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SOME FACTORS' EFFECTS ON THE SOLUBILITY OF PROTEIN FROM YELLOW MEALWORM (*TENEBRIO MOLITOR* L) LARVAE*

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Abstract: Studies were conducted to investigate the effects of pH value, extraction time, extraction temperature, ratio of material to extraction medium and salt concentration on the solubility of yellow mealworm larvae protein. The results showed that pH value greatly influenced the solubility, minimum solubility was found at pH 5.8 and a maximum at pH 10 – 12. Salt ion could increase the solubility at the iso-electric point pH and slightly decreased the solubility at the pH value higher than that of the iso-electric point. Other factors did not significantly affect the solubility of the protein.

Key words: yellow mealworm, protein, solubility
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INTRODUCTION

Protein deficiency is one of the most serious problems in the world, especially in developing countries. It has been estimated that about two-thirds of the population in the world are suffering from lack of protein, especially high-quality animal protein (Liu, 1992). It is therefore an urgent task to develop new protein resources in view of the rapidly increasing world population.

Insects have huge biological output, high reproduction capacity and are generally rich in protein. It was suggested that insects could become a possible resource of food protein (Defoliart, 1989).

Yellow mealworm (*Tenebrio molitor* L) is typically found to be injurious to insects in warehouses for agricultural products. It is known to be suitable experimental material for physiological and genetic research (Takiguchi, 1992). Some researches were done on the biological properties, feeding requirements, and feeding effectiveness of yellow mealworm (Xiao, 1994; Gerber et al., 1984). Chang Tong (1994) reported that yellow mealworm larvae could become an ingredient for Chinese sauces, biscuits, etc. Because of the difficulty of convincing people to eat insect food, extracting protein from insects and using it as food ingredients may be a way to use insects. There were investigations on housefly larvae (Li, 1992), honey bees (Ryan et al., 1983; Ozimek et al., 1985) and silkworm pupae (Wang, 1992). However, there are few reports on the extraction of yellow mealworm larvae protein.

This paper presents preliminary laboratory data on some factors' effects on the extracting solubility of yellow mealworm larvae protein. The results of this study are applicable to the production of protein from yellow mealworm larvae.

MATERIALS & METHODS

Mealworm larvae (7-10th instars) bought from the Hangzhou Flower and Birds market were fed wheat bran in plastic basin at normal room temperature (about 15 – 30 ℃).

Ten grams of fresh larvae mixed with different amount of distilled water depending on the desired insect/medium ratio were ground by a DS-1 grinder (Made by Shanghai Model Machinery Factory) and brought to the desired pH by adding a small amount of 6 mol/L HCl or 6

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mol/L NaOH. Depending on the experiment, the mixture was kept at the selected temperature for the desired period of time. The slurry was then transferred to 50 ml centrifuge tube and centrifuged for 10 minutes at 4 000 r/min. The supernatant was decanted from the solid residue. Nitrogen content and pH of the extract were determined after the nitrogen content of the sample of fresh larvae was determined. Nitrogen determination was carried out according to the micro-Kjildahl method(Wang, 1982). The ratio of nitrogen content of extract to nitrogen content of fresh larvae was defined as "protein solubility".

All procedures were conducted three times and the results were expressed as an average. The data were analyzed as described by Montgomery (1976).

1. Effect of ratio larvae/ extraction medium on protein solubility

The extracting ratios tested were 1:5, 1:10 and 1:15. For each extraction ratio, pH was varied from 2.4, 5.8, 10.5, to 12.2. Extraction time and temperature were held constant at 30 minutes and 30 ℃ respectively.

2. Effect of pH and extraction time on protein solubility

The pH of the slurry was adjusted to 2, 4, 6, 8, 10 or 12. At each pH, extraction time was varied from 0, 10, 20, 30 to 40 minutes. Extraction temperature was held constant at 30 ℃. The experiment was repeated at an extraction ratio of 1:5 and 1:10.

3. Effect of extraction temperature on protein solubility

Extraction temperature was varied from 15 ℃, 30 ℃ to 45 ℃. Extraction ratio and time were held constant at 1:10 and 30 minutes, respectively. For each extraction temperature tested, pH was varied from 2, 6, 10 to 12.

4. Determination of iso-electric point

The pH of slurry was adjusted from pH 4 to 6 at steps of 0.2. The extraction ratio, time and temperature were held constant at 10:1, 30 minutes. and 30 ℃, respectively.

