



Impact of Sodium Arsenate on Pancreas, Blood Glucose and Tissues Glycogen Levels in Albino Rat

KEYWORDS

Blood Glucose, Tissue Glycogen, Pancreas.

Vijaya Kumar, J.

Division of Toxicology, Department of Zoology, Sri Venkateswara University

Cynthia Sailaja, M.

Division of Toxicology, Department of Zoology, Sri Venkateswara University

Praveena, M

Division of Toxicology, Department of Zoology, Sri Venkateswara University

K. Jayantha Rao

Division of Toxicology, Department of Zoology, Sri Venkateswara University

ABSTRACT *The present study was designed to investigate the toxic effects of Sodium arsenate at its clinical concentration. Experimental rats were administered with Sodium arsenate 4 mg/kg body weight for a period of 30 days. The blood glucose, tissue glycogen were estimated besides histopathological studies of pancreas. Sodium arsenate treated rats showed elevated blood glucose levels and decline in tissue glycogen. Pancreatic tissue damage in experimental rats might be the possible reason for the biochemical changes in the present investigation.*

INTRODUCTION

In the recent years, industrial development and agricultural process have resulted in the increased levels of toxic metals in the environment, although relatively high concentrations can also occur naturally (Lopez Alonso et al., 2002). Heavy metals have been recognized as strong biological poisons because of their present nature, toxicity, tendency to accumulate in organisms and undergo food chain amplification (Dinodia et al., 2002). In the environment arsenic is found in organic and inorganic forms and in different valence or oxidation states. The most toxicologically potent arsenic compounds are in the trivalent oxidation state. Millions of people worldwide are suspected to be exposed to arsenic through contaminated drinking water, air and food (Liu et al., 2002). Exposure to arsenic for a short period of time causes metabolic disturbances and is considered as major public issue. (Roy et al., 2013). Chronic exposure to arsenic causes increase in blood pressure, diabetes, cardiovascular diseases and cancer (Rahman et al., 2009). Pancreas is a mixed glands acini organs are the exocrine portion of pancreas. Endocrine portion of pancreas is Islets of Langerhans. The α -cells produce glucagons were as the β - cells produce insulin. Glucagon acts on liver cells and stimulates glycogenolysis, and it converts amino acids and fatty acids into glucose which increases the level of glucose in the blood. Insulin regulates the normal glucose in the blood. It mainly acts on the liver cells and adipocytes and increases the uptake and utilization of glucose by the body cells.

MATERIALS AND METHODS

Healthy adult albino rat of Wistar strain same age group 90 ± 5 days and weight (180 ± 20 g) were taken from veterinary college, Bangalore and maintained in laboratory conditions ($26 \pm 2^\circ$ C; 12hr light and 12 hr dark cycles throughout the experimental period). The Animals were fed with standard food pellets (Amrut feed, Pranav Agro Industries, Pune) and water ad libitum.

Animals were exposed to different concentrations of sodium arsenate to evaluate LD_{50} (40 mg/kg b.w/48 hrs) according to Finney, D.J (1964). Animals were randomly divided into 3 groups with six animals in each group. Ten fold

lower concentration of LD_{50} i.e. 4.0 mg/kg body weight is taken as sub lethal dose. The first group of animals was considered as control. To the second group of animals single dose was given (on 1st day). To the third group of animals multiple doses were given (i.e. on 1st, 4th, and 7th, 10th). After stipulated time (single dose on 3rd, multiple on 13th day) the blood was collected without anticoagulant from the orbital sinus of the rat's eye. The selected tissues i.e. Brain, Kidney, Liver, Muscle and Testis were isolated from the control and experimental animals for estimation of Glycogen. The blood glucose level was measured by glucose oxidase/peroxidase enzymatic kit (Span Diagnostics Ltd., India). Glycogen content was estimated by the method of Carroll et al., (1956) using anthrone reagent 5% (w/v) homogenates of tissues were prepared in 10% trichloroacetic acid. The homogenate were centrifuged for 10 minutes and the supernatants were taken for the estimation of glycogen.

RESULTS

The blood glucose and tissue glycogen levels were altered in the sodium arsenate treated experimental rats when compared with control. Sodium arsenate treated rats showed an elevation in the blood glucose levels and decline in the tissue glycogen when compared to control which is statistically significant ($p < 0.05$) represented in Table - I.

