Pattern of Weight Gain and Glycaemic Response to Graded Dosages of *Allium Sativum* (Garlic) In Non-Diabetic Female Rats

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**ABSTRACT**

This study was designed to investigate the pattern of weight gain and glycaemic response to graded dosages of *Allium sativum* in non-diabetic female albino Wistar rats. Twenty female albino rats were grouped into 4 groups of 5 rats each. Group A served as control and only received food and water *ad libitum* while Group B, C and D received 7.5, 15 and 22.5 mg/kg of aqueous *Allium sativum* extract intraperitoneally for 27 days. The rats were fasted weekly and the blood samples were obtained from the tail vein for blood glucose determination using glucometer. Result showed that aqueous *Allium sativum* extract at high dose significantly reduced body weight and blood glucose level when compared to control group (P<0.05). Therefore, this work suggests that chronic intake of *Allium sativum* in non-diabetic individual at a high dose may cause hypoglycaemia but may be valuable to diabetic and obese individuals since it reduces blood glucose and body weight.

**Keywords:** *Allium sativum*, body weight, fasting blood glucose, hypoglycaemia, albino rats

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**How to cite this article:** Arokoyo DS, O Bamidele and TO Olagunju, 2014. Pattern of weight gain and glycaemic response to graded dosages of *Allium sativum* (Garlic) in non-diabetic female rats. Int. J. Med. Adv. 2(1): 1-5.

**INTRODUCTION**

Diabetes mellitus, often simply referred to as diabetes, is a group of metabolic diseases in which a person has high blood sugar, either because the body does not produce enough insulin, or because cells do not respond to the insulin that is produced (David and Dolores, 2001). It produces the classical symptoms of polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased hunger).

There is growing concern that diabetes and obesity will reach epidemic proportions, affecting the developing world in Asia and Africa more than the developed world (Amos et al., 1997; Rheeder, 2006). Type 2 diabetes mellitus is the more common form of diabetes affecting over 200 million people worldwide (Emerson et al., 2009). Type 2 diabetes is characterized by a dual pathogenesis of insulin resistance and impaired insulin secretion leading to hyperglycaemia usually associated with dyslipidemia, a risk factor for cardiovascular disease and stroke (Gong et al., 2009; Carmena, 2005). Plants have been the major source of drug for the treatment of diabetes mellitus in Africa and other ancient countries of the world. The importance of antidiabetic plants in the development of economic and effective treatment for diabetes, currently estimated to affect over 30 million people worldwide, has been recognized by the World Health Organization (WHO Technical Report Series, 1985).

*Allium sativum*, commonly known as garlic, is a species in the onion genus, *Allium*. Its close relatives include the onion, shallot, leek, chive (Block, 2010). Dating back over 6,000 years, garlic is native to central Asia (Ensminger and Audrey, 1994) and has long been a staple in the Mediterranean region, as well as a frequent seasoning in Asia, Africa and Europe. It was known to Ancient Egyptians, and has been used throughout its history for both culinary and medicinal purposes (Simonetti and Schuster, 1990). It has hemodynamic and haemostatic effects (Brosche et al., 1990), lipid-lowering effects (Ide and Lau, 1997), platelet effects (Apitz-Castro et al., 1992), fibrinolytic effects (Chutani and Bordia, 1981), vascular effects (Ashraf et al., 2004), antioxidative effects (Borek, 2001), anti-microbial effects (Benkeblia, 2004), anti-cancer effects (Milner, 2001), antiatherosclerotic effects (Koscielny et al., 1999), anti-diabetic effects (Sheela et al., 1995; Patricia, 1996), genitourinary effects (Dixit and Joshi, 1982), anti-inflammatory effects (Yang et al., 2004), anti-hypertensive effects (McMahon and Vargas, 1993), immunologic effects (Chisty et al., 1996) and several others.

