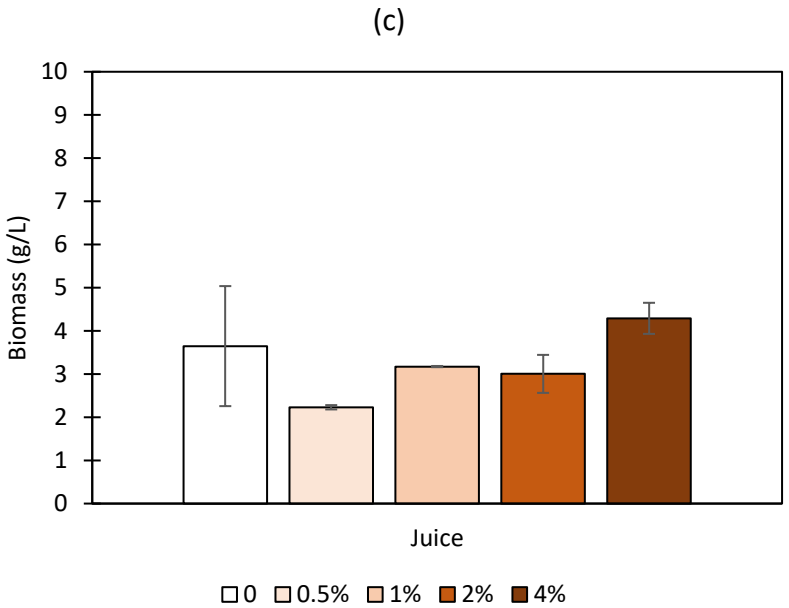
(Glucose+yeast extract)



