Iron complexation using spent yeast peptides for human supplementation

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Introduction

Iron (Fe) deficiency has been a main concern for World Health Organization (WHO), for being the cause of around 1.62 billion people with anaemia worldwide[1]. In fact, since the daily amount of Fe ingested is not enough for many people, the need of dietary Fe supplementation has emerged. However, the common salt-based Fe supplements are not efficient [2] , while peptides from different sources have been explored as an alternative vehicle, via Fe complexes. Spent brewer's yeast is an important source of peptides due to its protein content and growing availability from fermentation processes. Applying a circular economy concept, spent yeast has been used to produce ingredients with biological value, such as β-glucans, whereas the waste streams of these processes are used to recover proteins and peptides. The main objective of the present study was to use these by-products, rich in peptides, and assess their capability to complex Fe.

Methods

Membrane filtration & diafiltration

Waste stream of β-glucans extraction from spent yeast

Gpep > 1 kDa

Peptide-rich extract
(67.2% protein)

Fe-peptide complexes production

Factorial design (pH vs. time)

- Ratio protein:Fe (2:1)
- N_2 atmosphere

Freeze-dried

Complexes chemical & structural characterization

- *% Fe complexed (ICP-OES)*
- *X-ray diffraction*
- *Intrinsic fluorescence*
- *FTIR spectroscopy*
- *Scanning Electron Microscopy (SEM)*
- *Particle size (Mastersizer)*

Results

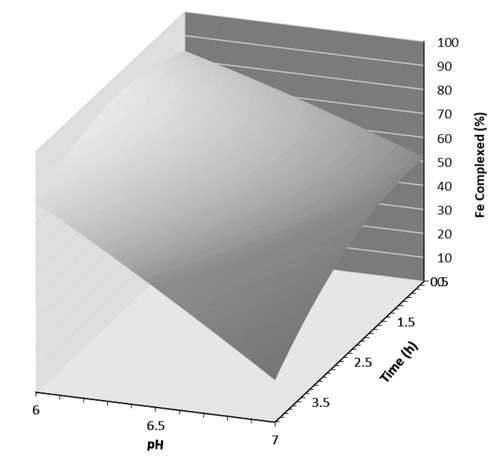

Figure 1. Response surface representing soluble Fe (as % of initially added) versus time and pH.

Gpep>1-Fe complex

Optimum conditions
- pH 6.0, 30 min
- Ratio protein:Fe (2:1)
- N_2 atmosphere

88.0 ± 3.1 complexed Fe (% of initial)

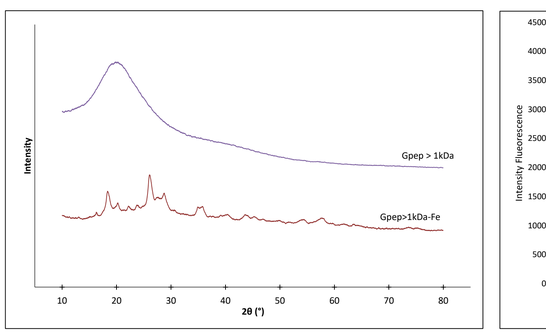

Figure 2. XRD patterns of Gpep>1kDa and Gpep >1kDa-Fe complex from 3 ° to 80° .

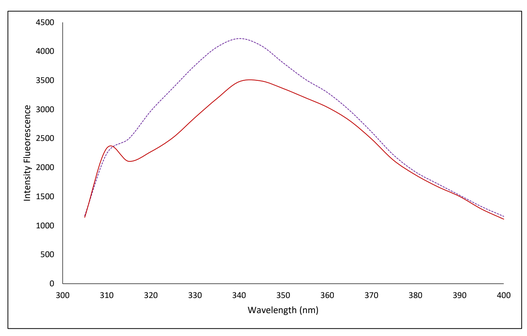

Figure 3. Fluorescence emission spectra of Gpep > 1kDa (dashed line) and Gpep>1kDa-Fe complexes (solid lines). Excitation wavelength = 280 nm; emission wavelength = 300 to 400 nm.°

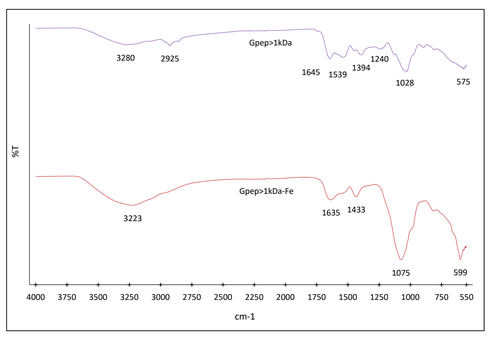

Figure 4. FTIR spectra of Gpep>1kDa and Gpep>1kDa-Fe complex in the region from 4000 to 550 cm-1 and identification of the main peaks observed.

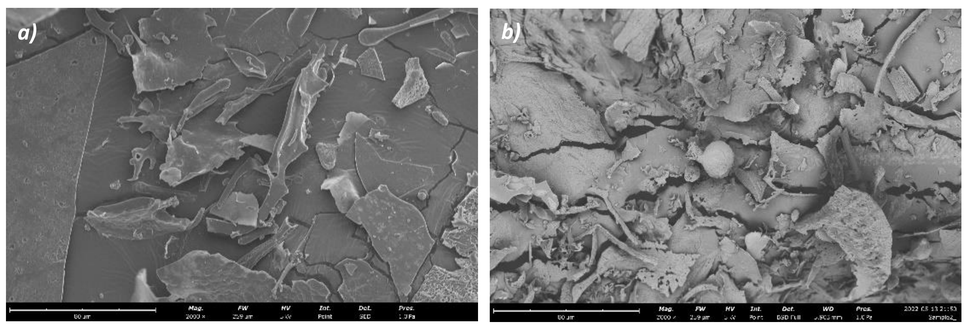

Figure 5. Scanning electron microscopy of Gpep > 1kDa (a) and Gpep>1kDa-Fe complex (b).

Table 4. Particle size of Gpep>1kDa and Gpep>1kDa-Fe complex: Dv 10, 50, 90 (μm)

		Gpep>1kDa	***Gpep>1kDa-Fe***
Particle size (μm)	*Dv 10*	9.12 ± 0.04	0.749 ± 0.001
	Dv 50	39.2 ± 0.1	11.1 ± 0.1
	Dv 90	83.2 ± 0.3	39.2 ± 0.1

Dv 10, 50, 90 - Values of equivalent volume-based sized diameters at 10%, 50% and 90% of distribution

Conclusions

The results of structural analysis showed the presence of synthetised Fe-peptides, observed in the alterations of XRD, intrinsic fluorescence and FTIR profiles in relation to Gpep>1 peptide-rich extract. On the other hand, SEM and mastersizer demonstrated a decrease of particle size during complex reaction, which can be related with the presence of the structural folding and molecular structure rearrangement. From the optimization study, a reaction of 30 min at pH 6.0 using a protein:Fe ratio of 2:1 and N_2 atmosphere were the optimal conditions for Gpep>1-Fe complexation. Thus, it is possible to synthetised Fe-peptide complexes using yeast waste streams, being our ingredient a potential candidate to be incorporated in a product for increasing human bioavailability of this mineral.

References

1. World Health Organization (2008) Worldwide prevalence of anaemia 1993–2005.
2. Athira S, Mann B, Sharma R, et al (2021). Food Res Int 141:110133. https://doi.org/10.1016/j.foodres.2021.110133.

Acknowledgements

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