CHAPTER - III

OBSERVATIONS

III. OBSERVATIONS

In the powerloom sector at Ichalkaranji, the workers were exposed to the various occupational health hazards and stresses. The building of the powerloom was overloaded with machines, so workers couldn't make free movements. There was also lack of proper ventilation and workers didn't get enough fresh air for breathing. The machines in the powerloom were old one and making loud noise. During weaving process, humidity was maintained for continuity of the yarn. The humidity along with heat generated by powerlooms produce thermal stress. The powerloom operations were carried out in closed settings, which were ill-illuminated. There was cotton dust, suspended in the surrounding atmosphere. The workers were constantly exposed to such a stressful situation. The experimental rats (*R. norvegicus*) were exposed to such workplace environment showed following alterations.

A. BEHAVIOURAL CHANGES

The experimental rats (*R. norvegicus*) exposed to above mentioned workplace environment in the powerloom sector. In contrast to the rat (control) the experimental rats showed following changes in their behavioural pattern.

Set S_1 :

1. Initially, during the first 5 minutes to 15 minutes of exposure animals were sensitive to touch, sound and pains. They were restless, showing bizarre movement and aggressive behaviour.
2. The rats smelled the air continuously.
3. They urinated and fecated.
4. After 15-20 minutes animals showed decreased locomotory activity and limp tail. Bizarre reaction was not observed. They sat still as if in sleeping posture.
5. They didn't consume food and water.

Set S_2 :

1. During 1st exposure, behavioural changes observed were as Set S_1.
2. During the 2nd exposure the animals did not show much changes in the behaviour as compared to the 1st exposure. They behave normally.

Set S_3 :

1. During 1st exposure, behavioural changes observed were as Set S_1.

2. During 2nd and 3rd exposures the animals did not show behavioural changes observed during 1st exposure. Their behaviour became normal.

B. HISTOPHYSIOLOGIC AND TOTAL PROTEIN CHANGES IN ORGANS OF EXPERIMENTAL ANIMALS :

1. Adrenal Gland :

There is a pair of adrenal gland situated retro-peritoneally and on the superomedial aspect of the front of the kidney. It is composed of morphologically, histologically, chemically and functionally two different parts; the adrenal medulla and the adrenal cortex. The adrenal medulla functionally related to secretion of the hormones, epinephrine and norepinephrine in response to sympathetic stimulation. The nor-epinephrine causes constriction of essentially all the blood vessels of the body, it causes increased activity of the heart, inhibition of gastro-intestinal tract, and so forth. Epinephrine cause almost the same effects as those caused by nor-epinephrine, but it has a greater effect on cardiac activity, it causes weak constriction of blood vessels. The metabolic rate of every cell in the body increased by these hormones especially by epinephrine.

The adrenal cortex secretes an entirely different group of hormones, called corticosteroids. Physiologically most important

adrenal cortical hormones can be divided into three groups according to their biological activity – the mineralocorticoids, acting predominantly on sodium and potassium balance, the glucorticoids, affecting carbohydrate and protein metabolism and the adrenal androgens, which exhibit approximately the same effects in the body as the testosterone.

Adrenal gland is called as stress gland. Any stress increases the organism's requirement for cortisol. Cortisol secretion often increases greatly in stressful situation and this is a significant benefit to the animal as they have life-saving role.

In present study following significant alterations were observed in the adrenal gland of rat (*R. norvegicus*), exposed to the stresses in powerloom sector.

The weight of the adrenal glands in rat (control) was 0.0040 gms, while in experimental rats it was increased. Significant increase in weight of adrenal glands was observed in set S_3 (S_3P_1 = 0.068, S_3P_2 = 0.050, S_3P_3 = 0.057 gms.) as compared with set S_1 (S_1P_1 = 0.009, S_1P_2 = 0.010, S_1P_3 = 0.006 gms.) and set S_2 (S_2P_1 = 0.006, S_2P_2 = 0.006, S_2P_3 = 0.080 gms.) (Table No.1).

Slight increase in the size of adrenal gland was observed. No change in the colour of adrenal glands was observed as compared with that of control.

a) Histologic Changes :

Internally adrenal gland composed of two distinct parts; the adrenal cortex and the adrenal medulla. The adrenal cortex is composed of 3 concentric zones. The outer thin zona glomerulosa, consists of group of small columnar, closely packed epitheloidal cells, secreting aldosterone. The middle largest cortical zone; the zona fasciculata, consists of columns of larger polyhedral cells containing two nuclei and large number of lipid droplets in their cytoplasm. These cells secrete cortisole and glucocorticoids and small amount of androgen. The zona reticularis, the deep layer consisting of an anastomosing network of polygonal epitheloid cells, secreting cortisole, glucocorticoids and adrenal androgen.

The cells of adrenal medulla are, modified post-ganglionic cells of sympathetic nervous system, called chromaffin cells. These cells secrete epinephrine and nor-epinephrine. Various kinds of stresses can affect structure and secretory activity of adrenal gland cells. In present study following histologic changes were observed in the adrenal gland of experimental rats

(*R. norvegicus*) exposed to the industrial stresses. These histologic changes in adrenal gland depicted in Plate I and Plate II. The section of adrenal gland of rat (control) includes normal histological elements of adrenal gland, such as adrenal medulla, zona reticularis, zona fasciculata, zona glomerulosa (Fig. 1 of Plate I and Plate II).

Following histologic alterations were observed in the adrenal gland of animals exposed to textile environment as compared to control animals.

Set S_1 (Plate I, Fig. 2 and 3) :

i. There was hypertrophy and hyperplasia of the cells in the cortex region especially in cells of zona fasciculata (Plate I, Fig. 2).

ii. Most of the cells in the zona fasciculata were without nucleus. Necrosis of nuclei was observed in S_1P_1 rat (Plate I, Fig. 2).

iii. Cortical cells showed granulated cytoplasm (Plate I, Fig. 2).

iv. Lesion was observed in zona fasciculata region of S_1P_2 rats (Plate I, Fig.3).

PLATE – I

Caption to Figures 1 to 4

Fig.1 Section of adrenal gland of rat (control). Note zona fasciculata (zf) x 400. HE.

Fig. 2 Section of adrenal gland of experimental rat S_1P_1 of Set S_1. Note hyperplasia (hp) and hypertrophy (ht) of cells of zona fasciculata. There are many enucleated cells (ec), x 400. HE.

Fig. 3 Section of adrenal gland of experimental rat S_1P_2 of set S_1. Note lesion (l) in zona fasciculata region x 400. HE.

Fig. 4 Section of adrenal gland of experimental rat of Set S_3. Note destruction of zona fasciculata cells and vacuolated cytoplasm (vc), enucleated cells (ec). x 400. HE.

PLATE – II

Caption to Figures 1 to 4

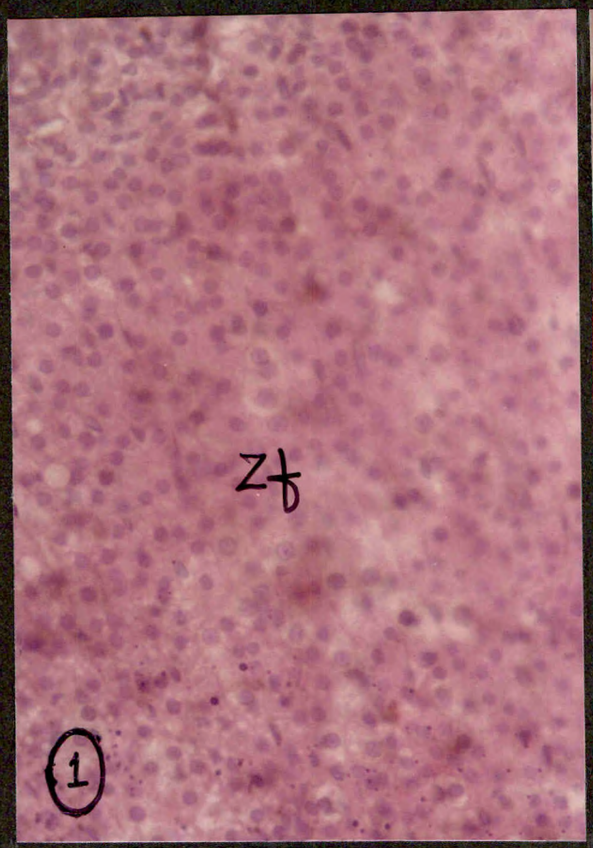
Fig. 1 Section of adrenal gland of rat (control). Note adrenal medulla (m) and zona reticularis (zr) x 400. HE.

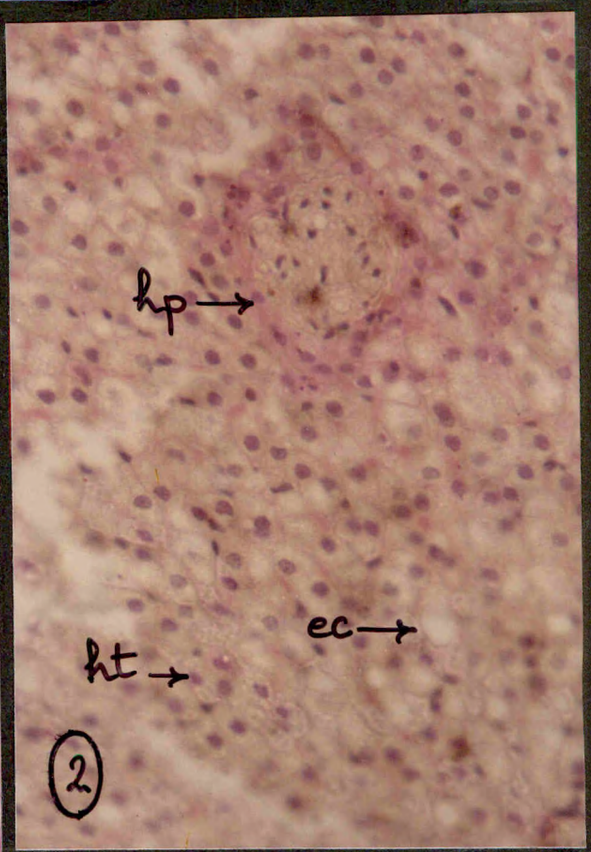
Fig. 2 Section of adrenal gland of experimental rat of Set S_2. Note localized hemorrhage (hr) and enlarged chromaffin cells (cc) x 400. HE.

