Optimisation of protein content during spray drying of Black soldier fly larvae protein.

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- In 2050, there will be a global shortage of protein to meet anticipated population growth from the current 7 to 11 billion people (van Huis, 2016)
- Insects are promising alternative protein sources that are capable of complimenting protein supply since they have a protein content of 37-65% and all essential amino acids required for human diet (Barragan-Fonseca et al., 2017)
- Black soldier fly larvae (BSFL) protein is a promising source of insect protein that can compliment protein supply
- BSFL protein has to be processed into a powder form so that it can be used in various food applications that include baby formulae, soups, nutraceuticals, protein shakes and protein bars
- Therefore, optimum spray drying conditions have to be investigated that will increase protein content in the powder product to produce high grade protein powder

Experimental approach

Alkaline extraction of BSFL protein (Temperature-85 °C, pH -11, time-180 min) → Bleaching of BSFL protein (Temperature-85 °C, pH -9, $[H_2O_2]$-0,05 wt. %, time-120 min) → Spray drying of BSFL protein (At design conditions given in **Table 1**)

Figure 1 Experimental approach for optimisation of protein content during spray drying.

Table 1 Independent factors and experimental domains for optimisation using a Central Composite Design (CCD.

Independent factors	Experimental domain
Temperature (°C)	180 - 220
Feed flow rate (L/h)	0.06 - 0.23
Maltodextrin content (%)	5 - 25

- **Figure 1** shows the experimental approach undertaken protein optimisation
- **Table 1** shows the experimental domains for independent factors used during optimisation

Experimental setup

Figure 2 Schematic of a laboratory spray dryer.

Results and discussion

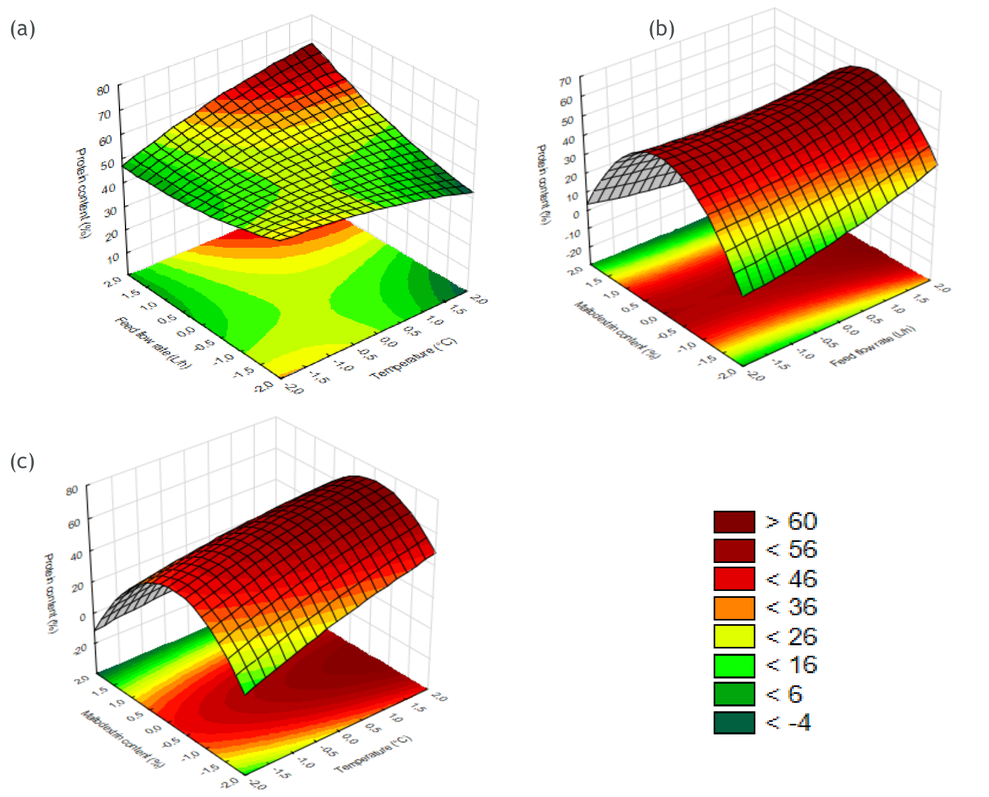

Figure 3 Response surfaces for optimisation of protein content during spray drying of bleached BSFL protein. (a) Surface plot of feed flow rate (L/h) and temperature (°C) at a constant maltodextrin concentration of 15% (b) Surface plot of maltodextrin concentration (%) and temperature (°C) at a constant feed flow rate of 0.15 L/h (c) Surface plot of maltodextrin (%) and feed flow rate (L/h) at a constant temperature of 200 °C.

Figure 4 Conversion of raw BSFL to a white protein powder

Results and discussion

Table 2 ANOVA table for optimisation of protein content during spray drying of protein.

Factor	SS	df	MS	F	p
Temperature (°C) (L)	11,554	1	11,554	0,62918	0,457868
Temperature (°C) (Q)	5,023	1	5,023	0,27353	0,619718
Feed flow rate (L/h) (L)	58,1	1	58,1	3,16383	0,1256
Feed flow rate (L/h) (Q)	6,79	1	6,79	0,36974	0,565434
Maltodextrin concentration (%) (L)	365,998	1	365,998	19,93042	**0,004263**
Maltodextrin concentration (%) (Q)	1288,852	1	1288,852	70,18448	**0,000157**
1L by 2L	39,161	1	39,161	2,13253	0,1945
1L by 3L	28,501	1	28,501	1,55204	0,259275
2L by 3L	36,551	1	36,551	1,9904	0,207984
Error	110,183	6	18,364		
Total SS	2395,419	15			

- **Regression equation**

- P=9 - 0.19 T - 474 F + 15.26 M + 0.0004 T*T- 437 F*F - 0.3401 M *M+ 3.54 T*F - 0.0255 T*M- 6.82 F*M-1.1

- **Optimum conditions**
- T= 220 °C , M= 15% and F= 0,23 L/h

Where: P= protein content (%), M= maltodextrin content (%), T= temperature (°C) and F= feed flow rate (L/h)

- Predicted optimum protein content = **52,3%**
- Experimental optimum protein content= **51.1%**

Conclusions and recommendations

- Optimum spray drying conditions: temperature-220 °C, maltodextrin content- 15% and feed flow rate = 0,23 L/h
- Optimum experimental protein content =51,1% (1.1% lower than predicted protein content)
- Spray drying conditions for optimising powder yield need to be investigated
- Powder properties for the BSFL powder need to be investigated to determine the behaviour of the powder at different humidity conditions during storage

References

van Huis, A. 2022. Edible insects: Challenges and prospects. Entomological Research, 52:161–177. DOI: 10.1111/1748-5967.12582

Barragan-Fonseca, K.B., Dicke, M. & van Loon, J.J.A. 2017. Nutritional value of the black soldier fly (Hermetia illucens L.) and its suitability as animal feed - a review. Journal of Insects as Food and Feed, 3(2):105–120. DOI: 10.3920/JIFF2016.0055