Antidiabetic activity of *Tenebrio molitor* linn powder by oral glucose tolerance test to swiss webster male mice

Erwin Samsul¹, Andreanus A. Soemardji², Siti Kusmardiyan² and Hadi Kuncoro¹³⁶

1. Laboratorium Riset dan Pengembangan Kefarmasian Farmaka Tropis, Fakultas Farmasi, Mulawarman University, Samarinda, 75119, INDONESIA
2. Pharmacology–Clinical Pharmacy Research Group, School of Pharmacy, Institut Teknologi Bandung, INDONESIA

*hadikuncoro@farmasi.unmul.ac.id*

Abstract
*Tenebrio molitor* Linn. is used by Indonesian people as a drug to reduce blood sugar levels. This study aims to examine the activity of *Tenebrio molitor* powder as antidiabetic. This research method used male mice with bodyweight 25-25 g, ages 2-3 months and divided into five groups with five male mice for each group. One group as negative control used CMC Na (1%) and one group as comparison control used Glibenclamide (5 mg/kg). This experiment used Oral Glucose Tolerance test procedure with modification. Administration of *Tenebrio molitor* powder dose 90 mg/kg BW and 45 mg/kg BW reduced blood glucose levels for 120 minutes with percentage 24,2% and 27,7% on glucose load, 22,4% and 21,9% on sucrose load, 17% and 21,7% on amyloam load.

The percentage decrease in blood glucose levels was lower than the comparison group of glibenclamide (5 mg/kg BW) with a percentage of 36,8% in glucose load, 23,2% in sucrose load and 22,6% in amyloam load. Based on the evaluation results of the *Tenebrio molitor* powder with glucose tolerance method at doses 45 and 90 mg/kg BW had antidiabetic activity, but its strength was lower compared to glibenclamide.

**Keywords:** *Tenebrio molitor* Linn powder, Antidiabetic Activity, Oral glucose tolerance test.

Introduction
Diabetes mellitus (DM) or commonly referred to “Kencing Manis” by Indonesian people is a disease characterized by a persistent increase in blood glucose levels which can be caused by a disruption of insulin action or alpha-glucosidase enzyme activity or both. According to the latest estimate of the International Diabetes Federation (IDF), 382 million people are living with diabetes in the world in 2013. In 2035 this number is expected to increase to 592 million people. Out of 382 million people, 175 million have not been diagnosed so that it is threatened to develop progressively into unconscious complications and without prevention.

In Indonesia, basic health research data shows an increase in the prevalence of diabetes from 6,9% in 2013 to 8,5% in 2018. International Diabetes Federation data in 2015 states that the estimated number of diabetics in Indonesia is estimated at 10 million. As per prevailing conditions in the world, diabetes is now one of the biggest causes of death in Indonesia. Sample Registration Survey data in 2014 showed that diabetes was the third biggest cause of death in Indonesia with a percentage of 6,7% after stroke (21,1%) and coronary heart disease (12,9%). If not addressed, this condition can cause a decrease in productivity, disability and premature death.

Considering how important drugs are for diabetes treatment, many researchers are trying to find and develop medicines for diabetes that are safe and of quality. For that, drugs derived from natural ingredients are the main choice because they are known for their safety and quality effects which are not inferior to synthetic drugs. One of the natural drugs known to the public is *Tenebrio molitor*. *Tenebrio molitor* is a kind of beetle of the genus *Tenebrio* and species is *Tenebrio molitor* Linnaeus. It has a black or dark brown color and is 5-7 mm long. *Tenebrio molitor* is easy to cultivate with low cost and fast life cycle. The use of *Tenebrio molitor* as medicine is carried out using being consumed alive which is put in a capsule shell and taken with water.

Material and Methods

Collection and identification: *Tenebrio molitor* (*Tenebrio molitor* Linn.) was obtained from one of the sellers in the city of Samarinda, Kalimantan Timur and bred in Research Laboratory, School of Pharmacy, Bandung Institute of Technology. The determination was carried out in Zoology Museum, School of Biological Sciences and Technology, Bandung Institute of Technology.

Preparation of experimental animal: Test animals used in this study were male swiss webster mice weighing 25-35 g aged 2-3 months with healthy conditions at Animal Laboratory, School of Pharmacy, Bandung Institute of Technology.

Preparation of powder: *Tenebrio molitor* Linn. is washed and cleaned with distilled water, then dried and weighed, then blended with 30 mL of distilled water. The results are then dried using a freeze dryer.