A.oryzae



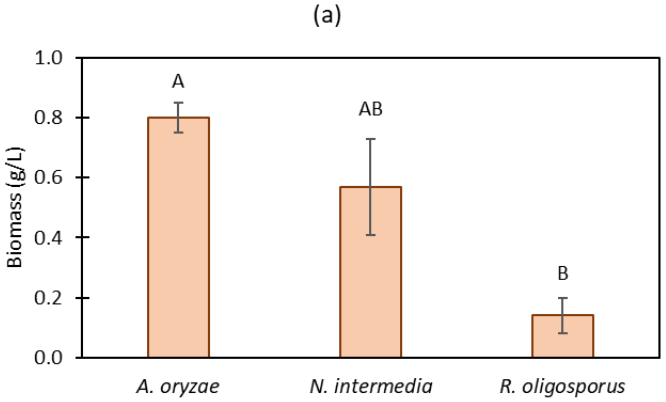
R.oligosporus

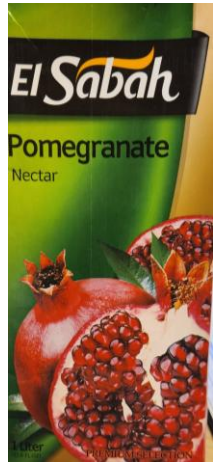


N.intermedia

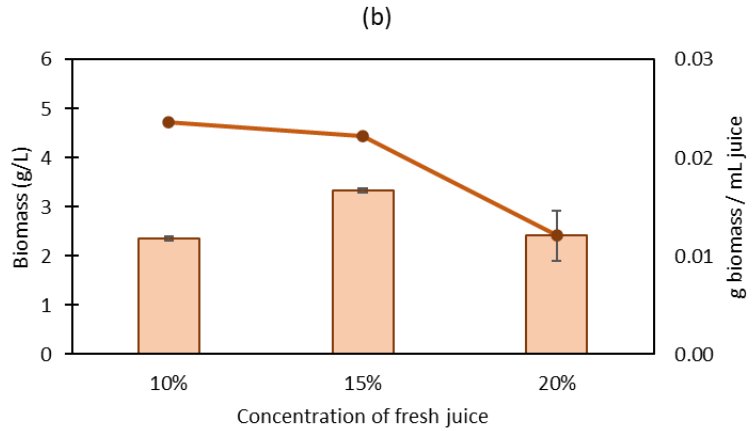
Effects of Juice

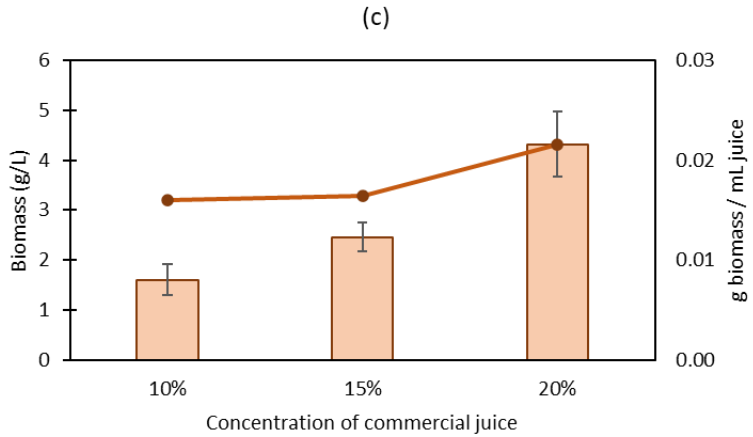
4% Fresh juice