Despite the fact that many works have been done on anti-diabetic effects of *A. sativum* in different diabetic animal studies, there is little or no information on its effects on healthy individuals taking into cognizance the fact that many people consume the plant without measure in a bid to prevent diabetes without considering the possible adverse effects. Therefore, the present study was designed to investigate the pattern of weight gain and glycaemic response to graded dosages of *A. sativum* in non-diabetic female albino Wistar rats.
MATERIALS AND METHODS

Animals: A total of 20 female Wistar albino rats with weight range of 120-200g from a rat trader in Osogbo, Osun state, Nigeria were used in this study. The animals were housed in the animal house of the Physiology Department, Faculty of Basic medical science, Bowen University, Iwo. All animals were fed with commercially formulated rat feed and water ad libitum. After randomization into various groups, the rats were acclimatized for a period of 2 weeks in the environment before the initiation of the experiment. Their cages were cleaned of waste daily and food and water changed daily.

Preparation of aqueous garlic extract: Fresh locally available garlic bulbs were purchased from a trader at Odo-Ori Market, Iwo, Nigeria. Aqueous onion extract was prepared from locally available garlic bulbs. The garlic bulbs were peeled on crushed ice, 50g of the peeled garlic cut into small pieces and homogenized in 700ml of cold, sterile 0.9% NaCl in the presence of some crushed ice. The homogenization was carried out in a blender at high speed for 10 minutes. The homogenized mixture was filtered 3 times through a sieve, the filtrate centrifuged at 2000 RCF for 10 minutes and the clear supernatant diluted to 1000ml with normal saline. The concentration of the garlic preparation was considered to be 50mg/ml on the basis of the starting saline. The concentration of the garlic preparation was measured by HPLC as 50mg/ml. The aqueous extract of garlic was stored at cool temperature until use. The rats were maintained on a normal diet and tap water ad libitum throughout the experiment.

Weighing of the rats: Each rat was weighed before the commencement of the experiment. Also the weights of the rats were taken weekly just before measuring the fasting blood sugar. Weights were taken using a weighing scale.

Experimental design: The animals were divided into 4 groups of 5 animals per group based on their weights. Group 1 (control group) was fed with normal feed and water only. Group 2 was fed with 7.5 mg/kg of mashed garlic intraperitoneally daily. Group 3 was fed with 15 mg/kg of mashed garlic intraperitoneally daily. Group 4 was fed with 22.5 mg/kg of mashed garlic intraperitoneally daily.

Extract administration: The aqueous garlic extract was injected intraperitoneally once daily. The rats were handled appropriately to restrict movements and prevent trauma to the rats during administration. Treatment was administered for a period of 27 days.

Measurement of fasting blood sugar level: Baseline fasting blood sugar (FBS) was recorded after the two weeks of acclimatization in all rats. The 1st fasting blood sugar recording was taken in all groups after the first week of intraperitoneal administration. Subsequently, the other FBS readings were taken at an interval of 4 days using blood collected from the tail region after an overnight fast (for approximately 12 hours). During over-night fasting, food and water were removed from their cages. Blood samples were obtained by cutting the tip of the tail with the aid of a clean sharp razor blade to allow one or two drops of blood to come in contact with the tip of the glucometer strip already inserted into the glucometer. The fasting blood sugar readings were then obtained from the glucometer. The result of blood glucose measurement by glucometer correlates excellently well with the result obtained from standard laboratory methods (Ajala et al., 2003).

Glucose monitoring system and its principle of operation: The glucose monitor used for this experiment was On-call Plus Blood Glucose monitoring system. The system comprises of a monitor and a test strip. Each test strip contains reactive chemicals: Glucose oxidase <25 IU, Mediator <300µg.

Blood is applied to the end of the test strip, and then automatically absorbed into the reaction cell where the reaction takes place. A transient electrical current is formed during the reaction and the blood glucose concentration is calculated based on the electrical current detected by the meter, then the result is shown on the meter display. The meters are calibrated to display plasma-like concentration results.

Statistical analysis: The results were tabulated as mean ±SEM (Standard Error of Mean), and were analysed using ANOVA (Analysis of variance) with multiple comparison (post HOC) i.e LSD with SPSS 16, and the results were considered significant at P<0.05.

