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Black Soldier Fly (Hermetia illucens) Prepupa Phase Fermentation by Organic Acids to Decrease Chitin Content

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Abstract. Black Soldier Fly (BSF) has high protein but there are of chitin that hardly be digested livestock such as poultry and monogastrics. Chitin is a natural polysaccharide abundantly found crustacean organisms and insects. Chitin bound to the exoskeleton, proteins, minerals and pigments. The aim of this research was to determine the concentration of organic acids which could reduce the chitin content of the prepupa phase of BSF through fermentation. This study used a completely randomized design (CRD) with five treatments P1 = BSF + 50% propionic acid + 50% formic acid, P2 = BSF + 40% propionic acid + 40% formic acid + 20% aquadest, P3 = BSF + 30% propionic acid + 30% formic acid + 40% aquadest, P4 = BSF + 20% propionic acid + 20% formic acid + 60% aquadest, P5 = BSF + 10% propionic acid + 10% formic acid + 80% aquadest with three repetitions. Parameters were chitin content, pH, total titrated acid and organoleptic test. The results of this study indicate that addition of 50% propionic acid + 50% formic acid resulted in the highest reduction in chitin content, namely 11.00%, pH 4.7, total titrated acid 0.014% and also has good aroma and texture.

Keywords: black soldier fly prepupa phase, chitin, organic acids

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1. Introduction

BSF is an insect that is currently being studied for its characteristics and nutritional content. BSF spread to subtropical and tropical regions of the world which originally came from America [1]. The life cycle of the BSF takes 38 - 41 days and consists of 5 life stages, i.e. eggs, larvae, prepupa, pupa and adult flies [2]. The increasing age of the BSF larvae will increase the fiber and chitin components [3].

Chitin is an abundant biopolymer isolated from organisms such as crustaceans, arachnids and insects [4]. Chitin is usually bound to proteins, various pigments and minerals [5]. In the BSF prepupa phase the chitin content was around 5.6% to 6.7% [6]. In their digestive tract, chickens have chitinase, but their ability to utilize chitin is very limited [7]. In broilers, the ability to digest insect nutrients varies and is determined by several factors including insect species, life cycle and processing to remove chitin content [8] [9].

A study by [10] showed chitin content in fish by fermentation process was reduced by using organic acids (formic acid and propionic acid), the ratio is 1: 1 and the amount of organic acid used was 3%. Another study also used organic acids as a fermenter to reduce chitin levels in BSF maggot flour where the initial content of chitin was 14.39%, decreased to 7.22% with a fermentation time of 8 days and the amount of organic acid used was 7% [11].

Based on BSF researchs previously, this research try to investigate the prepupa phase of the BSF fermentation with various levels of propionic acid and formic acid concentrations in order to reduce chitin content.

2. Materials and Methods

2.1. Materials

The BSF used was a prepupa phase of 3 kg, obtained from cultivators (18-25 days old BSF with fruit waste media, 30% moisture content, 2 cm thin media size and 33^{o} C temperature). Merck's propionic acid, Brataco Chemical's formic acid, 125 mm Whatman paper No.40, HCl 0.01 N, distilled water, phenoftalene, 3.5% NaOH and 0.1 N NaOH.

2.2. Methods

This study used a completely randomized design (CRD) with five treatments and three replications :

P1 = BSF + 50% propionic acid + 50% formic acid

P2 = BSF + 40% propionic acid + 40% formic acid + 20% aquadest

P3 = BSF + 30% propionic acid + 30% formic acid + 40% aquadest

P4 = BSF + 20% propionic acid + 20% formic acid + 60% aquadest

P5 = BSF + 10% propionic acid + 10% formic acid + 80% aquadest

3. Results and Discussion

3.1 Chitin content of BSF (Hermetia illucens) Prepupa Phase fermented by organic acids

After fermentation process of BSF (Hermetia illucens) in prepupa phase, data were collected and were persented in “Table 1”.

Table 1. Chitin content of BSF after fermenting by organic acids

Treatments	Repetations			Average
	1	2	3	
P1	10,95	10,85	11,20	11,00[a]
P2	12,10	13,15	11,60	12,28[b]
P3	13,90	15,05	14,15	14,36[c]
P4	15,80	15,45	15,85	15,70[d]
P5	16,80	16,35	17,45	16,86[e]

Note: Different letters in the same column indicate very significant differences (P <0.01)

BSF fermentation at various concentrations of organic acids had a very significant effect (P <0.01) on chitin content. “Table 1” showed that the higher the concentrations of organic acids used in the prepupa phase of the BSF fermentation caused higher reduction of chitin content. The highest reduction of chitin was obtained in P1 namely 11.00% before fermentation was 18.05% and the lowest reduction of chitin content was on P5 which is 16.86% before fermentation was 18.05%.