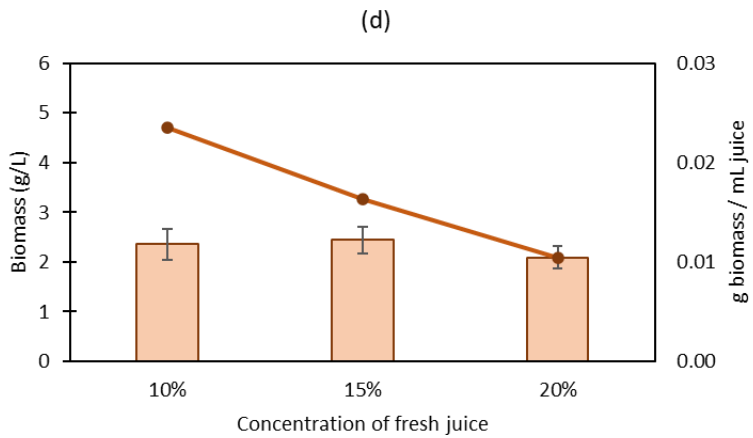
Fresh juice
A. oryzae

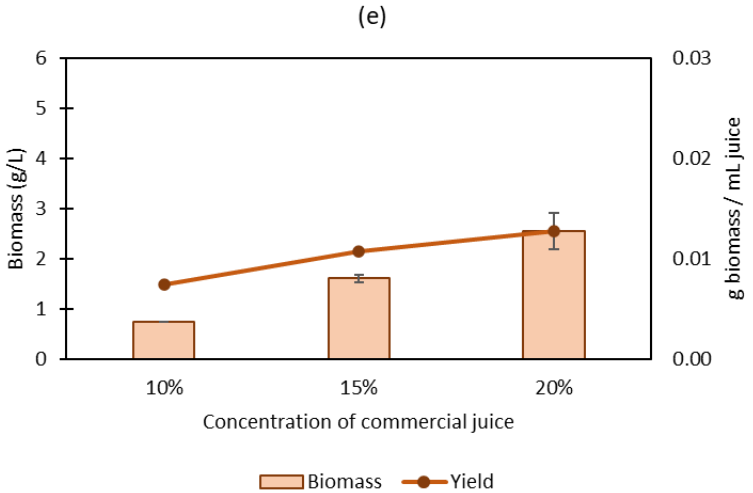




Commercial juice
A. oryzae

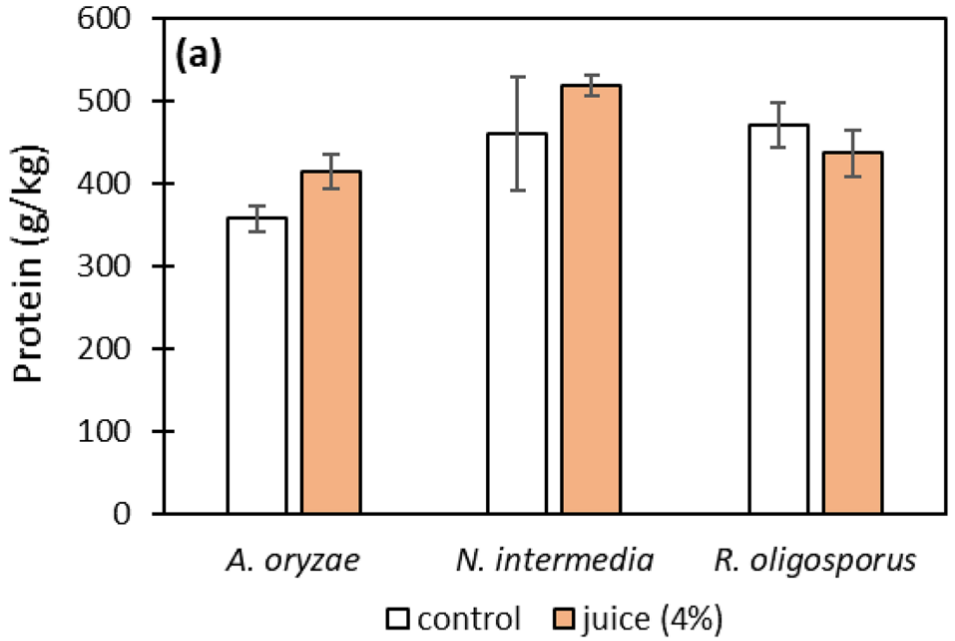
Fresh juice
N. intermedia



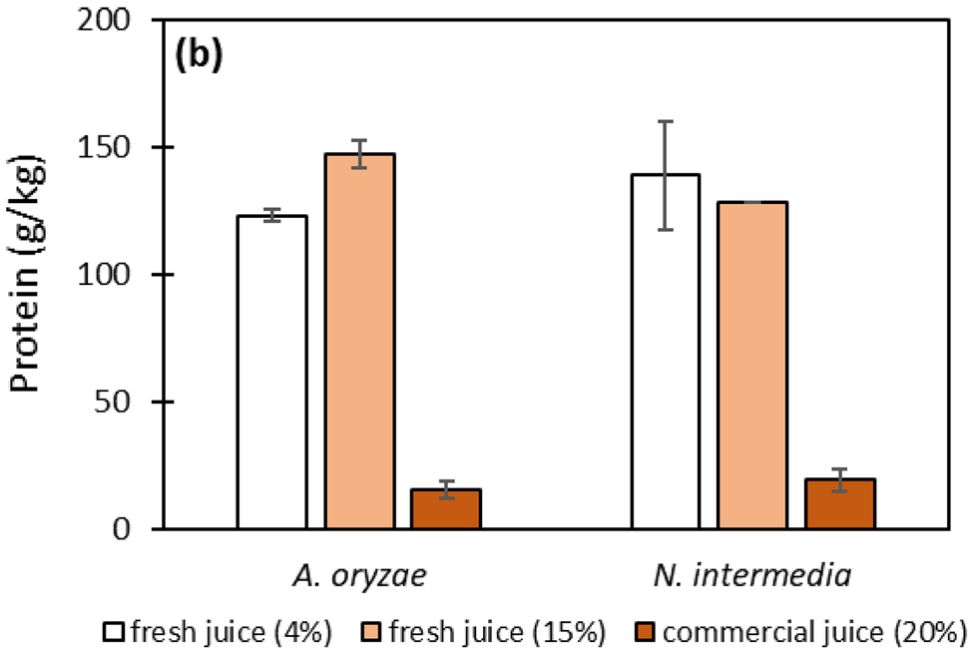