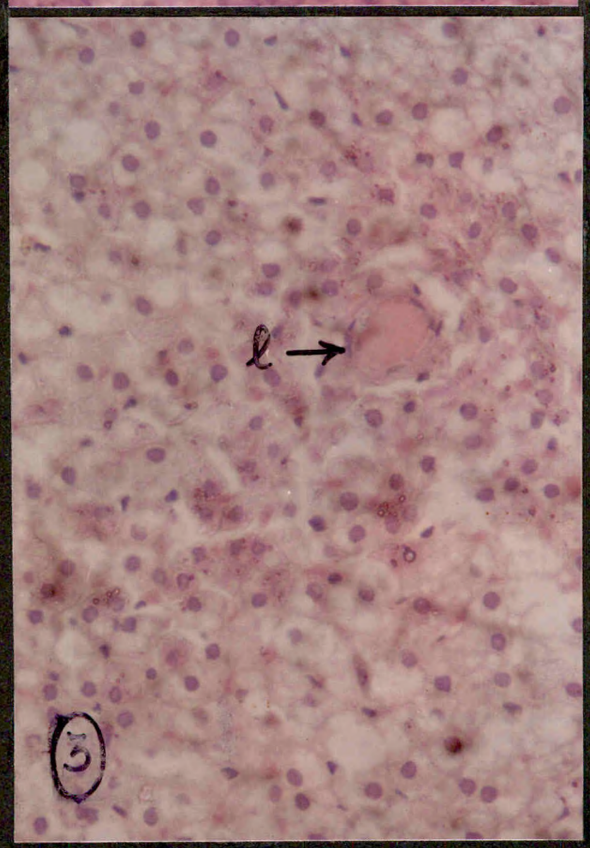
Fig. 3 Section of adrenal gland of experimental rat of Set S_3. Note enlarged medulla (m), destruction of chromaffin cells x 400. HE.

Fig. 4 Section of adrenal gland of experimental rat of set S_3. Note granulated cytoplasm (gc) in chromaffin cells of medulla.

PLATE - I







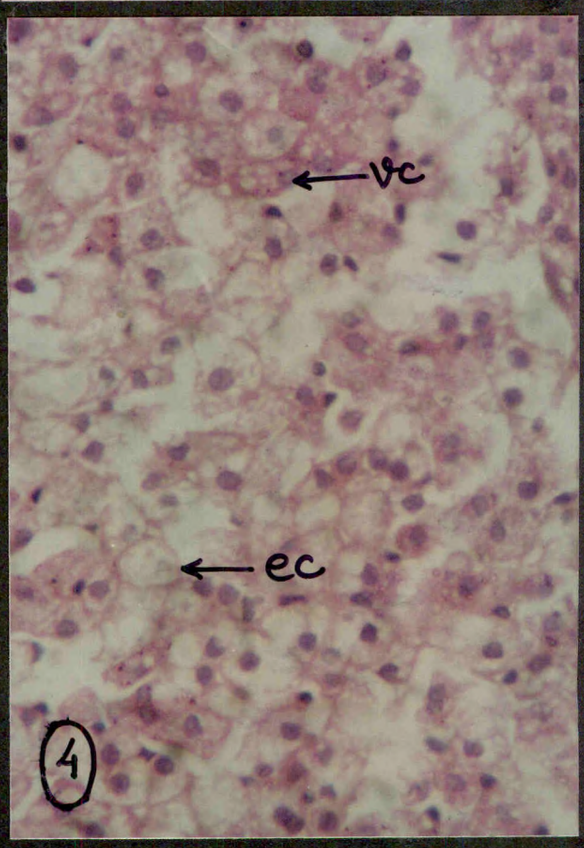
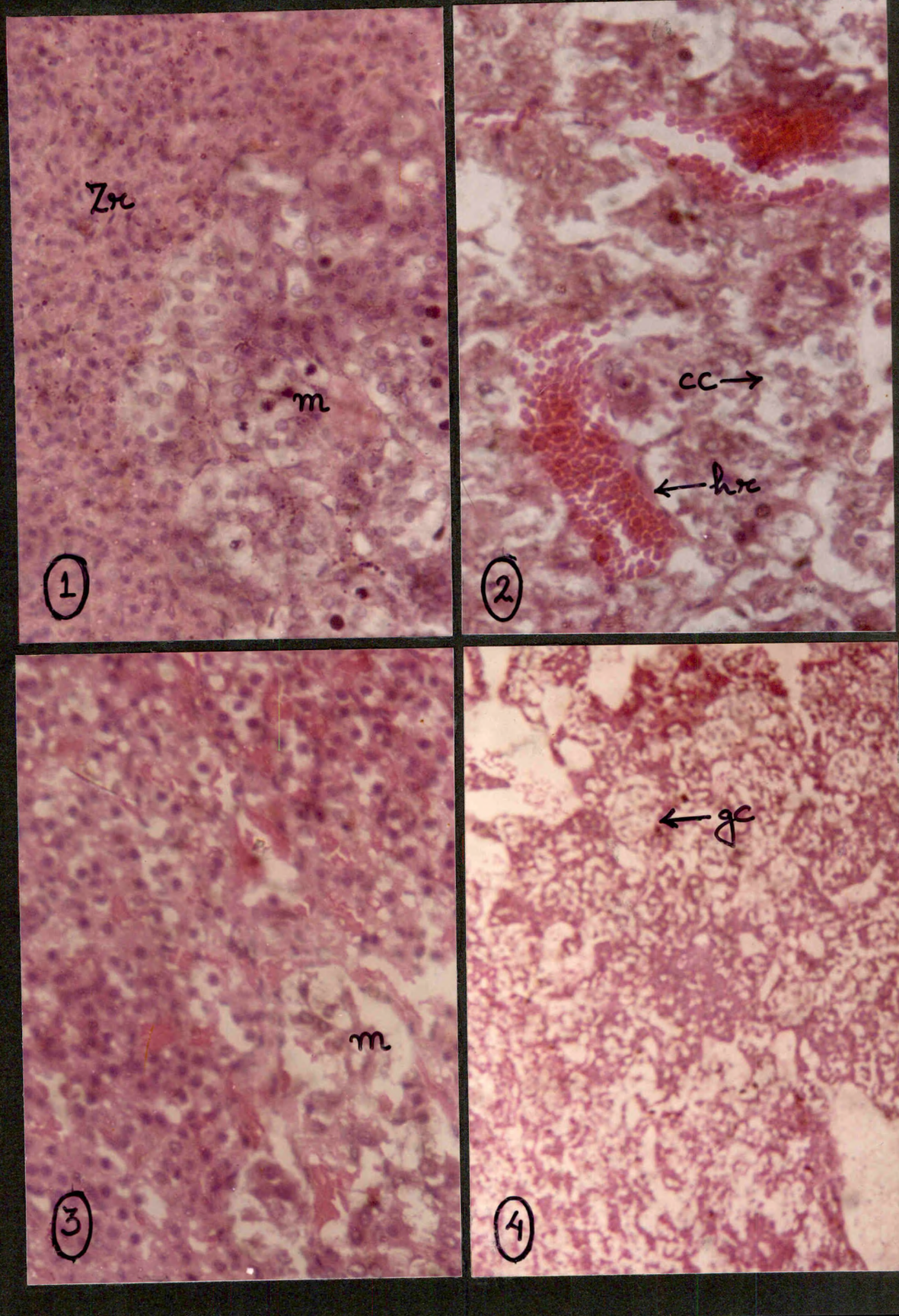


PLATE- II



vi. There was no any change in zona glomerulosa and in medulla region.

Set S_2 (Plate II, Fig. 2) :

i. There was progressively increased degeneration of cells of zona fasciculata.

ii. Enlarged chromaffin cells in medulla region (Plate II, Fig. 2).

iii. There was localized hemorrhage (hr) observed in medulla region (Plate II, Fig. 2).

iv. There were no changes in zona glomerulosa.