The use of organic acids as fermenter can reduce chitin content. This is due to the occurrence of an acidic atmosphere during fermentation which can degrade chitin so that the chitin breakdown was occurred thus increased digestibility.

The use of organic acids as a fermenter to reduce chitin levels has been investigated in shrimp waste silage with a mixture of organic acids (propionic acid and formic acid) at a level of 7% and fermentation time of 8 days showed the highest reduction in chitin, namely 9.92% from unprocessed shrimp waste of 16.89 %. [13] Silage from BSF prepupa phase by adding 99% propionic acid which is as much as 0.4% of the wet weight for 30 days showed the lowest yield of chitin reduction as much as 5.75%. [11] in fermentation of maggot flour with a fermentation time of 8 days, the amount of organic acids used was 7% resulted reduction chitin content of maggot flour which before fermentation was 14.39% while after fermentation it was reduced to 7.22%.

3.2. pH of BSF (Hermetia illucens) Prepupa Phase fermented by organic acids

Another parameter of this research was pH of BSF after fermentation by organic acids.

Table 2. pH of BSF phase prepupa after fermentation by organic acids

Treatments	Repetations			Average
	1	2	3	
P1	4,8	4,6	4,7	4,7[a]
P2	5,2	5,2	5,1	5,2[b]
P3	5,3	5,2	5,3	5,3[bc]
P4	5,7	5,6	5,6	5,6[d]
P5	7,6	7,7	7,6	7,6[e]

Note: Different letters in the same column indicate very significant differences (P <0.01)

"Table 2" showed that the higher concentrations of organic acids used in the prepupa phase of the BSF fermentation cause a decreased of pH. A feed component which has lower pH such as in P1 indicated the feed will be in good condition because patogenic bacterial cannot harm it.

BSF fermentation at various concentrations of organic acids had a very significant effect (P <0.01) on pH . The use of organic acids with different concentrations will cause a different pH decrease and the higher the organic acids concentration will also cause a lower pH decrease. This is because the acidic atmosphere during fermentation took place, where the pH decreases, the acidic atmosphere experiences stiffening due to the high concentration which causes the pH to decrease.

[14] making silage of golden snails with a mixture of propionic acid and formic acid at a concentration of 4% showed a low pH reduction of 4.9%. [12] from a combination of propionic acid and formic acid with a level of 7% and fermentation time of 8 days when the silage of shrimp waste showed the lowest pH decline, namely 3.83. [13] Silage from BSF prepupa phase by adding 99% propionic acid which was as much as 0.4% of the wet weight for 30 days shows a pH of 6.86.

3.3 Total Titrated Acid of BSF (Hermetia illucens) Prepupa Phase fermented by organic acids

Another parameter of this research was total titrated acid of BSF after fermentation by organic acids.

Table 3. Total titrated acid of BSF fermented by organic acids

Treatments	Repetations			Average
	1	2	3	
P1	0,014	0,014	0,014	0,014^{tn}
P2	0,021	0,021	0,021	0,021^{tn}
P3	0,028	0,028	0,028	0,028^{tn}
P4	0,036	0,036	0,036	0,036^{tn}
P5	0,043	0,043	0,043	0,043^{tn}

Note: The same letter in the same column shows no significant difference (P> 0.05)

"Table 3" shows that the higher the concentration of organic acids used in the prepupa phase of BSF fermentation caused the increase in the total titrated acid eventhough there were no significancy among parameters . The mean total titrated acid obtained in treatment P1 was 0.014, in treatment P2 was 0.021, P3 was 0.028, P4 was 0.036 and P5 was 0.043.

The prepupa phase of the BSF fermentation using different concentrations of organic acids caused increased the total titrated acid. This was because when fermentation takes place with a high acid concentration it will increase titrated acid, if the acid concentration is high it will decreased the pH.

According to [15] total acid fermentation and pH has a close bond where later when the total acid increases, the pH will decrease. [16] if the pH value is lower, then the total value of titrated acid will increase.

