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ACUTE AMMONIA STRESS ON CERTAIN METABOLIC ASPECTS OF BRAIN TISSUE OF COCKROACH *PERIPLANETA AMERICANA*

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ABSTRACT

Cockroaches are a pest to humans as they infest their kitchens and eat away right from books to clothes. Though various chemicals are used indiscriminately to destroy these orthopterans, no control is exercised yet over their population. This is because of their easy adaptability to domestic surroundings and development of resistant strains. Can ammonia solution be used to control this pest was tested in the present study. An attempt has been made to study the toxic effects of ammonia on certain metabolic aspects of brain tissue of cockroach *Periplanata americana*. The acute effect was studied by topical application of selected dose for half an hour and the effects of ammonia was studied by measuring the levels of glucose, glutamine, ammonia, urea, protein, free amino acids and acety cholinesterase enzyme levels in the brain tissue of Cockroach. The induced acute ammonia stress resulted in elevation of ammonia, urea, glutamine contents and decrement in protein, amino acids, and glucose and acetycholinesterase enzyme levels.

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INTRODUCTION

The growing menace of pests to various agricultural and food products have taken an ugly shape. Lot of work is done to eradicate these pests. Cockroaches are one such pests. These are omnivorous, eating books, papers, various products in kitchen, and many places. Several control methods to eradicate cockroaches have been tried (Appel and Tanley, 2000; Apel *et al.,* 2004, Baldwin and Kohler, 2007; Baldwin *et al.,* 2008). They range from different pesticides and chemicals etc (Olkowski and Olkonski 1991; Nasirian *et al.,* 2006; Sims and Appel, 2007). Ammonia is a toxicant to many organisms including humans. But for higher organisms, a high concentration would affect them. Hence, a low concentration of ammonia may not be toxic to men but might help to eradicate the cockroach density safely. With this idea, an effort has been made to understand the metabolic changes in cockroaches on ammonia exposure. Ammonia toxicity mainly acts on liver and brain tissue. Hence, if the brain metabolism is targeted, the eradication of cockroach through use of ammonia can be tried. The present investigation is to understand the effect of ammonia on brain metabolism of cockroach and to test whether the ammonia can be used as a measure to eradicate or reduce the population of cockroaches.

MATERIALS AND METHODS

Cockroach, *Periplanata americana* was used as test animal. Adult male cockroaches of approximately same size were collected for uniformity, as the behavioral patterns in the females were reported to be influenced by reproductive cycles. Animals with deformities were discarded. Brain tissue was used for biochemical studies.

In order to decide the required dosage for physiological studies, dosage mortality studies were conducted for determining the LD_{50}. The LD_{50} was found to be 3.5% of liquid ammonia and period of survival was 1 hr. For the present studies, the application was done with graduated syringes for uniform spraying on the dorsal side of the animal. Control cockroaches were maintained and were sprayed with distilled water. The experiments were conducted after the cockroaches were exposed to LD_{50}concentration for a period of half-an hour.

Biochemical estimations like ammonia, urea, free amino acids, glutamine, total proteins, glucose and acetyl cholinesterase were carried out using the methods of Ward *et al.,* 1975, Natelson, 1971; Moore and Stein, 1954; Colowick and Kaplan, 1967; Lowry *et al.,* 1951; Metcalf, 1951 respectively. The mean, Standard Deviation (SD) and t-test were calculated for different parameters (Pillai andSinha, 1968).

RESULTS AND DISCUSSION

The results for the various parameters studied (*i.e.* ammonia, urea, total proteins, free amino acids, glutamine, glucose, and Acetyl Cholinesterase) is presented in Table 1.

Cockroach, *Periplaneta americana* was exposed to 3.5% liquid ammonia mixed with water for half-an-hr after topical spray. No significant change was observed in the colour of the animal. The wings and legs of cockroach stiffened after half-an-hr of exposure. There was change in the terga plates. They have become hard. The abdominal plates showed constant unusual movements immediately after exposure. Further the animal could not stand properly and move. Almost all the animals went topsy turvy after ammonia spray. Bulging of eyes was noted in certain cases. The absorption range of liquid ammonia after topical application varied from 50-80%. There was increment of ammonia, urea, and glutamine levels in the brain tissue on ammonia exposed. Ammonia is converted into urea and glutamine as a detoxification measure. Hence, increment in urea and glutamine levels is possible. But the presence of arginase and urea production in brain tissue is not clearly suggested. Its action on liver tissue has seen reported (Ravikantha *et al.,* 2007). There is decrement in protein content and increment in amino acid levels in brain tissue on ammonia exposure. Ammonia toxicity might have resulted in protein degradation. But the amino acids thus released might have

Table 1: Studies on certain metabolic aspects of brain tissue of cockroach *Periplanata americana* on acute ammonia stress

Name of the parameter	Control (M±SD)	Experimental (M±SD), %change
Ammonia(μ moles of ammonia / g. wet weight of tissue)	8.341±0.194	13.105±0.268 (+57.12%)
Urea(μ moles of urea / g. wet weight of tissue)	3.668±0.235	4.572±0.178 (+24.6)
Total proteins(mg of proteins / g. wet weight of tissue)	34.011±4.427	24.801±1.838 (-27.08)
Free amino acids (μ moles of tyrosine / g. wet weight of tissu)	255.756±18.139	103.922±2.754 (-59.3)
Glutamine(μ moles of glutamine / g. wet weight of tissue)	2.976±0.039	3.307±0.065 (+11.1)
Glucose (mg of glucose /gm wet wt. of tissue)	0.547±0.027	0.039±0.065 (-92.8)
AchE(μ moles of urea formed / mg protein/h)	56.5±0.068	55.95 ±0.164 (-9.67)

All the values are mean ± SD of six individual observations. All the values are significant at $p < 0.01$

been utilized for other metabolic pathways like citric acid cycle to release energy. The tissue glucose levels also gave a decrement. As the brain glucose level is generally maintained in animals, a decreased level suggests inactivation of neural centre in these animals on ammonia exposure. This might have acted on its tolerance and consequent death.

Acetyl cholinesterase (AchE) activity of the tissues is a measure of alertness of the animal (Robinson *et al.,* 2010). Normally the activity levels of this enzyme is invariably higher in brain when compared to other tissues. Pesticides and ammonia are known to inhibit the AchE activity (Parveen, 2009; Shanta *et al.,* 2009). The AchE activity was high in the control cockroaches showing their alertness and alert brain. On spraying with liquid ammonia, the AchE activity showed a decrease. It is possible that toxic ammonia molecule is affecting the brain metabolism and makes the animal inactive. Thus ammonia exposure on cockroaches has affected the neural centre and probably ammonia can be used to reduce the cockroach population. But further work is required to give any conclusive decision on ammonia exposure on cockroaches.

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