Set S_3 (Plate I, Fig. 4 and Plate II, Fig. 3 and 4) :

i. Cells of zona fasciculata enlarged, most of the cells were without nuclei (Plate I, Fig. 4).

ii. There was destruction of cells in zona fasciculata (Plate I, Fig. 4).

iii. The cytoplasm of cells of zona fasciculata was vacuolated (Plate I, Fig. 4).

iv. There was enlargement of medulla. Chromaffin cells destruction occurred on large scale in S_3P_1 rat (Plate II, Fig. 3).

v. There was localized hemorrhage in medula region as well as in zona reticularis and cells of zona reticularis enlarged (Plate II, Fig. 3).

vi. The cells of medulla showed granulated cytoplasm in S_3P_2 rat (Plate II, Fig. 4).

b. Alterations in Protein Content :

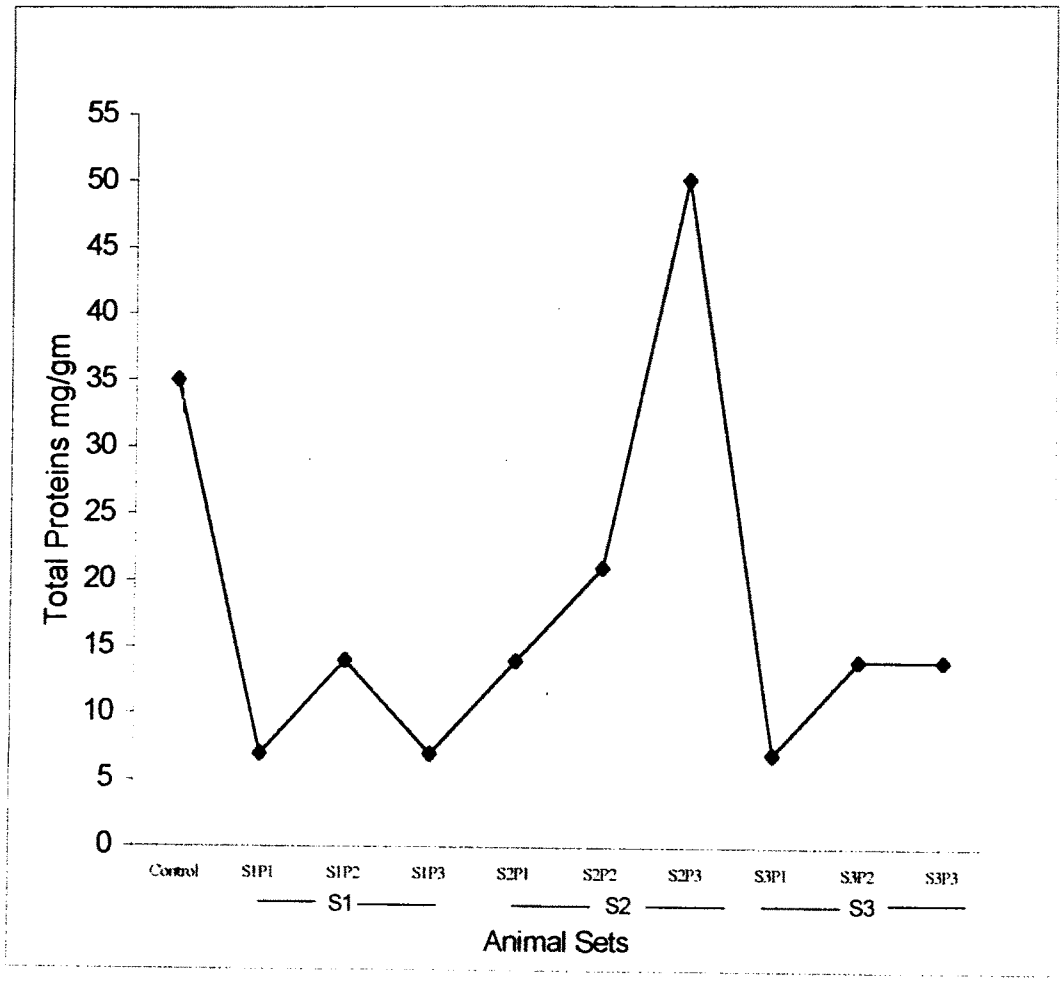
Proteins play important role in adrenal gland. The structural integrity adrenal gland cells is maintained by the proteins. Proteins also play important role in synthesis of adrenal medullary hormones that is catecholamines. Catecholamines are protein in nature. They are formed from tyrosine, the basic aminoacid. After exposure to the severe stress the excretion of epinephrine and nor-epinephrine found to be decreased, leading to various pathophysiological disorders.

The amount of the total protein in the adrenal gland of the rat (control) was 28 mg/ gm of adrenal. In experimental rat (*R. norvegicus*) following alterations were observed in the total protein content of Adrenal gland.

In Set S_1, the amount of protein remain unchanged in rat S_1P_1, and it was 28 mg/gm of adrenal.

In rat S_1P_2 it was increased than that of control and it was 35 mg/gm of adrenal. While in rat S_1P_3 the total protein content

Figure 1
Changes in Total Protein Content in Adrenal Gland in Rat Exposed to Textile Environment



was decreased than that of control and it was 21 mg/gm of adrenal.

In Set S_2, there was again increase in the amount of proteins in rat S_2P_1 and it was about 35 mg/gm of adrenal.

In rat S_2P_2 protein quantity was decreased than control rat and it was 21 mg/gm of adrenal.

In rat S_2P_3 again there was significant increase in amount of protein as compared to that of control and it was 42 mg/gm of adrenal.

In Set S_3, the amount of proteins in rat S_3P_1 was increased than control and it was 35 mg/gm of adrenal. While in rats S_3P_2 and S_3P_3 it was decreased than that of rat (control) and it was 21 mg/gm of adrenal.

The total protein content in the adrenal gland of control and experimental rat is shown in Table No.2 and figure 1.

All above observations indicating significant changes in the adrenal gland of experimental rat (*R. norvegicus*), exposed to powerloom environment, both in histology as well as in protein content.

2. Kidneys :

The kidney is an organ of homeostasis of the internal environment as well as it is an organ of excretion in higher vertebrates. Kidney clears the blood plasma of unwanted substances as it passes through the kidney. The endproducts of metabolism, such as urea, uric acid, creatinine and urates are removed by the kidney. In addition many other ions accumulated in the body in excess quantities are also removed by the kidney. These functions of the kidney are impaired by renal diseases or by a diversity of morbid conditions, primarily affecting other tissues and systems, which include circulatory failure, acid-base imbalance of the organism, change in the volume of the extracellular fluid, potassium deficiency, diseases of the adrenals, parathyroid gland and other endocrine organs, general metabolic changes and so on. Various environmental stress factors, toxins also affect the normal functioning of the kidney and produce histo-physiological and pathological alterations in kidney.

In present study significant changes were observed in the kidney of rat (*R. norvegicus*) exposed to the stresses in powerloom sector.

The weight of the kidney in rat (control) was 0.640 gms, while in experimental rats it was increased. There was significant increase in the weight of kidney in set S_1 (S_1P_1 = 0.989,

S_1P_2 = 2.576, S_1P_3 = 1.155 gms.) and in set S_3 (S_3P_1 = 2.200, S_3P_2 = 1.160, S_3P_3 = 1.151 gms.) but less increase in set S_2 (S_2P_1 = 0.854, S_2P_2 = 0.840, S_2P_3 = 1.456 gms.) as compared to set S_1 and set S_3 (Table No.1). There was slightly increase in the size of kidney of experimental rat as compared with the size of the kidney of the rat (control). However there was no any change in shape and colour of kidney in experimental rat as compared with that of rat (control).

a) Histologic Changes :

Internally kidney consists of outer cortex and inner medulla zone. The basic structural and functional unit of the kidney is nephron. The kidney of rat consists about 30,000 nephrons (Vimtrup, 1928). Each nephron consists of malpighian carpuscles formed of glomeruls and Bowman's capsule and brings about ultrafiltration of blood. The renal tubule consists of a simple epithelium that varies from squamous to cuboidal to columnar. The cells of proximal convoluted tubule (PCT) have elaborate basal interdigitations and apical microvilli as well as highly developed lysosomal apparatus, involved in the intracellular degradation of absorbed proteins, PCT reabsorbs approximately 80% of all the proteins, aminoacids, glucose, water and most ions and electrolytes from the tubular filtrate. The distal convoluted

tubule has fewer microvilli and less elaborate basal labyrinth than PCT, consistent with its role in hyperosmotic absorption. It has lower ion permeability, Loop of Henle consisting ascending and descending limbs, which are lined by simple squamous cells with few organelles. The descending limb is permeable to sodium and water, while the ascending limb is not. Sodium pumped out of the ascending limb increases the concentration within the interstitial space and dilute urine. The loop of Henle functions to create a linear osmotic gradient in the interstitial space by counter current multiplication. The collecting duct has an important role in production of concentrated urine by reabsorption of water under the influence of ADH. These normal functions and structure of nephron can be affected by various kinds of stresses and endotoxins leading to different abnormalities.

In present study following histologic alterations were observed in kidney of experimental rat (*R. norvegicus*) exposed to the textile environment. The alterations in the histology of kidney depicted in Plates III and IV. The section of kidney of the rat (control) included normal histological elements of kidney, such as proximal tubules, distal tubules, Henle's loop, collecting tubules glomerulus and Bowman's capsule (Plate III, Fig. 1).

Following histologic alterations were observed in the kidney of rat exposed to the textile environment as compared to control animals.

Set S_1 (Plate III, Fig. 2 and Plate IV, Fig. 1)

i. There was swelling and flattening of renal tubules as well as of glomeruli. There was change in the shape of renal tubules (Plate III, Fig. 2).

ii. There was swelling of glomeruli and urinary space as compared to that of control (Plate III, Fig. 2).

iii. Displacement of nuclei of tubular epithelial cells was observed.

iv. Necrosis of the tubular epithelial cells was observed (Plate III, Fig. 2).

v. There was accumulation of edematous fluid in the medulla region (Plate IV, Fig. 1).

