Comparisons of pupae oil fatty acids composition and development parameters in a mulberry- and artificial diet- fed insect pest, *Spodoptera litura*

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The diets of insects generally provide a sufficient supply of energy and building materials for body growth and development, but should also contain essential nutrients. When digest these foods, insects could distribute them to various pathways such as body development, cell functions, energy reserves and immune response (Jervis et al., 2008). Among these, fatty acid plays an essential role for insects and its composition varies with the kinds of diets and insect species. As a polyunsaturated fatty acids (PUFA), it is well demonstrated that linolenic acid (LA) is an important constituent of phospholipids and ensures the mobility of proteins embedded in the cell membrane of insects (Arien et, al., 2015). However, many insect species are lack of de novo LA synthesis capacity. Therefore, intake from diets becomes the main pathway for some insects to utilize LA (Visser et al., 2010; Malcicka et al., 2017).

After digesting LA from foods, they are usually stored in some certain body parts or developmental stages in insects. Many studies reported that pupa stage could accumulate LA and many other fatty acids. For instance, pupae oil of silkworm (*Bombyx mori* L.) contains high level of *α*-linolenic acid and has the potential to be an alternative PUFA resource (Zhao et al., 2015; Liu et al., 2015). The common cutworm *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) is one of the most destructive polyphagous pests of soybean, cotton and vegetable crops in China (Sheng et al., 2014). Recently, it also causes serious damage in mulberry trees in eastern China. Based on the similar feeding habit, we hypothesis that invertebrate pests feed on mulberry trees may also have higher level of certain types of fatty acids including LA. In order to examine this hypothesis, we conducted a series experiments to examine the fatty acid profile of mulberry-fed *S. litura* pupae and take the artificial diet-fed pupae as a control. Meanwhile, key developmental parameters were also measured.

As shown in Table 1, the majority of fatty acid components was higher in ML pupae oil than in AD oil except for linoleic acid (C18:2). By contrast, *α*-LA (C18:3) content in ML oil was more than 4 folds than in AD oil. This strongly suggested that *S. litura* pupae could yield high levels of *α*-LA when digested mulberry leaves compared to artificial diet. Therefore, we speculated that a special biotransformation pathway of fatty acids may exist in mulberry leaves-fed *S. litura* pupae. Meanwhile, our result showed that the *α*-LA content in ML pupae oil was even higher than in soybean oil, corn oil, or rapeseed oil which was popular plant-derived oil presently (Nagao et al., 2001). When compared to silkworm pupa oil, *α*-LA content was lower (Zhao et al., 2015) and we speculated that feeding habit specificity of these invertebrates may be the primary cause. In future studies, more monophagous pests of mulberry, such as *Diaphania pyloalis* or *Hemerophila atrilineata*, would be tested to examine their *α*-LA contents.

As shown in Table 2, the development duration was longer in ML *S. litura* than in AD treat. Pupae weight and mortality rate were comparable between AD and ML treatments. Longer development duration of mulberry leaves-fed *S. litura* larvae implied that they may need more time to complete their life history features and they could effectively accumulate *α*-LA content. On the other hand, pupae weight and mortality were similar between two treatments, which suggested that the total biomass and death risk were not affected by food alteration.

Table 1 Fatty acid composition in *S. litura* pupae oil derived from artificial diet and mulberry leaves

Food source	Fatty acids (%)				
	C16:0	C18:0	C18:1	C18:2	C18:3
Artificial diet (AD)	35.53 ±0.72	1.73 ±0.016	24.44 ±0.25	32.61 ±0.042	3.92 ±0.070
Mulberry leaves (ML)	44.13 ±0.57	5.60 ±0.26	26.33 ±0.25	4.21 ±0.060	17.45 ±0.050

Table 2 Development parameters of *S. litura* when digested artificial diet and mulberry leaves

Food source	Development durations (days)	Pupae weight (mg)	Mortality rate (%)
Artificial diet	17.66 ±1.73	376.43 ±22.86	19.76 ±2.43
Mulberry leaves	23.84 ±0.46	347.38 ±37.64	20.43 ±2.44

In conclusion, our study would provide a novel strategy of integrated pest management. Utilization of precious fatty acids in insect pests may be a new candidate approach to broaden the resources of PUFA, which is vital for human health.

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