Commercial juice
N. intermedia

Protein Contents

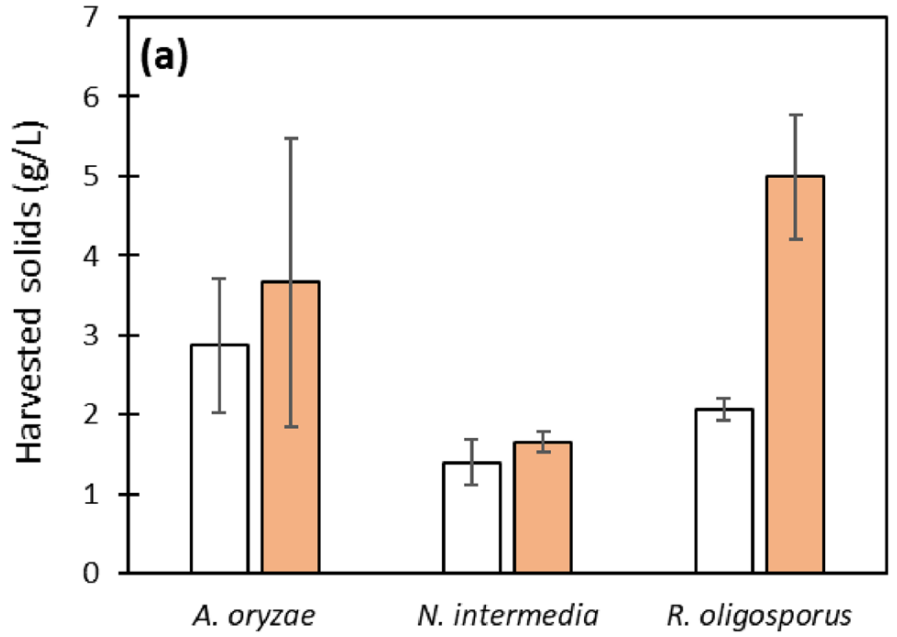


In glucose and yeast extract media



Without Supplementation

Effects of Aril



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