RESULTS

The results of the experiment are tabulated as Mean ± Standard Error of Mean.

Effect of water and normal rat chow on blood glucose and weight: Rats in group 1 (control group) experienced a steady increase in their mean body weights as seen in table 2.0 and figure 2.0 which was not statistically significant (P>0.05). There was no statistical difference in their mean blood glucose levels (P>0.05).

Effect of low dose garlic administration on blood glucose and weight: Rats in group 2 (low dose group) experienced a slight increase in their mean body weights as seen in table 2.0 and figure 2.0 however this increase is not statistically significant (P>0.05). The slight increase noticed in their mean blood glucose level is also not statistically significant (P>0.05).

Effect of moderate dose garlic administration on blood glucose and weight: There was a slight decline in the mean weights of group 3 rats and this is statistically significant (P<0.05) when compared to the control group (group 1) on the 7th and 11th days. A slight increase in the mean blood glucose level was observed on the 7th day of treatment followed by a decline throughout the experiment. This difference was statistically significant (P<0.05).
Table 1: Effect of garlic administration on fasting blood glucose of non-diabetic rats

<table>
<thead>
<tr>
<th>Day</th>
<th>Group 1 (control)</th>
<th>Group 2 (low dose)</th>
<th>Group 3 (moderate dose)</th>
<th>Group 4 (high dose)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>56.40±8.52</td>
<td>64.20±1.36</td>
<td>68.40±5.63</td>
<td>71.40±1.33</td>
</tr>
<tr>
<td>7TH</td>
<td>57.80±2.27</td>
<td>65.60±1.17</td>
<td>71.40±2.38</td>
<td>73.00±3.26</td>
</tr>
<tr>
<td>11TH</td>
<td>75.60±1.03</td>
<td>67.30±2.50</td>
<td>68.50±7.29</td>
<td>66.80±3.38</td>
</tr>
<tr>
<td>15TH</td>
<td>77.80±1.88</td>
<td>69.80±4.53</td>
<td>64.75±2.29</td>
<td>62.60±2.70</td>
</tr>
<tr>
<td>19TH</td>
<td>78.00±1.90</td>
<td>70.40±2.04</td>
<td>60.00±3.19</td>
<td>54.80±3.01</td>
</tr>
<tr>
<td>23RD</td>
<td>79.80±4.09</td>
<td>72.00±5.59</td>
<td>56.75±2.78</td>
<td>50.80±1.46</td>
</tr>
<tr>
<td>27th</td>
<td>81.00±2.21</td>
<td>81.00±2.71</td>
<td>52.00±1.08</td>
<td>46.40±0.93</td>
</tr>
</tbody>
</table>

significant at P<0.05 in comparison to group 1 (control);  very significant at P<0.01 in comparison to group 1 (control)

Table 2: Effect of garlic administration on body weight of non-diabetic rats

<table>
<thead>
<tr>
<th>Day</th>
<th>Group 1 (control)</th>
<th>Group 2 (low dose)</th>
<th>Group 3 (moderate dose)</th>
<th>Group 4 (high dose)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>125.80±3.06</td>
<td>129.20±2.44</td>
<td>148.00±5.20</td>
<td>154.80±3.67</td>
</tr>
<tr>
<td>7TH</td>
<td>129.20±1.71</td>
<td>133.60±2.20</td>
<td>147.60±5.04</td>
<td>151.20±3.60</td>
</tr>
<tr>
<td>11TH</td>
<td>131.20±1.46</td>
<td>135.60±1.17</td>
<td>146.25±6.05</td>
<td>144.80±3.76</td>
</tr>
<tr>
<td>15TH</td>
<td>134.60±2.01</td>
<td>139.20±3.35</td>
<td>145.25±5.95</td>
<td>133.80±6.28</td>
</tr>
<tr>
<td>19TH</td>
<td>141.80±1.20</td>
<td>143.00±2.77</td>
<td>144.25±6.30</td>
<td>128.60±3.67</td>
</tr>
<tr>
<td>23RD</td>
<td>143.20±2.80</td>
<td>145.20±2.40</td>
<td>143.00±5.07</td>
<td>121.00±4.01</td>
</tr>
<tr>
<td>27TH</td>
<td>144.20±4.01</td>
<td>147.60±2.16</td>
<td>140.25±4.77</td>
<td>118.80±4.07</td>
</tr>
</tbody>
</table>

significant at P<0.05 in comparison to group 1 (control);  very significant at P<0.01 in comparison to group 1 (control)

