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The effects of earthworm concentration and extraction time on solubility of protein

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KEYWORDS

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ABSTRACT

Earthworm (*Lumbricus rubellus*) is known to contain proteins making it suitable for alternative high-protein resources for feed or animal food. Exctraction of proteins from earthworms is not an easy task and it requires multiple steps for purifying the protein extract. Furthermore, the extraction of earthworm protein is considered as uneconomical due to high operational cost. Therefore, altering the process is necesarry to enhance the extraction. The objective of this research is to optimize the solubility of protein from earthworm juice. The design used in this research is a completely randomized design consisting of two factors which are A (earthworm concentration) and B (extraction time). The results show that solubility of protein was 28.12% and the soluble solid was 67.63%. The optimum process includes earthworm concentration of 15% and extraction time of 90 minutes.

Introduction

Lumbricus rubellus worm has a high protein content accounted for 64-76% consisting of eight types of essential amino acids and five types of non-essential amino acids. Essential amino acids in worms are histidine, leucine, isoleucine, valine, methionine, phenylalanine, lysine, and threonine, while the non-essential amino acids are arginine, cystine, glycine, serine, and tyrosine. Beside protein, worms also contain 7-10% of fat, 0.55% of calcium, 1% of phosphorus, and 1.08% of crude fiber (Palungkun, 2010).

The efficiency of the extraction process may affect the cost and the amount of extract obtained. Extraction using anaerobic process for 2 days was able to extract protein as many as 7% and dissolved material reached more than 50% (Hidayat et al., 2016). Extraction by boiling method has never been studied and used before. The purpose of this study was to determine the effect of boiling time on the soluble protein content of *Lumbricus rubellus* worm.

Material and Methods

The research was conducted at Bioindustry Laboratory, Department Agroindustrial Technology, Faculty of Agricultural Technology, Universitas Brawiaya, Malang.

This study was carried out using a composite factorial design with two factors of percentage of extracted worms and extraction time. The percentage of extracted worms added include 5%, 10%, and 15%. The extraction time used include 30 minutes, 60 minutes, and 90 minutes.

The analysis conducted includes: total soluble protein / soluble amino (N-formol) analysis and total soluble solids analysis.

Result

Soluble Protein

The results showed that the percentage of worms and boiling time significantly affected the amount of dissolved protein (Fig. 1).

Soluble Solids

The result of the analysis of the soluble solids shows the interaction between the percentage of worms and the extraction temperature (Fig. 2).

Optimisation

The optimization analysis showed that the maximum dissolved protein is 28.12% and soluble solid is 67.63% was achieved in the addition of earthworm of 15% with the extraction time of 90 minutes.

Amino acids profiles

Amino acid composition of earthworm extracts can be seen in Table 1.

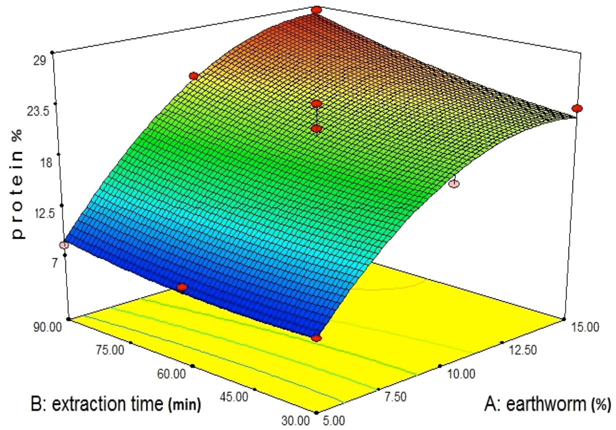

Figure 1. Effect of percentage of earthworm and extraction time on soluble protein.

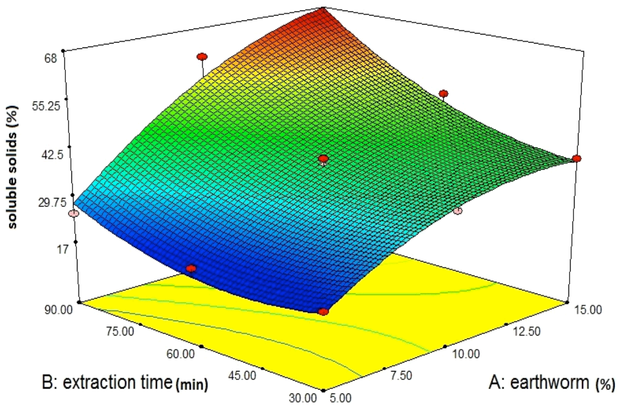

Figure 2. Effect of extraction time and percentage of earthworm on dissolved solids.

Table 1 Amino acid composition of earthworm extracts

Amino acids	Earthworm extract (mg/L)	Cooked leave of *Brasicca* Sp (mg/g).	Beef broth (µmol/100 mL)
L-Aspartic	148.80	282	46.8
L-Glutamic	198.90	397	18.9
L-Asparagine	10.70	-	-
L-Histidine	36.30	95	119.4
L-Serine	70.70	136	13.7
L-Glutamine	8.80	397	-
L-Threonine	97.90	133	8.3
L-Glycine	212.40	151	58.6
L-Arginine	73.20	192	13.5
L-Alanine	587.20	159	118.0
L-Tyrosine	237.40	95	7.2
L-Thryptophan + L-Methionine	185.70	53 (no thryptophan)	7.2
L-Valine	523.90	138	15.4
L-Phenylalanine	237.60	139	17.6
L-Isoleucine	385.40	98	10.5
L-Leucine	312.60	236	17.4
L-Lysine	201.00	192	19.6

Discussion

Based on Figure 1, it can be seen that the increase in soluble protein is more likely to be affected by the percentage of earthworms added than the extraction time. The higher the earthworm is added to the extraction process, the higher the amount of dissolved protein. These results are consistent with previous studies that performed biological extraction (Hidayat et al., 2016). Protein solubility increased sharply in the earthworms addition of the percentage 5% to 10%, then it decreased until the percentage of earthworms was 15%. Variation of extraction time did not show any significant difference and tended to slope. This is in accordance with the research of Qiaoyun et al. (2017) on tea residues. Factors other than proteins present in the extracts make the extraction time have no effect when compared to the percentage of the extracted material.

The result of statistical analysis showed the interaction between the percentage of earthworms added and the extraction time. The higher the percentage of earthworms added and the extraction time, the more soluble solids produced. This is due to the more material added, the more dissolved solids will be produced before reaching the saturation point. In addition, the longer extraction time, soluble solids will be higher. This is because the insoluble material, due to the bonding of other compounds, dissolves as the contact time between the material and the solvent increases. This result is in agreement with Kim (2017) research on coumarin extraction of *Cinnamomum cassia* wood and Trapani et.al. (2017) on olive oil extraction.

Table 1 shows that amino acid of earthworms is better than amino acid of decoction of *Brassica* sp (Lisiewska et al., 2008) especially valine, phenylalanine, leucine, lysine, tyrosine, alanine, glycine and asparagines. In addition, earthworm amino acid is more complete than amino acid from meat extract (Pereira-Lima et al., 2000). These results indicate that amino acid extracted from worm is well used as source of nutrients.

Conclusions

The optimum extraction process uses worms as many as 15% with 90 minutes extraction time. The amino acid composition of earth worm extract is no different from beef extract.

Conflict of interest

The authors declare that there is no conflict of interest in this publication.

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