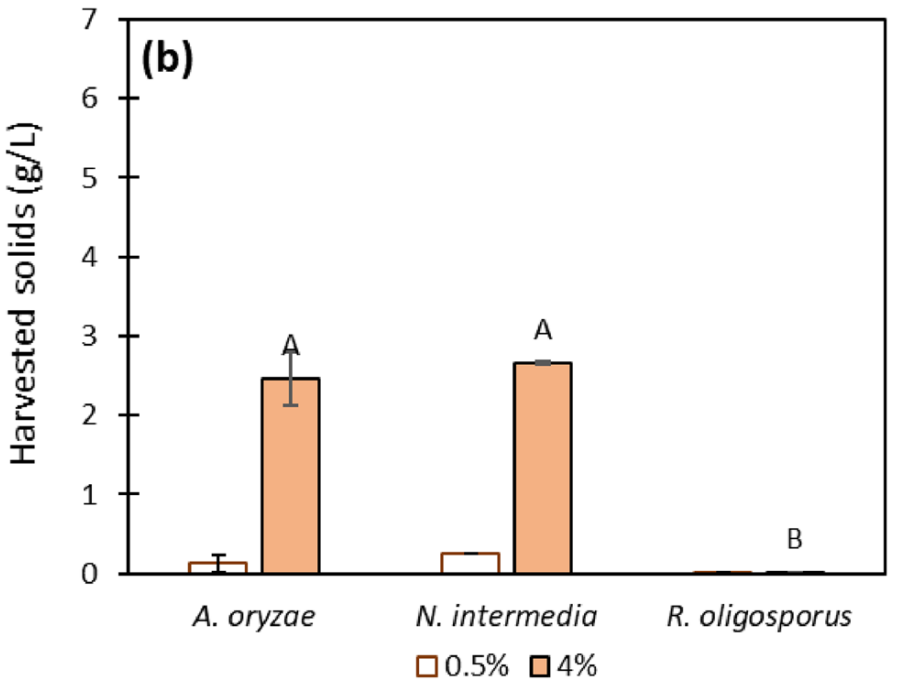
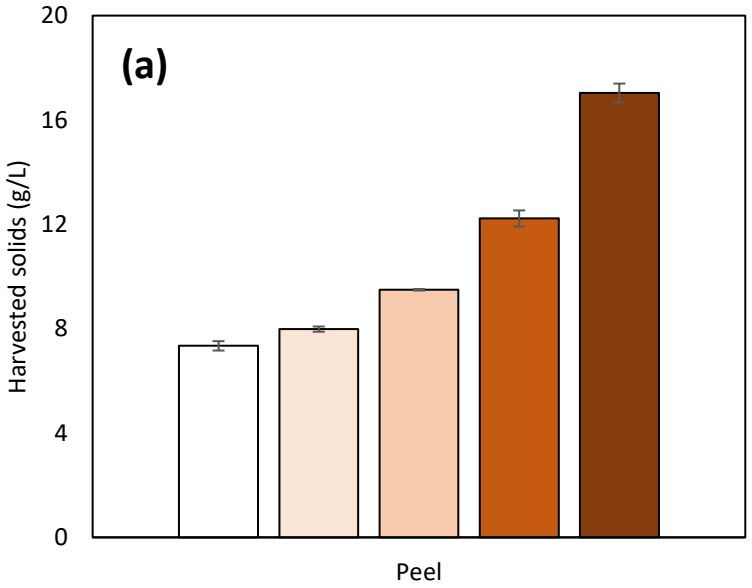


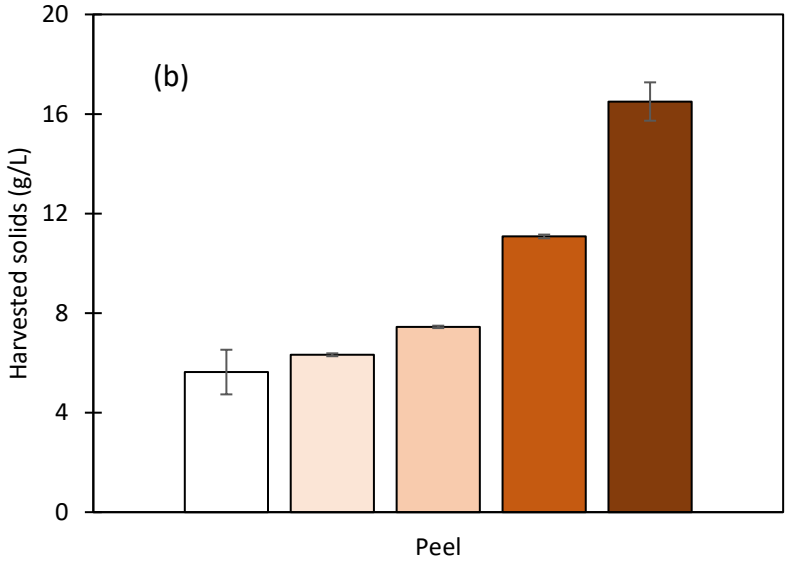
Without Supplementation

Effects of Peel

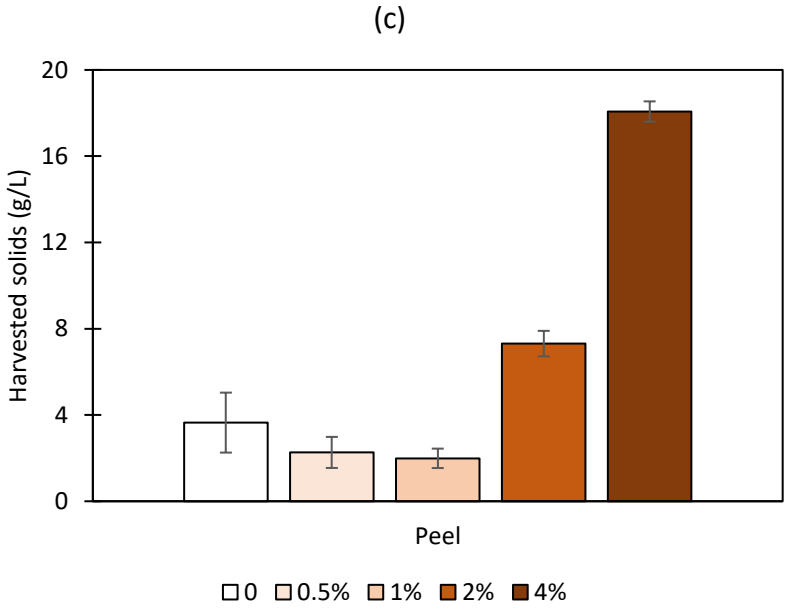
(Glucose+yeast extract)