Powder Characteristic: Characteristics of *Tenebrio molitor* Linn. powder include determination of drying shrinkage, particle size, organoleptic examination, examination of chemical content.
Experimental Design: Nondiabetic mice were performed for Oral glucose tolerance tests (OGTT) according to standard method. OGTT was performed after 4 weeks of the experimental period on overnight fasted diabetic rats followed by an oral administration (2 g/kg of body weight) with different loaded glucose, sucrose and amylum. Blood samples were collected from the tail vein of each animal model just after oral administration at 0, 30, 60, 90 and 120 minutes for the assay of glucose. Glucose concentration was measured with an blood glucose meter (Accu-Check active).

Group I stands for normal control group (CMC Na 1%). Group II was treated with glibenclamide (5 mg/kg body weight), Group III was treated with Tenebrio molitor powder (9 mg/kg body weight), Group IV was treated with Tenebrio molitor powder (45 mg/kg body weight), Group V was treated with Tenebrio molitor powder (90 mg/kg body weight).

Results and Discussion

Based on the results of the research, for 60 days Tenebrio molitor Linn breeding was carried out and Tenebrio molitor Linn has several stages of the life cycle, namely the first stage in the form of eggs. It is not visible because of white color like the food in the form of yeast, then develops into larvae, pupae, young Tenebrio molitor Linn. and adult Tenebrio molitor.

Yeast used has a composition of rice, garlic, chili, white pepper and fennel. As for the maintenance, site has a temperature of 26.6°C and humidity as much 65% to get optimal development. Tenebrio molitor Linn is made into powder by blending and then the results are dried using a freeze dryer to maintain the stability of the substances contained inside which is thought to reduce blood glucose levels in mice and also make it easier to induce to oral mice. After characterization powder drying shrinkage of 8,08% (8.08 ± 0.18) was obtained and powder can be categorized including fine powder because it can pass through the sieve with mesh number 60 and does not pass sieve mesh number 80. Organoleptically, the powder has a dark brown color, smells typical and has no taste and has a protein content of 0,58%; this protein is thought to have the effect of lowering blood glucose. As for the method used is Oral Glucose Tolerance Test, five groups consist of 1 pain group, 1 comparison group and 3 test groups with each dose 9 mg/kg BW, 45 mg/kg BW and 90 mg/kg BW with glucose load, sucrose load and amylum load.

The purpose of using sucrose and amylum is to see the response of Tenebrio molitor Linn. because sucrose and amylum are also carbohydrates found in foods that are often consumed by the public. The results showed that Tenebrio molitor Linn at doses 45 mg/kg BW and 90 mg/kg bw had the ability to reduce blood glucose lower than glibenclamide. Observations are presented in table 1, table 2 and table 3.

Statistical data showed that Tenebrio molitor powder at doses of 45 mg/kg BW and 95 mg/kg BW could reduce blood glucose levels by 120 minutes with a percentage of 24.2% and 27.7% in glucose load, 22.4% and 21.9% in sucrose load, 17% and 21.7% in amylum load. Percentage of glucose reduction the blood was lower than the comparison group glibenclamide (5 mg/kg BW) with a percentage of 36.8% in glucose load, 23.2% in sucrose load and 22.6% in amylum load.

The research showed that doses of 45 and 90 mg/kg BW could reduce blood glucose levels in mice but the ability to reduce blood glucose was lower than glibenclamide. This is thought to be the mechanism of action of Tenebrio molitor powder in reducing levels of blood glucose by increasing the mechanism of absorption of glucose and pancreatic beta cell insulin secretion. An increase in blood glucose levels with a greater glucose burden than the administration of sucrose and amylum.