Set S_2 (Plate IV, Fig. 2) :

i. There was complete damage of tubular epithelium.

ii. Displacement of nuclei of tubular epithelial cells.

iii. Tubular lumen was completely filled with necrotic mass in most of the renal tubules (Plate IV, Fig. 2).

PLATE – III

Caption to Figures 1 and 2

Fig. 1 Cortical region of kidney of rat (control). Note normal glomerulus (g) and renal tubules (t) x 400. HE.

Fig. 2 Section of kidney of experimental rat in Set S_1. Note swelling and flattening of renal tubules (t) and glomerulus (g), displacement of nuclei and necrosis of tubuler epithelium x 400. HE.

PLATE – IV

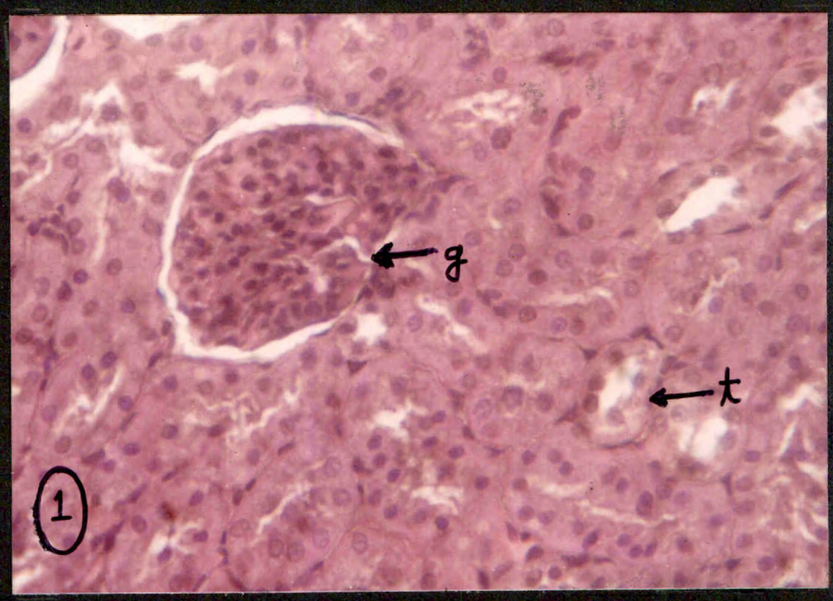
Caption to Figures 1 to 3

Fig. 1 Section of kidney of experimental rat in set S_1. Note accumulation of edematous fluid (ef) in medulla region x 400. HE.

Fig. 2 Section of kidney of experimental rat in Set S_2, showing tubular lumen completely filled with necrotic mass (nm), damage of tubular epithelium x 400. HE.

Fig. 3 Section of kidney of experimental rat in Set S_3. Note fibro-elastic hyperplasia (fh) of artery x 400. HE.

PLATE- III



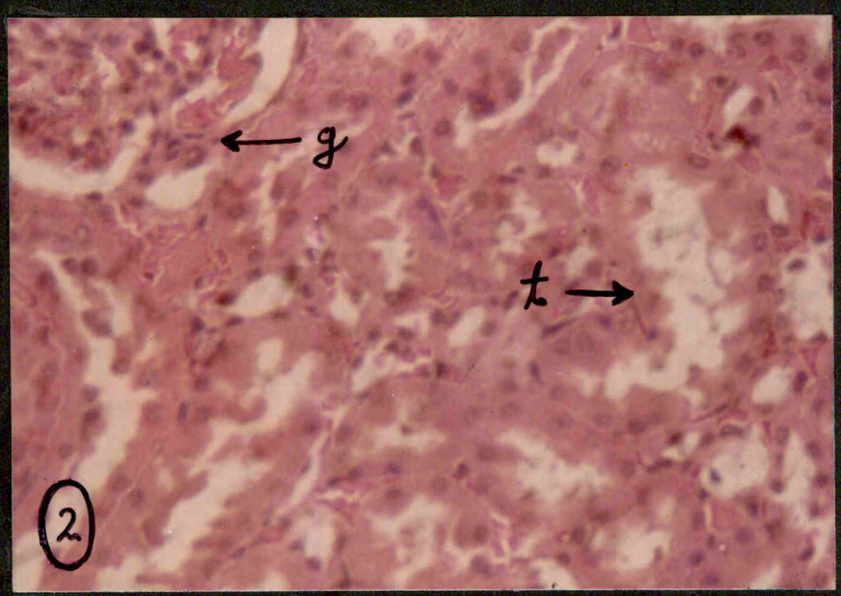
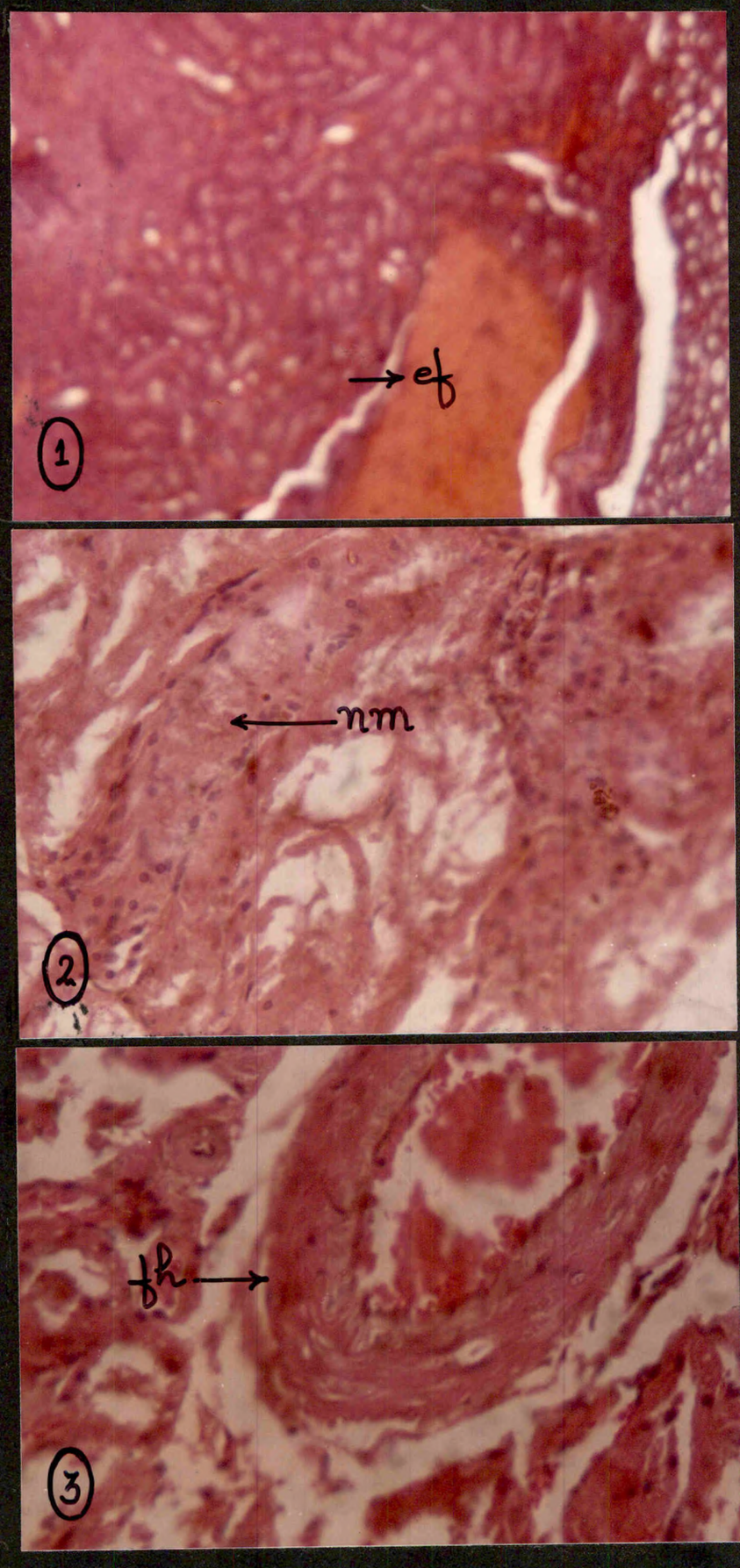


PLATE- IV



Set S_3 (Plate IV, Fig. 3) :

i. There was complete damage of most of the renal tubules.

ii. Necrotic mass observed in the lumen of renal tubules.

iii. There was fibro-elastic hyperplasia of artery in the kidney.