A.oryzae



R.oligosporus



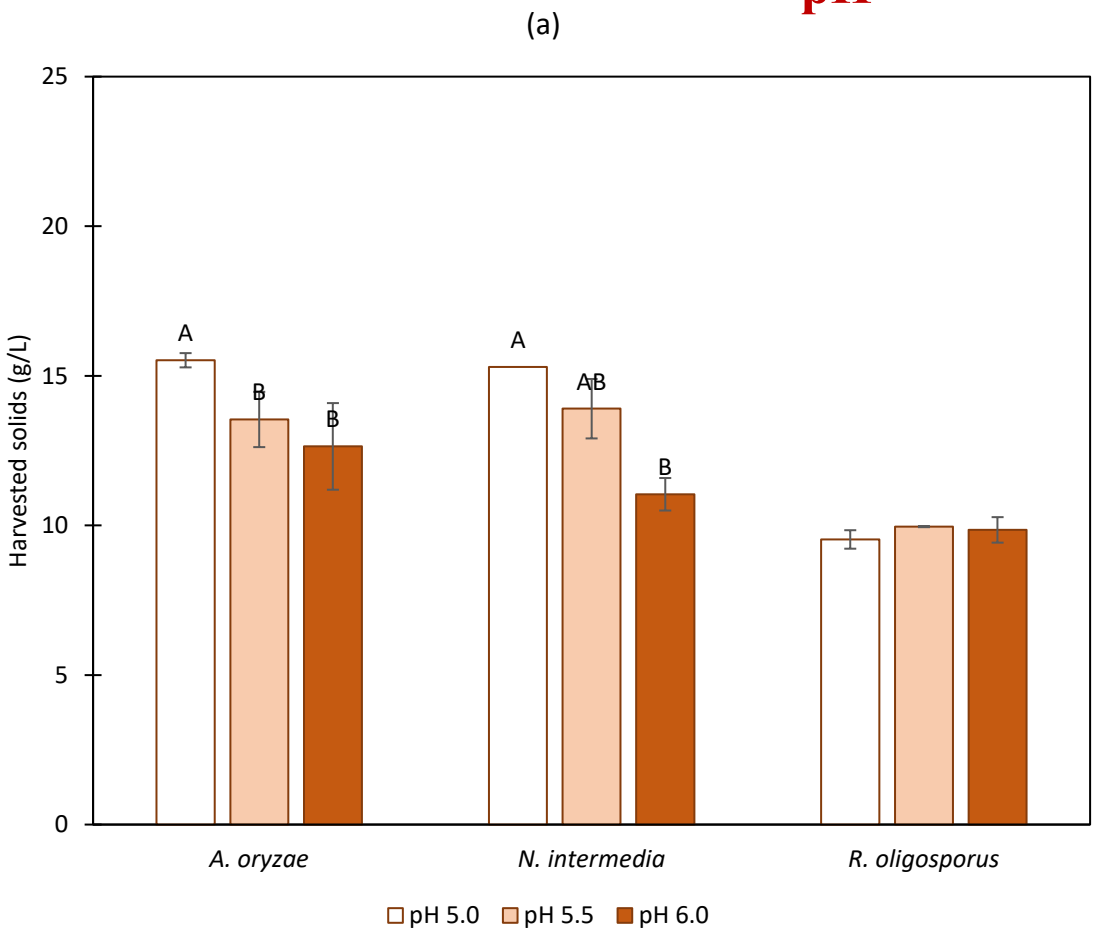
N.intermedia

	Protein (g/kg)
Harvested solids	65.56 ± 0.74

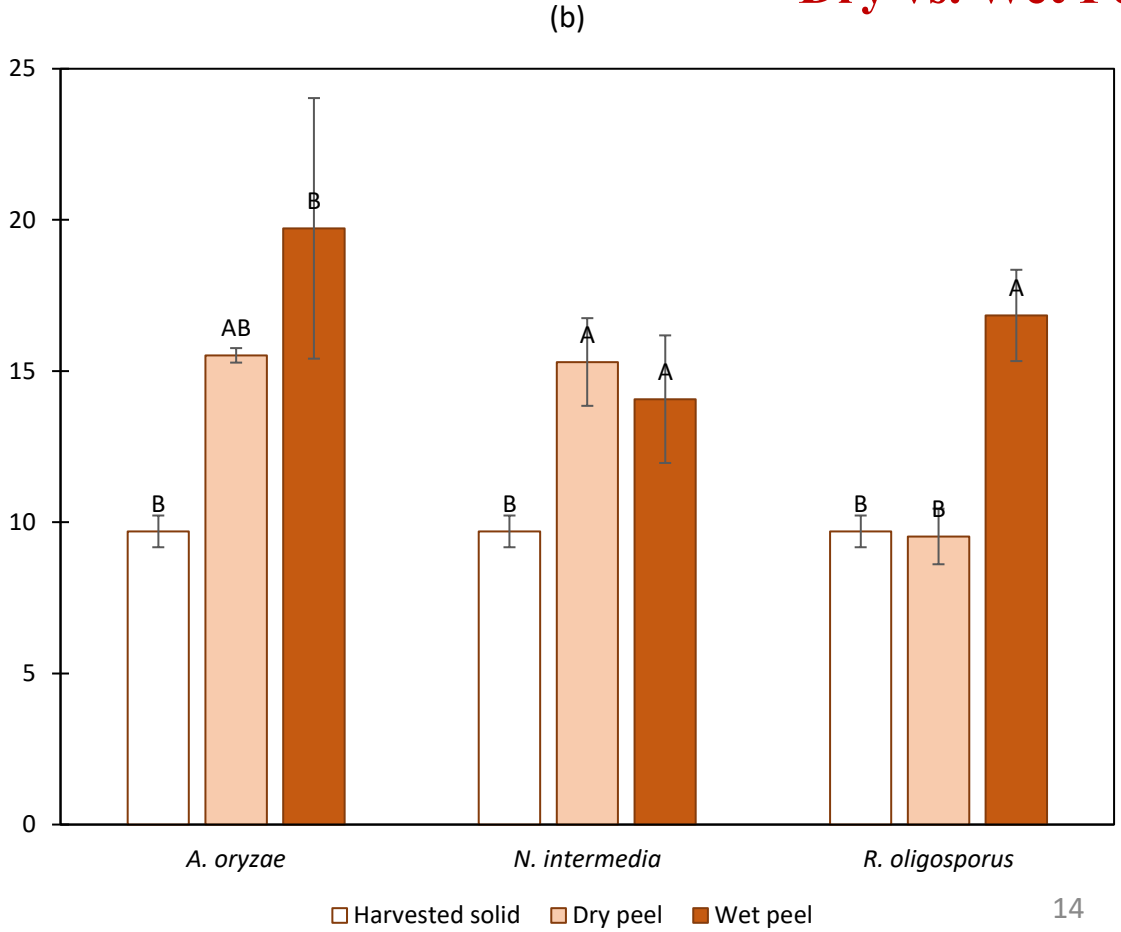
Effects of Peel

Protein (g/kg)	*A. oryzae*	*N. intermedia*	*R. oligosporus*
Dry peel (4%)	85.41 ± 7.56	76.90 ± 0.86	74.54 ± 0.00
Wet peel (16%)	77.44 ± 1.34	68.42 ± 1.66	64.51 ± 2.61

