Impact of *Acheta domesticus* powder in bread's nutritional and sensory properties

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Introduction

According to the UN, current food production won't be enough to feed the projected global population of 2050. As such, it is of the utmost importance to start the development of sustainable alternatives. Edible insect powder is a promising sustainable alternative to traditional livestock-derived protein. Insects provide high protein content, fibre, essential minerals, and have a neutral taste, making them suitable for various food applications. Insect-based food products can meet the growing demands of the global population while addressing nutritional and environmental challenges such as protein deficiency, water scarcity and global warming[1,2]. Project SPIN (Sustainable ProteIN, PRR-C05-i03-I-000192-LA9.5), in line with these challenges, aims to develop new protein rich products based on more sustainable sources. One developed product is bread with the incorporation of *Acheta domesticus* (common house cricket) powder.

Objectives

To study the impact on nutritional (proximate and fatty acid composition) and sensory properties of mixed bread, from a 10% substitution of Rye flour with *Acheta domesticus* powder.

Materials and analysis

Mixed bread was prepared with the following materials: wheat flour T65, whole rye flour, fresh yeast, salt, water. One control batch was produced without cricket powder and three batches were made with cricket powder, replacing 60% of rye flour with cricket powder (totalling 10% incorporation). The breads were analysed for proximate composition, microbiological safety, lipid profile and sensory analysis. Sensory analysis was comprised by hedonic and profile tests. An untrained panel participated in three sessions, for a total of 59 responses. The samples were evaluated in triplicate using a 5-point hedonic scale, from 1 ('disliked') to 5 ('liked very much'). Color, texture, odor, and taste were also ranked.

Results and discussion

Proximate analysis

		Method	Cricket powder	Bread (control)	Bread with cricket powder (10%)
Energy	J	Calculation	1751	1056	1020
	Cal		417,0	251,5	242,9
Humidity	%	Gravimetric	4,130	34,76	37,12
Protein	%	Kjeldahl	64,22	11,12	17,27
Lipids	%	Soxlet	13,86	0,082	0,801
Carbohidrates	%	Calculation	4,22	50,59	40,03
Total fibre	%	Weende	9,260	1,978	3,233
Ash	%	Gravimetric	4,320	1,473	1,551

The proximate analysis shows the incorporation of insect powder in the bread mix, in substitution of part of rye flour, lead the resulting bread to have more protein and fibre content, while decreasing the carbohydrate content. Fat content also increased, but its values still represent less than 1% of the bread composition. However, the fatty acid profile of the insect powder and the bread with its incorporation is quite similar.

Fatty acid content

Gas chromatograph with flame ionization detector (GC-FID)

Fatty acid (g/100 g of fat)		Cricket Powder	Bread with cricket powder (10%)
Palmitic acid	C16	28,03	25,97
Stearic acid	C18	9,085	7,195
Oleic acid	C18:1 (9)	23,69	24,09
Linoleic acid	C18:2 (9,12)	30,91	34,55
Linolenic acid	C18:3 (9,12,15)	0,600	1,418
Saturated	SFA	39,46	35,44
Monounsaturated	MFA	26,34	26,98
Polyunsaturated	PUFA	33,06	36,43
ω6/ω3	$\sum \frac{\omega 6}{\omega 3}$	16,27	14,95
Atherogenic Index (AI)	$\frac{C12 + 4 \times C14 + C16}{\sum MUFA + \sum \omega 6 + \sum \omega 3}$	0,527	0,450
Thrombogenic Index (TI)	$\frac{C14 + C16 + C18}{\frac{\sum MUFA}{2} + \frac{\sum \omega 6}{2} + 3 \times \sum \omega 3 + \frac{\sum \omega 3}{\sum \omega 6}}$	1,095	0,892
hypocholesterolemic / hypercholesterolemic	$HH = \frac{C18{:}1 + PUFA}{C12 + C14 + C16}$	1,921	2,254

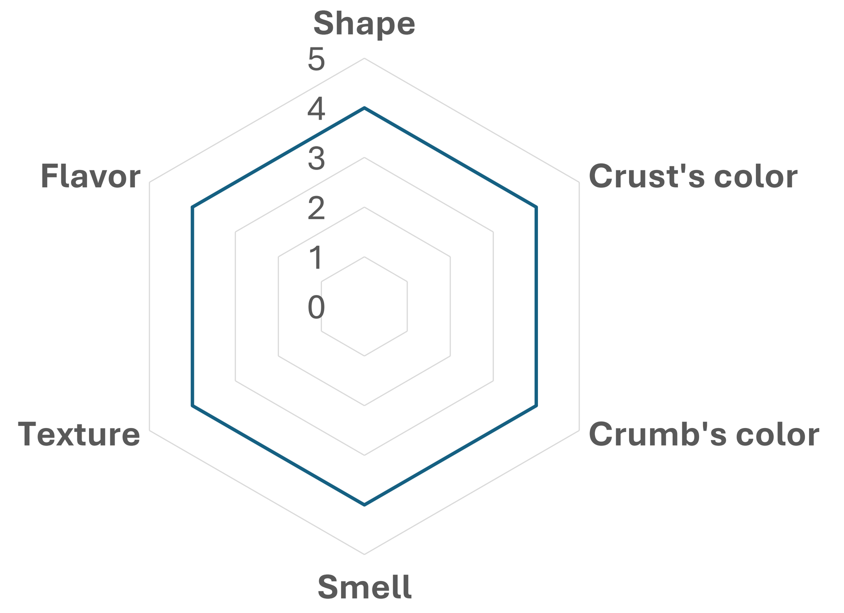
Resulting bread has a good amount of unsaturated fatty acids, totalling 63% of FA. The FA composition results in a good balance of nutritional indices of AI, TI and H/H, being similar to those of chicken (about 0.38, 0.77 and 2.73 respectively[3]). However, the ratio ω6/ω3 is, although in line with common breads, elevated, having a value close to 15 when the ideal value is around 4[4].

Microbiological analysis

Microbiological Parameter (UFC/g)	Method	Bread with cricket powder (10%)
Microorganisms at 30 ºC	ISO 4833-1:2013	<2500
Spores at 30 ºC	ISO 4833-1:2013	<1000
Bacillaceae	ISO 7932:1993	<1,0
Molds and Yeasts ($a_w \leq 0,95$)	ISO 21527-2:2008	<1,0
Enterobacteriaceae	ISO 21528-2:2004	<1,0

Microbiologically, the bread with insect powder incorporation meets all safety parameters.

Sensory analysis



The sensorial analysis shows a high degree of satisfaction from the participants. All sensorial parameters, although not perfect, have been rated as a 4/5. Tasters also showed great interest in the product, with **36%** saying they would buy the bread and **47%** saying they would probably buy the bread.

Conclusions

The developed bread can be seen as a success. It is a safe product with an improved nutritional balance for human health. It is also accepted from a consumer standpoint, further exalting the product. A more comprehensive analysis is underway to include more indicators, such as amino acid content, antioxidant activity and total phenolic content (TPC).

Acknowledgement

SPIN-Sustainable Protein project is funded by RRF – NextGenerationEU.

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