'Table - I about here'

Table- I: Effect of Sodium Arsenate on blood glucose (mg/100 ml of blood) and glycogen content in different tissues (mg/gm wet wt. of tissue) of albino rats. All the values are mean of six individual values significant at $P < 0.05$. S.D - Standard Deviation. Values in parenthesis indicate percent change over control.

S. No	Name of the sample		Control	Single Dose	Multiple Dose
1.	Blood	Mean	78.6650	109.87	129.88
		SD \pm	5.22656	6.42468	6.06212
		%		(39.67)	(65.10)
2.	Brain	Mean	11.7850	9.9850	7.9100
		SD \pm	0.87049	0.9371	1.07635

		%		(-15.27)	(-32.88)
3.	Liver	Mean	19.9683	16.6133	14.0267
		SD±	0.83547	1.08279	1.01899
		%		(-16.80)	(-29.75)
4.	Kidney	Mean	16.5333	13.7617	11.6400
		SD±	1.42698	1.25268	0.98785
		%		(-16.76)	(-29.60)
5.	Muscle	Mean	18.3100	16.1233	13.5883
		SD±	1.33619	1.34363	1.66542
		%		(-11.94)	(-25.79)
6.	Testis	Mean	12.7800	10.2367	7.8433
		SD±	1.39502	1.00426	0.79784
		%		(-19.90)	(-38.62)
7.	Blood	Mean	78.6650	109.87	129.88
		SD ±	5.22656	6.42468	6.06212
		%		(39.67)	(65.10)

Figs. A-F: Effect of Sodium Arsenate on Pancreas in Albino rat.

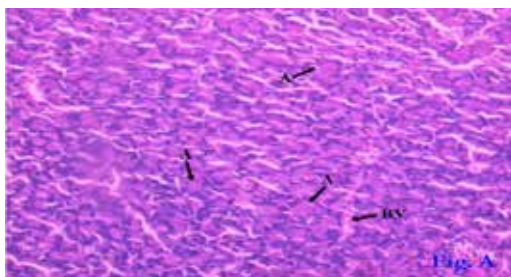


Fig. A : Control Pancreas Showing Acini (A) with Blood Vessel (BV). 100 X.

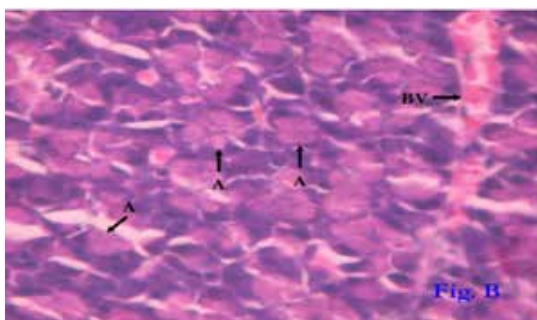


Fig. B : Control Pancreas Showing Acini (A) With Blood Vessel (BV). 400 X.

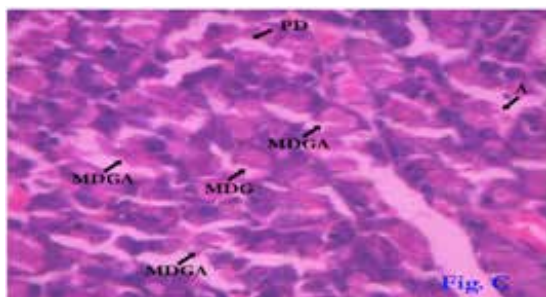


Fig. C : Pancreas under single dose showing moderate degeneration (MDG) in Acini with pancreatic duct (PD). 400 X.

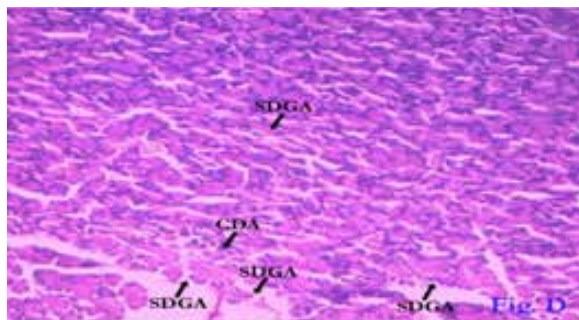


Fig. D : Pancreas under multiple dose showing sever degeneration in Acini (SDGA); cellular disarray (CDA). 100 X.