pH



Dry vs. Wet Peel

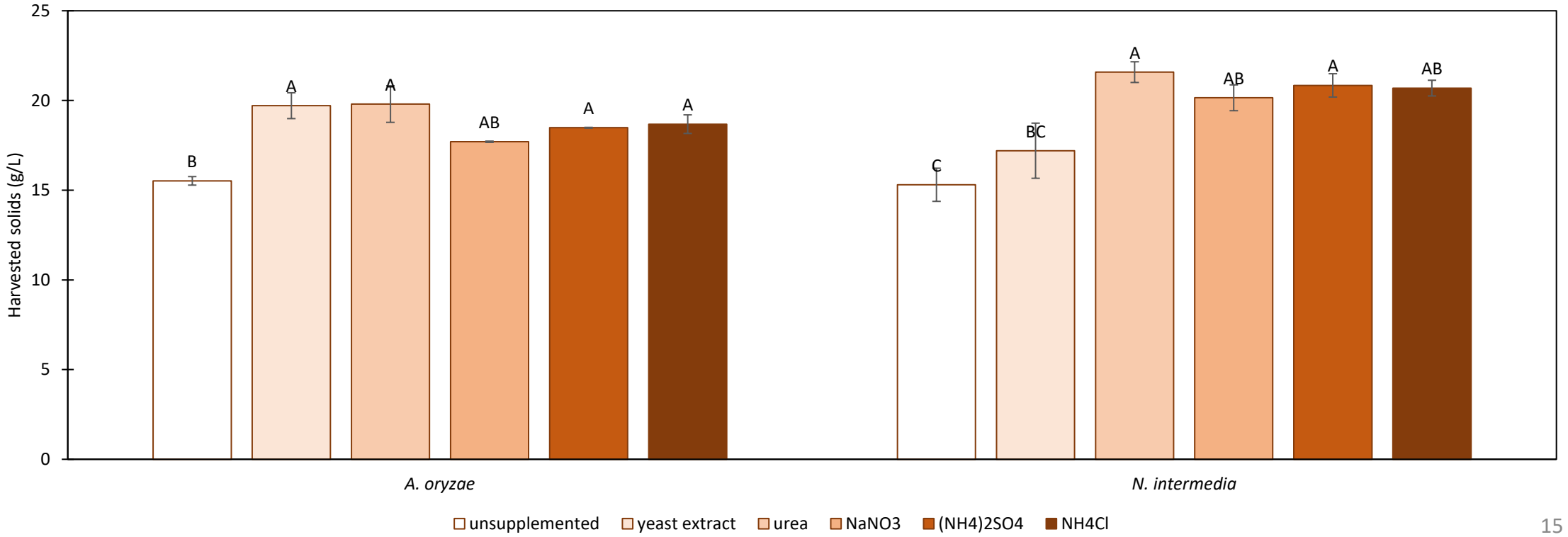


Effects of Peel

Nitrogen Supplementation

Protein (g/kg)	A. oryzae	N. intermedia
Yeast extract	198.63 ± 36.37	148.42 ± 12.04
Urea	137.53 ± 2.59	137.81 ± 0.27
$NaNO_3$	102.56 ± 0.74	124.22 ± 6.15
$(NH_4)_2SO_4$	142.81 ± 3.45	143.63 ± 9.27
NH_4Cl	130.11 ± 0.76	132.10 ± 1.92

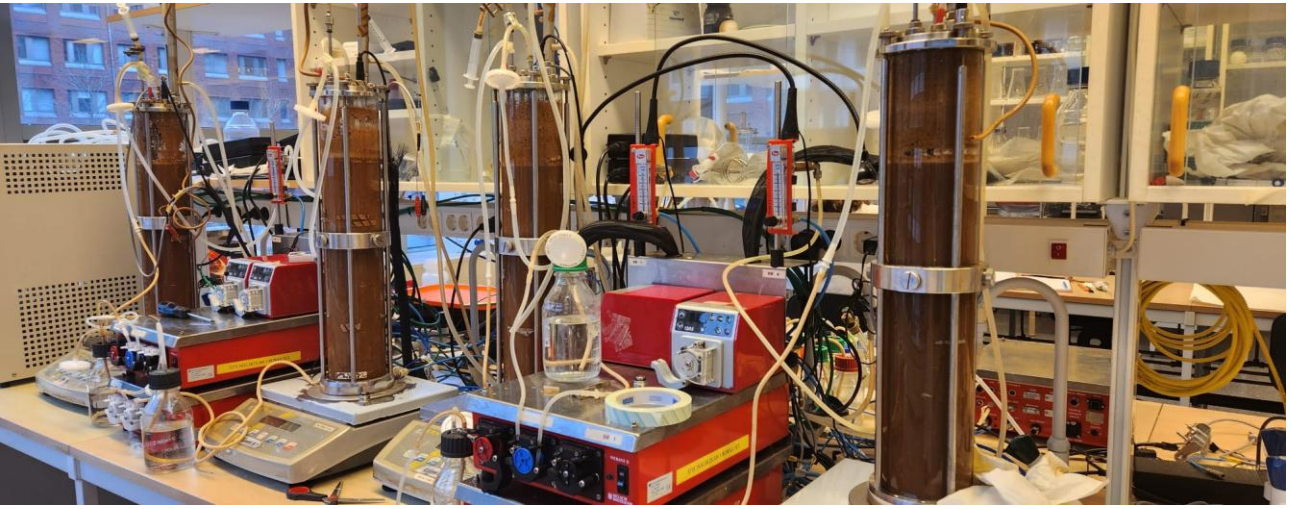
(c)



Bubble column reactor and biomass characterization

Stage 2

- pH 5
- Cultivation time: 48h
- Volume: 3700 ml



Fungal strain	Yeast extract g/L	Pomegranate Peel g/L
A.oryzae N.intermedia	5	40

Biomass production

Fungi	Harvested solids g/L	Yield g biomass / g substrate
A. oryzae	20.35 ± 1.15	0.51 ± 0.03
N.intermedia	19.88 ± 1.58	0.50 ± 0.04