3.4 Organoleptic Tests of BSF (Hermetia illucens) Prepupa Phase fermented by organic acids

Organoleptic test is a method in testing the quality of a material. Organoleptic tests were carried out to determine physical differences including aroma and texture. The morphology of the prepupa phase of the fermented BSF is presented in "Figure 1".

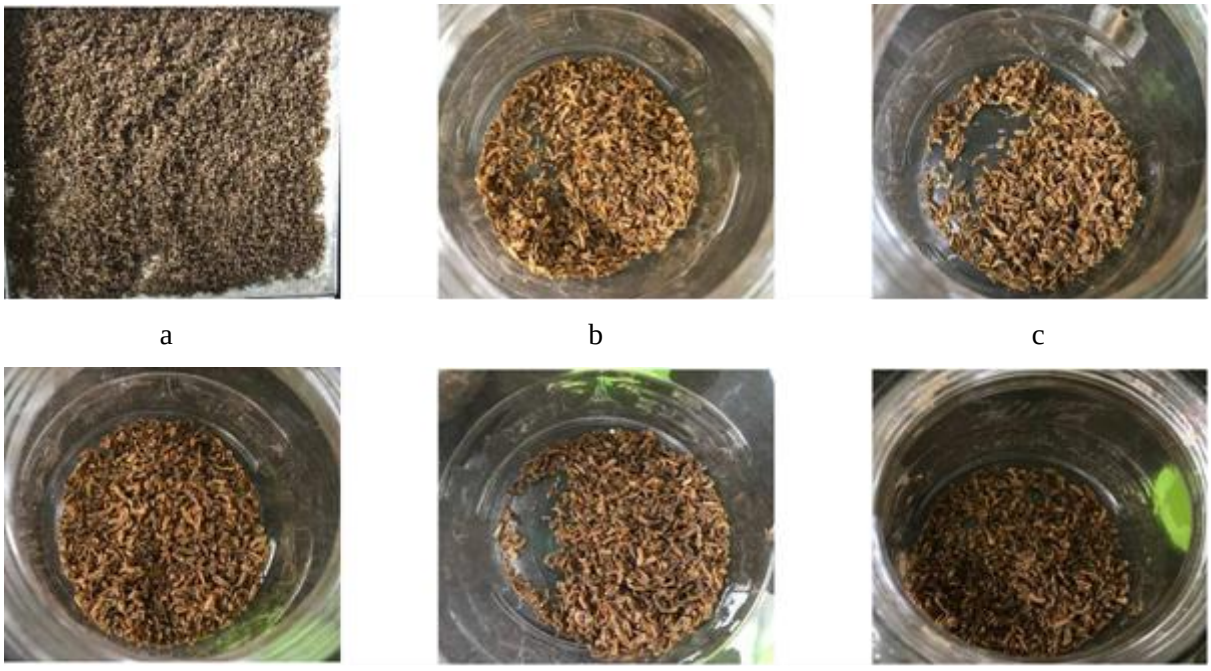

Figure 1. (a) P0: BSF non fermentation;
(b) P1 = BSF + 50% propionic acid + 50% formic acid;
(c) P2 = BSF + 40% propionic acid + 40% formic acid + 20% aquadest;
(d) P3 = BSF + 30% propionic acid + 30% formic acid + 40% aquadest;
(e) P4 = BSF + 20% propionic acid + 20% formic acid + 60% aquadest;
(f) P5 = BSF + 10% propionic acid + 10% formic acid + 80% aquadest

The fermentation results showed changes in texture and aroma. The unfermented BSF prepupa phase has a soft texture, while the fermented BSF prepupa phase has a different texture which was crumble. Chicken prefer to consume feed in crumble than others.

Aroma of a material can be tested using the sense of smell. The organoleptic aroma test results showed that there was a difference in aroma between the BSF in the non fermented prepupa phase and those fermented using organic acids. The non fermented BSF prepupa phase has a distinctive aroma like the dried BSF which is slightly fishy. The fermented prepupa phase of BSF has a different aroma, which is slightly acidic for the P1 treatment. In P2, P3, P4 and P5

treatments have a distinctive and sour aroma. [17] from the organoleptic test showed that there was a difference in the aroma between fermented and non fermented.

4. Conclusion

Based on the results of this study showed that P1 treatment BSF + 50% propionic acid + 50% formic acid resulted in the highest reduction in chitin content 11.00%, pH 4.7, total titrated acid 0.014% and organoleptic test showed the texture was crumble and slightly sour aroma.

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