5. Effect of NaCl concentration on protein solubility

Extraction conditions were as follows: extraction ratio 1:10, temperature 30 ℃, extraction time 30 minutes. The pH value of the slurry was varied at 2.4, 5.8 and 10.0. For each pH value, NaCl was added to the slurry to obtain the following normalities: 0, 0.2, 0.4, 0.6, 0.8, 1.0 mol/L.

RESULTS & DISCUSSION

1. Effect of larvae/ extraction medium ratio on protein solubility

It seemed that solubility was highest at a larvae to extraction medium ratio of 1:10 except at the pH of the iso-electric point (Fig. 1). This result suggests industrial extraction using extraction ratio of about 1:10. The results are similar to those obtained in research on silk worm pupae (Wang, 1992) and housefly (Li, 1992). One reason is that at the ratio of 1:5 it was difficult to completely pulp the sample.

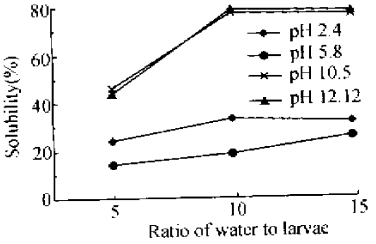

Fig.1 Effect of different ratio larvae/extracting medium on protein solubility at different pH, extraction temperature 30 ℃ and extraction time 30 minutes

2. Effect of pH and extraction time on protein solubility

The protein solubility profiles of Fig.2 indicate that the solubility decreased as pH rose from 2 to 4. Minimum protein solubility occurred in

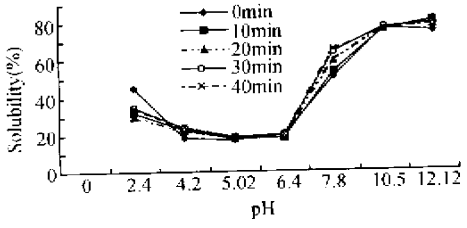

Fig.2 protein of Effect of pH and extraction time on the solubility of mealworm larva protein atextraction ratio 1:10 and extraction temperature 30 ℃

the pH range 4 – 6.5, wherein 18 – 19% of the the larva remained in solution at the extraction ratio 1 : 10. In the alkaline medium, solubility increased with pH rises and saturated at pH 10 – 12. The data also showed that the maximum amount of protein that can be extractable by the experimental technique employed was 79.17%. The 79% maximum protein solubility was lower than that of housefly larva protein extracted by Li (1992).

It was found that the difference in protein solubility at different extraction time was not significant ($P > 0.05$).

3. Effect of extraction temperature on protein solubility

The data in Table 1 show a weak tendency of increasing solubility of mealworm larva protein as the extracting temperature rose from 15 ℃ to 45 ℃. But this tendency was not statistically significant ($P > 0.05$), suggesting that the protein could be extracted at any temperature within this range.

Table 1 Solubility of yellow mealworm larvae protein at different extraction temperature

pH	Temperature(℃)		
	15	30	45
5.8	19.06	22.52	22.26
2.4	35.34	34.85	32.27
10.5	72.01	76.97	79.70
12.12	76.00	78.64	80.51

4. Estimation of iso-electric point

An accurate experiment showed that the iso-electric point of the larva protein was at about pH 5.8, when the solubility of larva protein was 17.5%. This data is useful for isolating the protein from extracts and making preliminary estimates of the amount of larvae protein that can be recovered as a curd or protein isolate. For example, it is possible to get a curd containing 65.76% of the yellow mealworm larvae protein by extracting at pH 12.12 and then isolating at pH 5.8.

5. Effect of NaCl concentration on protein

Fig.3 illustrates the influence of NaCl on the extraction of ground yellow mealworm larvae protein. The result shows that: (1) at near iso-electric point the protein solubility increased with increasing salt concentration; (2) at high pH value, the solubility increased with increasing salt concentration and then decreased after NaCl concentration exceeded 0.6 mol/L; (3) at low pH, the solubility decreased with increasing of NaCl concentration. These results are partially similar with the fish protein solubility researched by Meinke (1972).

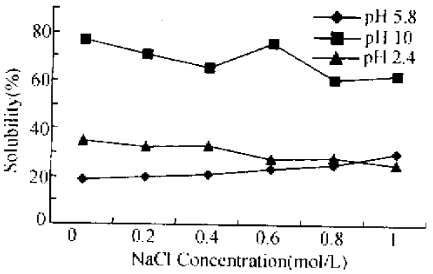

Fig.3 Protein solubility effected by NaCl concentration at different pH extraction time(30 min.) and extraction temperature(30 ℃)

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