A.oryzae

N.intermedia

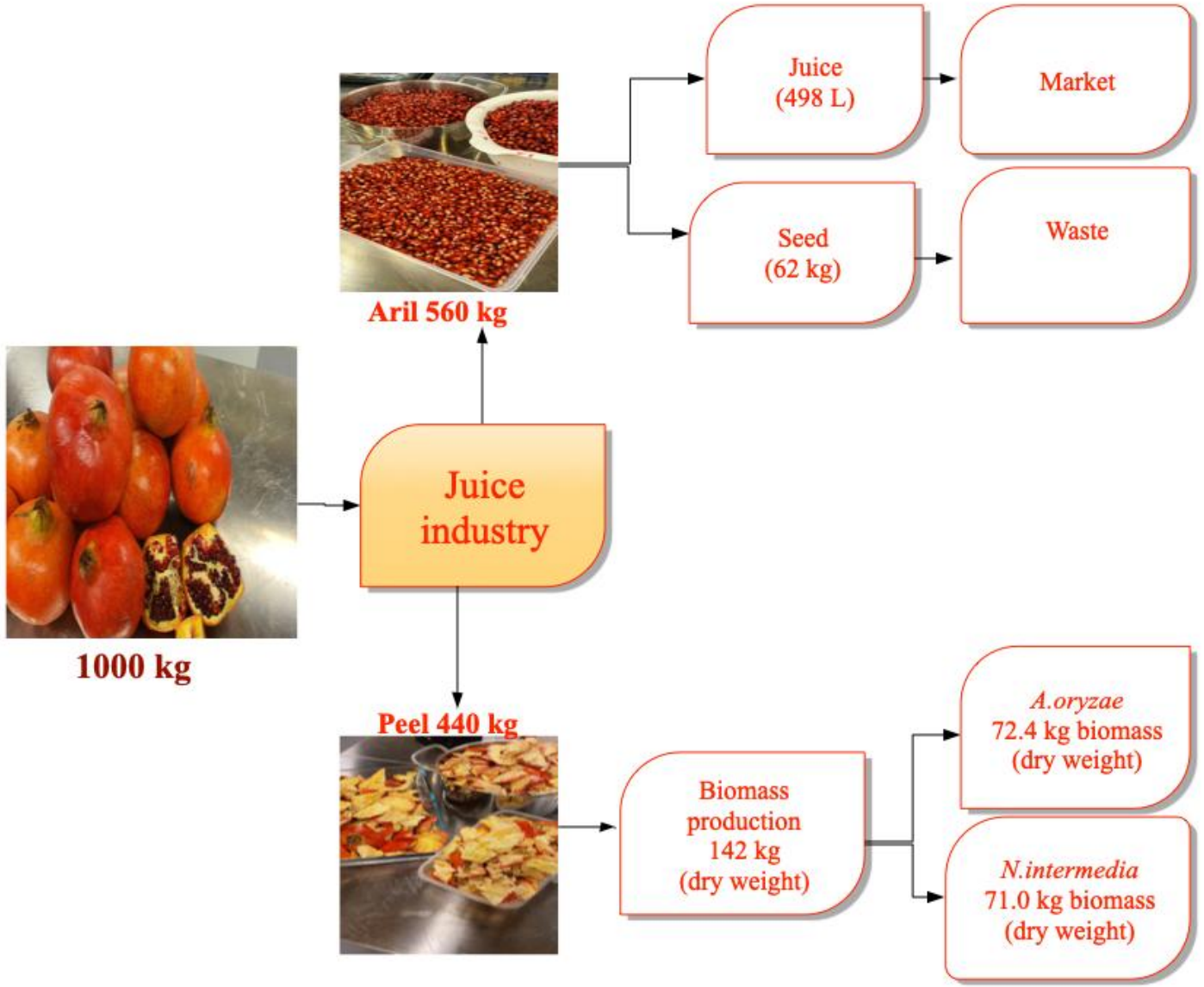
Biomass characterization

	Unit	Peel	*A. oryzae*	*N. intermedia*
TS	(g/kg)	890.41 ± 0.37	952.83 ± 0.38	949.02 ± 0.40
Volatile solid	(g/kg)	847.06 ± 1.60	915.90 ± 4.01	922.03 ± 0.08
Ash	(g/kg)	43.35 ± 1.96	36.93 ± 3.63	26.99 ± 0.32
Total fat	(g/kg)	0.80 ± 0.08	**15.31 ± 5.36**	**13.95 ± 3.31**
Protein	(g/kg)	29.89 ± 2.78	**179.09 ± 3.41**	**121.53 ± 3.21**
Nitrogen	(g/kg)	5.15 ± 0.48	28.66 ± 0.54	19.44 ± 0.51
D glucose	(g/kg)	130 ± 1.41	12.00 ± 0.00	10.50 ± 0.71
D fructose	(g/kg)	117 ± 4.24	6.00 ± 2.83	8.50 ± 2.12
Sucrose	(g/kg)	0.00	0.00	0.00
Crude Fibers	(%)	16.73 ± 0.10	**40.09 ± 0.40**	**40.49 ± 2.90**

Conclusions

- *A.oryzae* and *N.intermedia* were resistant to the effects of pomegranate juice.
- Aril was not a good substrate for the strains investigated.
- All the strains utilized proved to be resistant at higher concentrations when peel was used as substrate.

Fungal biomass production from an industrial perspective



Thank you!

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