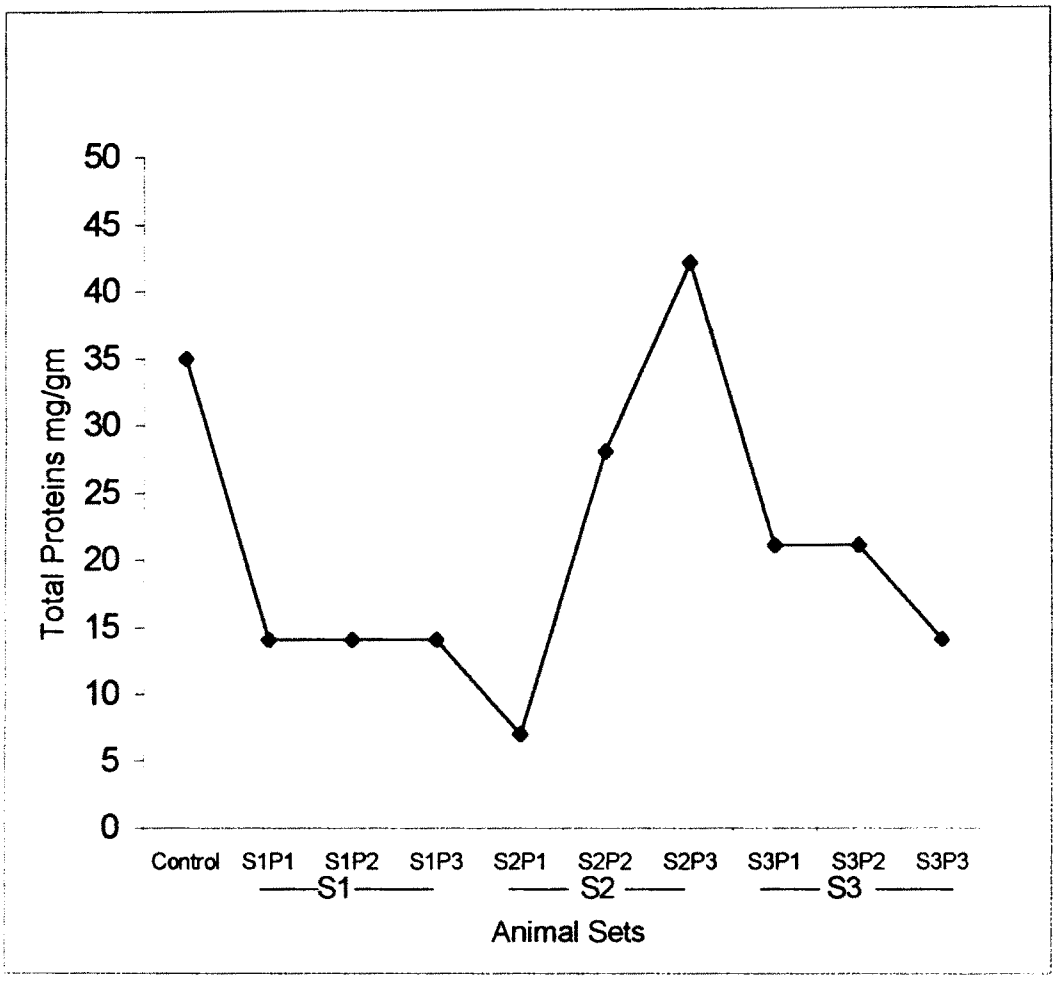
b) Alterations in Protein Content :

About three quarter of the body solids are proteins. Proteins are primary importance, both structurally and functionally as they are needed for structure and growth of organisms and also for metabolic reactions.

The proteins play important role in the kidney. The functional unit of kidney is nephron. The structural integrity of tubular cells maintained by the proteins. Lack of proteins destroy number of nephrons and ultimately affect the kidney functioning. Excess of proteins also leads to various types of renal disorders. Various stresses may cause changes in normal content of individual tissue proteins and damage of protein synthesis process within the organs. In present study following results were obtained regarding total protein in kidney of rat (*R. norvegicus*), exposed to the stresses in powerloom sector. The total protein content in kidney of control and experimental animals is shown in Table No.2 and figure 2.

Figure 2

Changes in Total Protein Content in Kidney in Rats
Exposed to the Textile Environment



Amount of the total protein in the kidney of control rat was 35 mg/ gm of kidney. In experimental rat the amount of total protein in the kidney decreased as compared to the control.

In Set S_1 the decrease in amount of proteins was constant in all the 3 rats (S_1P_1, S_1P_2 and S_1P_3) and it was 14 mg/gm of kidney.

In Set S_2 there was decrease in amount of proteins in 1st rat (S_2P_1) and was 7 mg/ gm of kidney.

In 2nd rat (S_2P_2) the amount of protein increased than 1st rat but not than control and it was 28 mg/gm of kidney.

In 3rd rat (S_2P_3) the amount of protein was increased significantly than 1st and 2nd rat and also than that of control and it was 42 mg/gm of kidney.

In Set S_3 - The amount of protein was decreased in all the 3 rats (S_3P_1, S_3P_2 and S_3P_3) as compared to that of control. In 1st (S_3P_1) and 2nd (S_3P_2) rats the amount of protein was 21 mg/gm of kidney, while in 3rd (S_3P_3) it was decreased than 1st and 2nd rats of this set and was 14 mg/gm of kidney.

Thus the overall observations indicating significant alterations in kidney of rat exposed to the powerloom environment both histologically and in protein content.

3. Heart :

The heart is propulsive muscular pump. It is actually two separate pumps, a right heart that pumps the blood through the lungs and a left heart that pumps the blood through the peripheral, organs. In turn, each of these two separate hearts is a pulsatile two chamber pump composed of an atrium and a ventricle. The atrium functions principally as an entry way to the ventricle, but it also pumps weakly to help move the blood into the ventricle. The ventricle in turn supplies the main force that propels the blood through either the pulmonary or the peripheral circulation. Special mechanisms in the heart maintain cardiac rhythmicity, and transmit action potential throughout the heart muscles to cause the heart's rhythmical beat. But sometimes this rhythmic heart beating affected by any heart condition, that reduces the ability of the heart to pump blood. Usually the cause is decreased contractility of the myocardium resulting from different reasons that makes the heart a hypo-effective pump. Different kinds of stresses and environmental factors are also responsible for disturbing the cardio-vascular system in animal and man. In present investigation it was aimed to study the effect of stresses in powerloom sector on the heart of rat (*R. norvegicus*) and following significant alterations were observed.

The weight of the heart in rat (control) was 0.600 gms. While in experimental rats it was increased progressively in all the three rats in each set as compared to that of control rat. Significant increase in the weight of the heart was observed in set S_2 (S_2P_1 = 1.210, S_2P_2 = 1.213, S_2P_3 = 1.212 gms.) as compared to set S_1 (S_1P_1 = 0.800, S_1P_2 = 0.932, S_1P_3 = 1.260 gms.) and S_3 (S_3P_1 = 0.836, S_3P_2 = 0.886, S_3P_3 = 1.091 gms.) (Table 2).

The size of heart in the experimental rat was increased as compared to that of control. There was change in the colour of heart of experimental rat. The colour of heart in rat (control) was fresh red but in experimental rat it was blackish red. No change in the shape of heart was observed.

a) Histologic Changes :

The wall of the heart consists mainly three layers; endocardium, myocardium and epicardium. Here the blood supply is very rich, especially that to the myocardium. The endocardium is a membrane, which covers all inner surface of the heart. It is very thin and transparent in the ventricles. It consists of single layer of flat, polygonal endothelial cells, smooth muscle cells present in this layer. A subendocardial layer consists of loose connective tissue with some adipose tissue mixed in small blood vessels, nerve fibers and branches of impulse conducting

system of the heart. The myocardium consists of cardiac muscle fibers, grouped to form bundles and layers, separated by perimysium. The epicardium the visceral layer of pericardium is a thin, transparent serous membrane, covering the outer surface of the heart. It consists of single layer of mesothelial cells resting on a basal lamina and a thin layer of loose connective tissue. Among various factors, stress is considered to be a risk factor that disturbs the various cardio-vascular parameters. In present investigation following histologic alterations were observed in the heart of rat (*R. norvegicus*), exposed to the stresses in powerloom sector. These observations were restricted to histology of heart ventricle only.

The section of the heart of the rat (control), showing the wall of ventricle consisting normal epicardium, myocardium and endocardium respectively in (Fig. 1 of Plates V, VI and VII).

Set S_1 (Fig. 2 of Plates V, VI and VII)

i. There was no much significant changes were observed in the epicardium of the ventricle (Plate V, Fig. 2).

ii. Significant changes were observed in the myocardium. There was elongation of muscle fibers and vacuolation in striated muscles of myocardium (Plate VI, Fig. 2).

iii. There was hypertrophy of endocardium, swelling of cells of endocardium (Plate VII, Fig.2).

Set S_2 (Fig. 3 of Plates V, VI and VII)

i. The cells of epicardium become elongated and narrow (Plate V, Fig.3). There was hyperplasia of the epicardial cells. Cells were compactly arranged, without intercellular space.

ii. There was necrosis of myocardial muscle cells. Necrotic mass observed in vacuoles (Plate VI, Fig.3).

iii. Degeneration of endocardial cells begin and there was hemorrhage (Plate VII, Fig. 3).

Set S_3 (Figs. 4 of Plates V, VI and VII) :

i. The cells of epicardium become thin, narrow and elongated than in set S_2. There was increased hyperplasia of epicardial cells (Plate V, Fig. 4).

ii. Muscle cells of myocardium become thin, narrow and elongated. Wide vacuoles were observed (Plate VI, Fig. 4).

iii. There was degeneration of endocardial cells (Plate VII, Fig. 4).

PLATE – V

Caption to Figures 1 to 4

Fig. 1 Section of heart ventricle of rat (control) showing epicardium (ep) x 400. HE.

Fig. 2 Section of heart ventricle of experimental rat of Set S_1. Note epicardium (ep) with no significant change x 400. HE.

Fig. 3 Section of heart ventricle of experimental rat of Set S_2. Note elongation and hyperplasia of cells in epicardium (ep) x 400 HE.

Fig. 4 Section of heart ventricle of experimental rat of Set S_3. Note elongation and hyperplasia of epicardial cells (ep) x 400 HE.

PLATE – VI

Caption to Figures 1 to 4

Fig. 1 Section of heart ventricle of rat (control). Note myocardium (my) x 400. HE.