DISCUSSION

At present many setbacks are being experienced in antidiabetic therapy with the use of synthetic anti-diabetics drugs such as acetohexamide (ACE), chlorpropamide (CHL), glibenclamide (GLI), and tolbutamide (TOL). However, due to debilitating side effects, the efficacy of these compounds are debatable as many of them have been consumed by healthy individuals in a bid to prevent diabetes without recurs to the possibility of adverse effects (Singh and Jatwa, 2012). Hence, plants have been suggested as a rich, and yet unexplored source of potentially useful antidiabetic drug. Garlic is an example of such plants, commonly taken to combat the occurrence of diabetes. Many components of garlic, such as APDS-allyl propyl disulphide, allicin-diallyl disulphide oxide, flavonoids and many others have been implicated in their hypoglycaemic effect but the most important is allicin SACS, what it does is to compete with insulin for insulin-inactivating sites in the liver, which abolishes insulin inactivation. Consequently, the free insulin is increased. SACS (S-allyl cysteine sulfoxide), an antioxidant isolated from garlic, has also been found to significantly stimulate insulin secretion from beta cells isolated from normal rats. In this study, non diabetic rats treated with *Allium sativum* extract at the end of the experiment, had significantly lower fasting blood sugar (FBS levels) when compared with the non-diabetic control group. The anti-hyperglycaemic effects of *Allium sativum* was noticed at two different levels, for two different doses. It was observed that the extract had a more pronounced effect at a high and moderate dose than when administered at a low dose as it was observed that rats given low dose of *Allium sativum* extract still had normal fasting blood sugar (FBS levels) when compare with control. This is in agreement with the research work by Eidi *et al.*, 2006 where oral administration of garlic extract for 14 days significantly reduced serum glucose in diabetic rats (P<0.05) . It is also in agreement with the research work done by Martha *et al.* (2006) where oral and intraperitoneal aqueous extracts of garlic produced no significant change at low doses (50 mg/kg). It has also been demonstrated that *Allium sativum* has a significant effect on the body weight of the non-diabetic rats used in this experiment. Rats treated with a low dose of *Allium sativum* extract showed a weight gain which was not significant during the experiment. Rats treated with a
moderate dose of *Allium sativum* extract showed a significant weight loss during the experiment and rats treated with a high dose of *Allium sativum* extract showed a significant weight loss. Therefore, the effect of *Allium sativum* on the weight of non-diabetic rats is dose-dependent. It is likely to be due to presence of Allyl isothiocyanate, a major component of garlic, which exhibits anti-inflammatory and anti-obesity effects (O’est *et al.*, 1999). From the result of the experiment, we can also deduce that 27 days of treatment is not enough time for reducing body weight and fasting blood sugar (FBS) if administering *Allium sativum* at a dose of 7.5 mg/kg, but if the dose is increased to about 15mg/kg or 22.5mg/kg, 27 days may be enough to significantly reduce body weight and fasting blood sugar (FBS) in non-diabetic female albino rats.

**Conclusion:** Results from this study showed that aqueous extract of *Allium sativum* reduces body weight and fasting blood glucose level in non-diabetic female albino rats. The effect of garlic on body weight and fasting blood glucose level are dose related. Therefore, chronic intake of aqueous extract of *Allium sativum* in non-diabetic individuals at high dose(s) may not be encouraged in that it may bring about hypoglycaemia. However, this may be important or advantageous in diabetic and obese individuals to reduce blood sugar and weight respectively. This work supports the earlier findings that *Allium sativum* has hypoglycaemic potential in diabetic rats.

**REFERENCES**