<table>
<thead>
<tr>
<th>Test Groups</th>
<th>Average Blood Glucose Level (mg/dL)</th>
<th>T0</th>
<th>T30</th>
<th>T60</th>
<th>T90</th>
<th>T120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Control (Na CMC 1%)</td>
<td></td>
<td>91 ±33,04</td>
<td>110,66±26,53</td>
<td>133,66 ±40,07</td>
<td>120,33 ±40,77</td>
<td>121,33 ±44,5</td>
</tr>
<tr>
<td>Comparison (Glibenclamide 5 mg/kg bw)</td>
<td></td>
<td>133 ±27,07*</td>
<td>180,33±15,01*</td>
<td>208,33±38,18*</td>
<td>159,66±6,35*</td>
<td>131,660±24,5</td>
</tr>
<tr>
<td>SJ 9 (Tenebrio molitor powder 9 mg/kg bw)</td>
<td></td>
<td>111±6,92</td>
<td>154 ±37,32*</td>
<td>161,66 ±42*</td>
<td>156,66 ±41</td>
<td>144,33 ±48,01</td>
</tr>
<tr>
<td>SJ 45 (Tenebrio molitor powder 45 mg/kg bw)</td>
<td></td>
<td>147,33±10,69*</td>
<td>219,33 ±20,5*</td>
<td>242,66 ±23,28*</td>
<td>215,66 ±14,01*</td>
<td>184 ±10,53*</td>
</tr>
<tr>
<td>SJ 90 (Tenebrio molitor powder 90 mg/kg bw)</td>
<td></td>
<td>152 ±16,09*</td>
<td>210 ±13,07*</td>
<td>228,33 ±45,54*</td>
<td>213,33 ±57,5*</td>
<td>165 ±26,51*</td>
</tr>
</tbody>
</table>
Table 2
The average change in blood glucose of mice with an oral glucose tolerance method given a sucrose load

<table>
<thead>
<tr>
<th>Test Groups</th>
<th>Average Blood Glucose Level (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T0</td>
</tr>
<tr>
<td>Pain Control (Na CMC 1%)</td>
<td>109.66 ± 2.51</td>
</tr>
<tr>
<td>Comparison (Glibenclamide 5 mg/kg bw)</td>
<td>135.66 ±11.93*</td>
</tr>
<tr>
<td>SJ 9 (Tenebrio molitor powder 9 mg/kg bw)</td>
<td>114.33 ±1.15</td>
</tr>
<tr>
<td>SJ 45 (Tenebrio molitor powder 45 mg/kg bw)</td>
<td>123,33 ±4.16*</td>
</tr>
<tr>
<td>SJ 90 (Tenebrio molitor powder 90 mg/kg bw)</td>
<td>140,66 ± 4.5*</td>
</tr>
</tbody>
</table>

Table 3
The average change in blood glucose of mice with an oral glucose tolerance method given an amylum load

<table>
<thead>
<tr>
<th>Test Groups</th>
<th>Average Blood Glucose Level (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T0</td>
</tr>
<tr>
<td>Pain Control (Na CMC 1%)</td>
<td>72.33 ±15,63*</td>
</tr>
<tr>
<td>Comparison (Glibenclamide 5 mg/kg bw)</td>
<td>100,33 ±12,66*</td>
</tr>
<tr>
<td>SJ 9 (Tenebrio molitor powder 9 mg/kg bw)</td>
<td>84,33 ±12,85</td>
</tr>
<tr>
<td>SJ 45 (Tenebrio molitor powder 45 mg/kg bw)</td>
<td>112 ±12,12*</td>
</tr>
<tr>
<td>SJ 90 (Tenebrio molitor powder 90 mg/kg bw)</td>
<td>77,66 ±8,5*</td>
</tr>
</tbody>
</table>

Information: *: different meaningful (p<0.05) to pain control; T0: 0 Minutes; T30: 30 Minutes; T60: 60 Minutes; T90: 90 Minutes; T120: 120 Minutes.

Fig. 1: Tenebrio molitor Linn. life cycle

It can be caused by giving a glucose load included in the monosaccharide group faster or ready to be absorbed compared to the provision of sucrose (disaccharide) or amylum (polysaccharide) where two types of carbohydrates require more complex mechanism to become glucose. As we know that digestion of carbohydrates begins with the help of alpha-amylase enzymes produced by salivary glands which can break the glycoside bonds in disaccharides and polysaccharides and thereafter will occur in the small intestine by the presence of pancreatic alpha-amylase enzyme which is secreted by the pancreas so that it is thought to increase blood glucose levels by lowering the burden of sucrose and amylum compared to glucose load. Observations can be seen in the figure 2.
**Conclusion**

Based on the results of evaluation of glucose tolerance methods of *Tenebrio molitor* Linn. powder, doses of 45 and 90 mg/kg BW can reduce blood glucose level but lower decreasing power compared to glibenclamide.

**Acknowledgement**

Authors gratefully thank to Faculty of Pharmacy, Universitas Mulawarman, Samarinda and School of Pharmacy, Institut Teknologi Bandung, Indonesia for all facilities to support this research.

**References**

1. Indonesia Ministry of Health: Beware of Diabetes “Eat Well Live Well” Situation and Analysis of Diabetes, Data and information Center, Indonesia Ministry of Health, Jakarta, 1-3 (2014)


(Received 25th March 2019, accepted 02nd June 2019)