Fig. 2 Section of heart ventricle of experimental rat of Set S_1. Note myocardium (my) with elongated muscle fibers and vacuolation (v) x 400. HE.

Fig. 3 Section of heart ventricle of experimental rat of Set S_2. Note necrosis of myocardial muscles. Necrotic mass (nm) in the vacuoles (v) x 400. HE.

Fig. 4 Section of heart ventricle of experimental rat of Set S_3. Note myocardium (my) with thin, narrow, elongated cells, separated by vacuoles (v) x 400. HE.

PLATE – VII

Caption to Figures 1 to 4

Fig. 1 Section of heart ventricle of rat (control). Note endocardium (en) x 400. HE.

Fig. 2 Section of heart ventricle of experimental rat of Set S_1. Note hypertrophy of endocardium (en) x 400. HE.

Fig. 3 Section of heart ventricle of experimental rat of Set S_2. Note degeneration of endocardial cells (arrow) and hemorrhage (hr) x 400. HE.

Fig. 4 Section of heart ventricle of experimental rat of Set S_3. Note degeneration of endocardium (en) x 400. HE.

PLATE- V

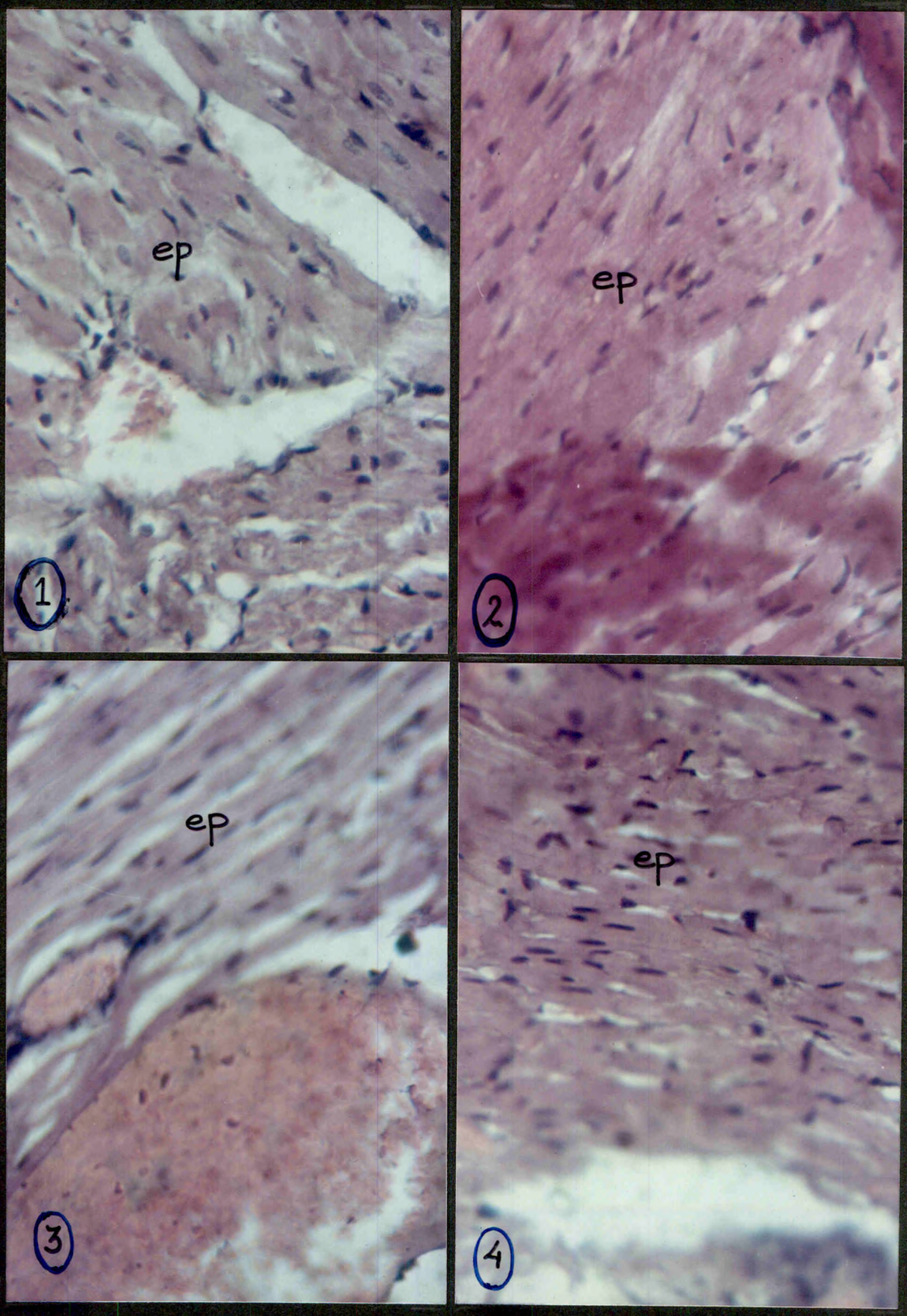
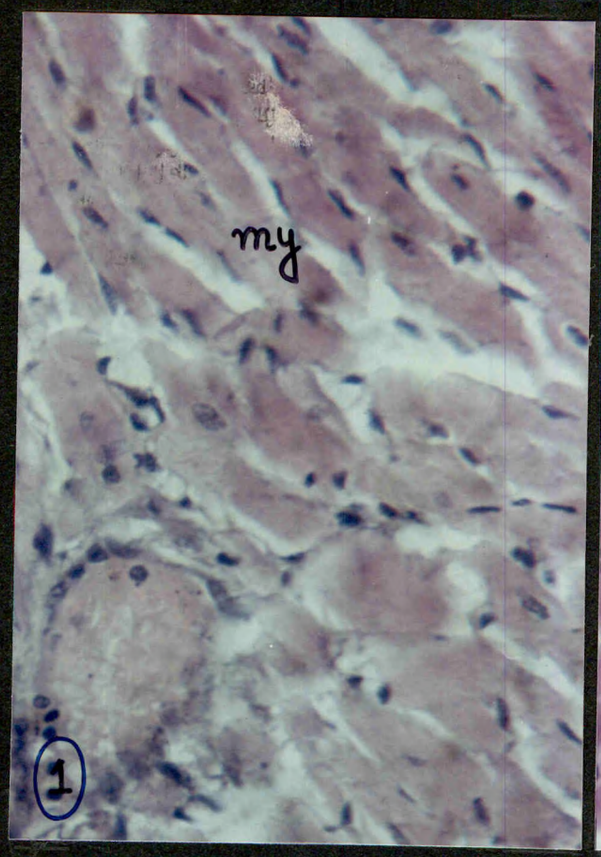
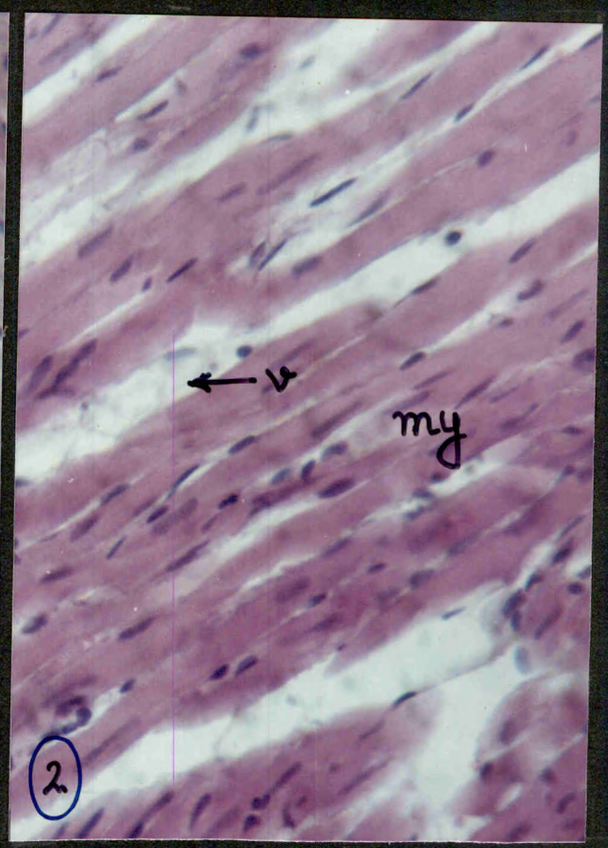
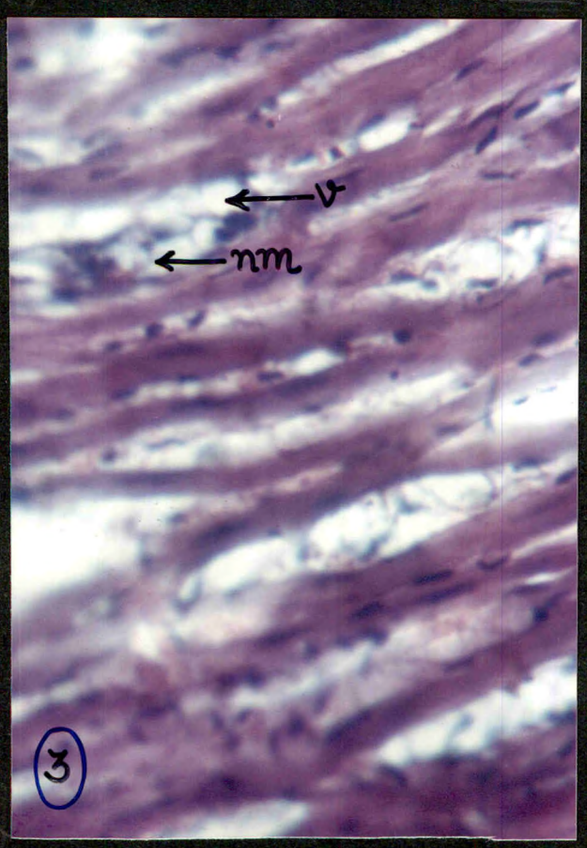