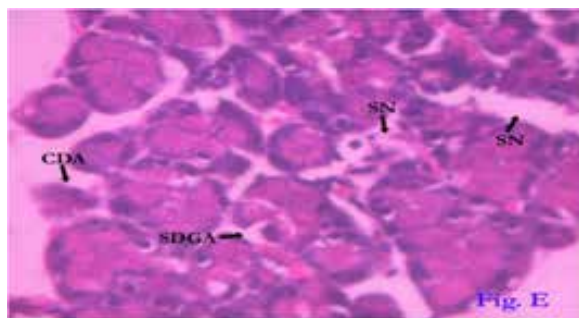


Fig. E : Pancreas under multiple dose showing cellular disarray (CDA); Sever Degeneration in Acini (SDGA); Severe Necrosis (SN). 400 X.

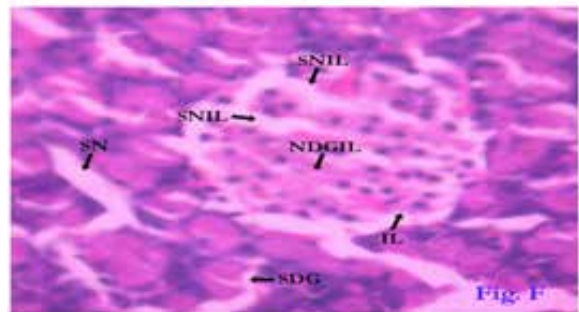


Fig. F : Pancreas under multiple dose showing sever degeneration in Acini (SDGA); severe necrosis (SNA); severe necrosis In Ilet of Langerhans (SNIL); nuclear degeneration in Ilet of Langerhans (NDGIL). 400 X.

Discussion

In the present study, the treatment with Sodium arsenate increased the glucose concentration in serum. **Miller et al. (2002)** reported that trivalent arsenic inhibits the uptake of glucose into cells, gluconeogenesis, fatty acid oxidation and further production of acetyl CoA. Pyruvate dehydrogenase, and enzyme of glucose metabolism, is susceptible to arsenic induced reactive oxygen species (ROS) generation (**Aposhian and Aposhian, 2006**).

Among the test tissue higher glycogen was observed in liver followed by muscle, kidney, testis and brain. Highest glycogen content of liver is acceptable due to its involvement in glycogen synthesis and utilization. The glycogen largely concerned with strong and export of hexose units for maintenance of blood glucose. Though brain tissue is metabolically active, lower glycogen content was

observed, since it lacks the inherent potential to store glycogen and is dependent on blood glucose for all its metabolic activities (Lehninger, 2004). In the present investigation the gradual decreases of glycogen level in the different tissues of Sodium arsenate treated albino rat was recorded in single and multiple doses treated.

The increased concentration of glucose in this study, may be due to the binding of arsenic to the sulfhydryl groups of glucose metabolizing enzymes, and thereby blocked the uptake of glucose. The altered blood sugar may also due to islet cells toxicity, because arsenic administration caused severe pancreatic damage (Mukherjee et al., 2004). In our observation, the treatment with sodium arsenate induced ROS production, which may reduce insulin production by pancreatic cellular damage (Figs. A–F) leads to the increased glucose concentration in blood. Besides the damage of islets of langerhans, acini also severely damaged in the present investigation which may results the alteration of digestive enzymes in the experimental rats.

Increased blood glucose level in arsenic exposed animals indicates hyperglycemic condition has been reported previously (Izquierdo-Vega et al., 2006) could be due to the impaired insulin secretion from β -cell of pancreas or im-

paired glucose metabolism in liver. Arsenic causes pancreatic β -cells apoptosis (Lu et al., 2011) and suppress insulin secretion causing increased glucose in blood. This might be cause of increased glucose in the body. According to Pimpar and Bhawe (2010) exposure to high levels of arsenic causes diabetes and increased levels of glucose in blood.

Decrease in glycogen level in fish due to pesticide effect has been reported (Vijayavel et al., 2006 and Crestani et al., 2005). Chandra Mouli (2008) also reported a fall in glycogen levels in fish *Heteropneustes fossilis* exposed to cypermethrin. Arsenic accumulation was more pronounced in liver than pancreatic tissue. (Hitesh Vashrambhai Patel and Kiran Kalia, 2014).

Decrease in glycogen level was reported by some other authors in fluoride treated mice liver (Jayasankar, 2007) and Ravi sekhar et al.(2009) in albino rat exposed to cypermethrin. Madhava Rao (2007) also found decreased glycogen levels in amphibian model, *Rana hexadactyla* exposed to azadirachtin. Thus more catabolic rate of glycogen could be the another possible reason for decrease of glycogen and increase of blood glucose in the present investigation.

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