PLATE- VI







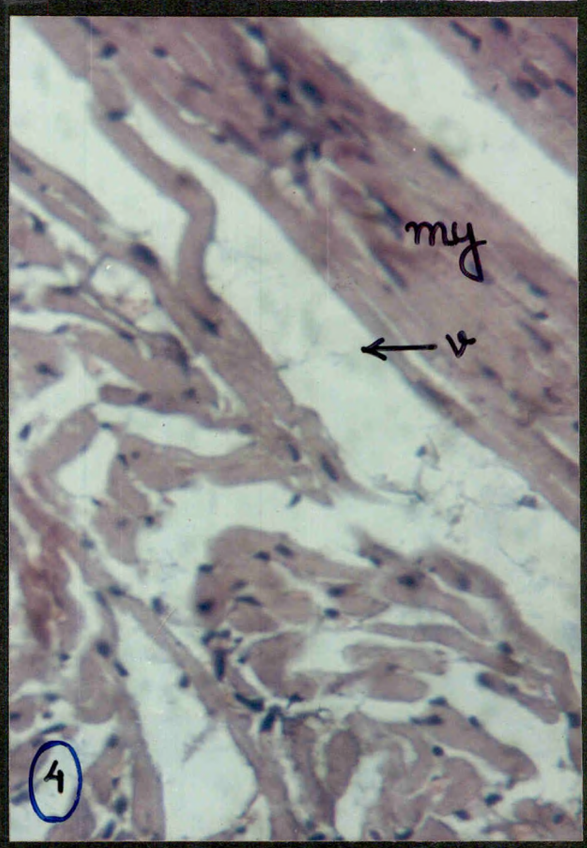
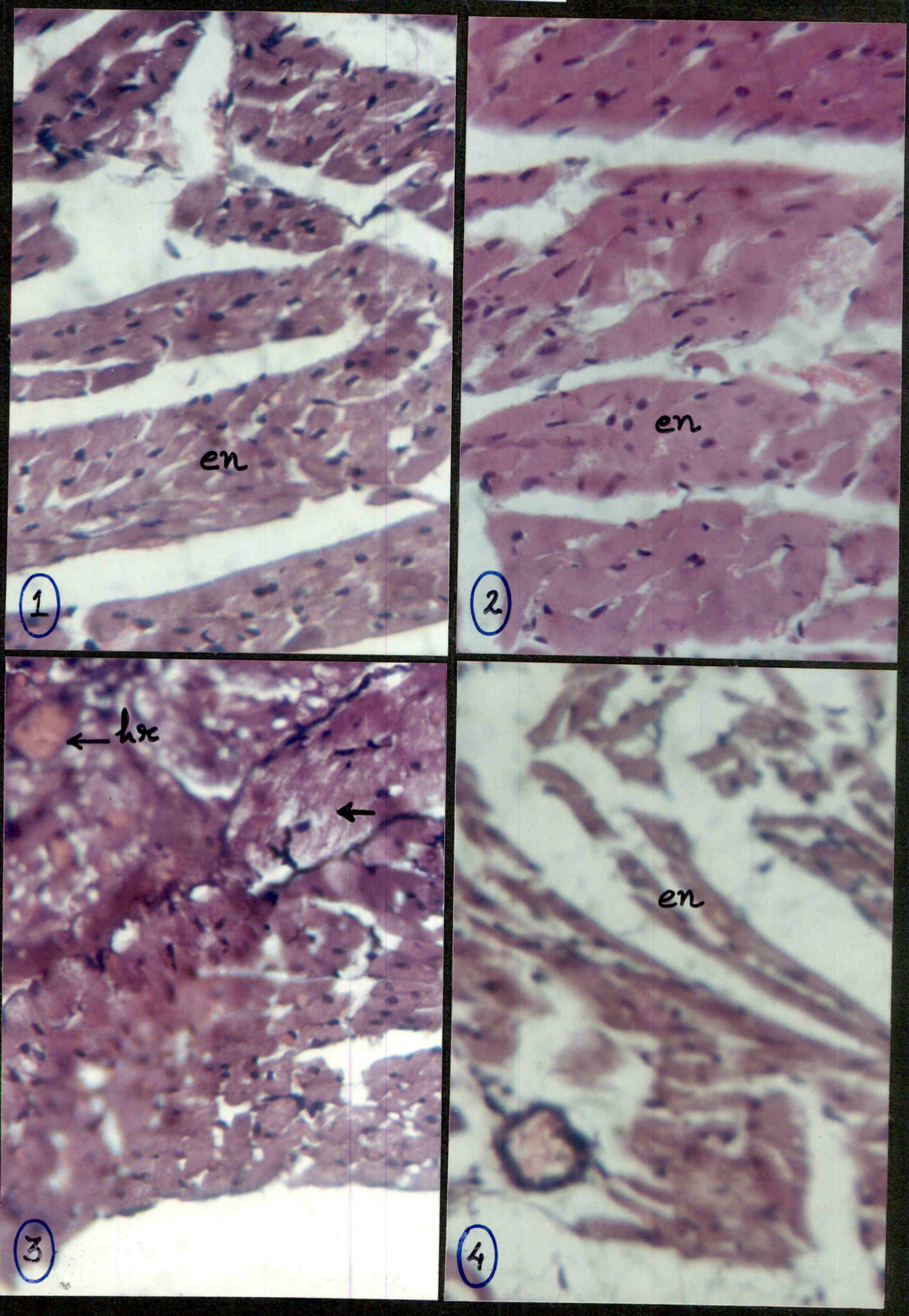


PLATE- VII

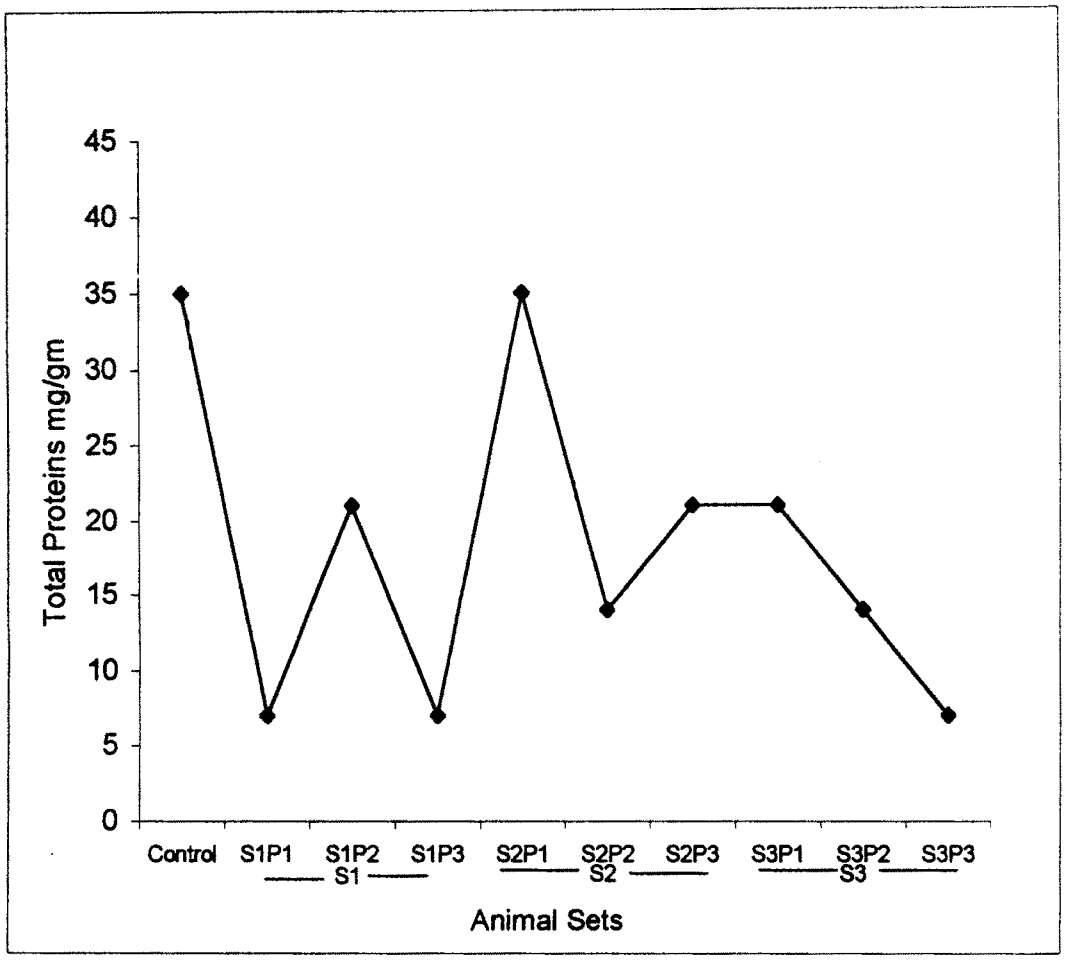


b) Alterations in Protein Content of Heart :

Proteins make up most of the solid matter of the heart muscles. The contractile machinery itself is made up of proteins. Proteins play important role in the functioning of the cardiac muscles. From functional point of view there are three types of muscle proteins such as stroma proteins, which hold the rest of the structures in place. Secondly the ordinary cellular proteins, which act as the enzymes, responsible for guiding the chemical reactions within the cell and thus for keeping the contractile system supplied with energy. Thirdly special contractile proteins which are the principle structural components of the muscle cells and are the bundles of the fibrous proteins actin and myosin. Besides actin and myosin the another contractile protein is tropomyosin, which is involved in sensitizing the contractile proteins to calcium. Thus proteins play important role in functioning of the muscles. Various factors may cause the change in the muscle proteins, which leads to change in functioning of the muscles. So in present study total proteins in heart muscles were studied to observe if any change in the total protein in the heart of rat (*R. norvegicus*) due to stresses in the powerloom sector and following results were obtained; which are shown in Table No.2 and Figure 3.

Figure 3

Changes in Total Protein Content in Heart in Rat Exposed to Textile Environment



In rat (control) the total protein content in heart was 35 mg/ gm of heart muscles. While in experimental rat (*R. norvegicus*) it was decreased in all the three sets.

In Set S_1, the total protein content in heart in rat S_1P_1 was 7 mg/gm of heart tissue, in rat S_1P_2 it was 21 mg/gm and in rat S_1P_3 it was 7 mg/ gm of heart.

In Set S_2, the total protein content in heart in rat S_2P_1 was 35 mg/gm, in rat S_2P_2 it was 14 mg/gm and in rat S_2P_3 it was 21 mg/gm of heart muscles.

In Set S_3, the total protein content of heart in rat S_3P_1, S_3p_2 and S_3P_3 was 21, 14 and 7 mg/ gm respectively.

Thus all above observations indicating that the total protein in heart of experimental rat exposed to the stresses in powerloom sector was decreased as compared with that of rat (control).

Thus like other tissues in present investigation the heart also showed significant histological changes and protein changes in experimental rats exposed to the stress in powerloom sector.

4. Gastro-Intestinal Tract (GIT) :

A. Stomach :

The stomach is an expanded reservoir of the digestive tract, in which food is compressed, churned and mixed with gastric

juice and mucus to form a pulp like mass, the chyme. Anatomically stomach can be divided into Cardiac portion, fundus, body, pyloric antrum and pyloric channel. The gastric juice secreted by stomach contains mainly the pepsin, a protein splitting enzyme and hydrochloric acid. The stomach is a poor absorptive area of the GIT because it lacks the typical villus type of absorptive membrane and also because the junction between the epithelial cells are tight junctions. Only few highly lipid soluble substance, alcohol and some drugs can be absorbed in small quantity. Increased or decreased secretory activity of stomach leads to various stomach disorders. Exposure to the various toxic substances and physical factors induce pathological changes in stomach. In present study following significant changes were observed in the stomach of rats (*R. norvegicus*), exposed to the stresses in the powerloom sector.

The weight of the stomach in rat (control) was 1.950 gms, while in experimental rats it was found increased progressively in set S_1 (S_1P_1 = 3.573, S_1P_2 = 3.220, S_1P_3 = 2.030 gms.), Set S_2 (S_2P_1 = 4.450, S_2P_2 = 2.210, S_2P_3 = 5.210 gms.) and set S_3 (S_3P_1 = 6.422, S_3P_2 = 6.120, S_3P_3 = 8.735 gms.) as compared to the control. Significant increase was observed in Set S_3 (Table 1). There was increase in the size of stomach as compared to that of control. The shape of stomach remain unchanged. The colour of

stomach in control rat was fresh creamy white, but in experimental rat it becomes dull and dirty white.

a) Histologic Changes :

Histologically the wall of the stomach consists of 4 layers. The mucosa is the innermost layer. It is one of the most active secretory tissues of the body. It is relatively thick and structurally highly modified, consisting of simple epithelium; lamina propria and muscularis mucosa. The epithelium is invaginated to form tubular gastric pits, that are variable in length in different regions of the stomach. The gastric glands in cardiac stomach are small, tubular branched and contain mucus secreting cells and few parietal cells. In corpus and fundus region gastric glands are tall, well developed, and contain mucous neck cells, chief cells, parietal cells and enterochromaffin (argentaffin) cells. Gastric glands in these regions consists of three parts; a base, neck and isthmus. Mucous cells are present in isthmus and neck of the gland. These cells produce acidic glycoproteins, rather than the more neutral mucus. The chief (zymogenic) cells are present in the body of the gland, and intermingle with parietal and mucous neck cells towards the neck region. These cells secret pepsinogen and other proteolytic pro-enzymes. In rat they produce gastric intrinsic factor as well, which mediates the absorption of Vit. B_{12}. The parietal (oxyntic cells) are concentrated mainly in the

central half of gastric gland, produced hydrochloric acid. The enterochromaffin cells are synthesize and/or store serotonin. In pyloric region another type of cells called argyrophil cells. They produce gastrin hormone which stimulate parietal cells to secrete HCl. A lamina propria is thin connective tissue layer forms a packing among the many gastric glands, and contains capillary plexus, nerves and lymphatic vessels. Fibroblast, macrophages, plasma cells and mast cells may also be present in this layer. The muscularis mucosa at the base of gastric glands, consists of two layers of smooth muscle cells, an inner circular and outer longitudinal. The submucosa, surrounds the mucosa. It consists loose connective tissue containing blood vessels, nerves, lymphatic vessels and lymphatic nodules. Around submucosa present the muscularis externa consisting of the inner oblique, middle circular and outer longitudinal muscle layers. The contraction of the muscle fibers aid in dividing macerating and hemogenizing the food and in emptying the stomach. The serosa is thin outer covering, formed by connecting tissue and the mesothelium, the later a single layer of squamous cells. Various stresses and endocrine abnormalities may arrest gastro-intestinal functions. In present study the following histologic changes were observed in the stomach of rat (*R. norvegicus*), exposed to the powerloom environment.

PLATE – VIII

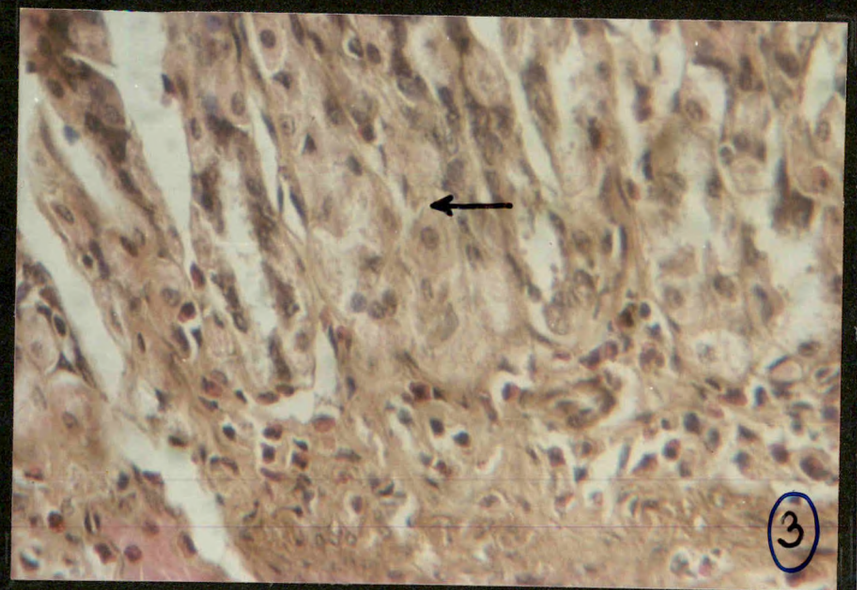
Caption to Figures 1 to 4

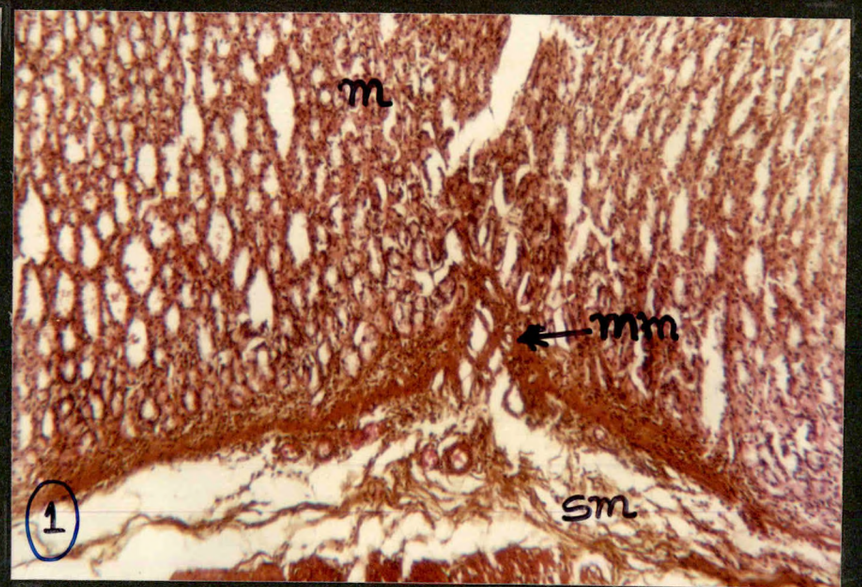
Fig. 1 Section of stomach of rat (control). Note mucosa (m), muscularis mucosa (mm), submucosa (sm) x 400. HE.

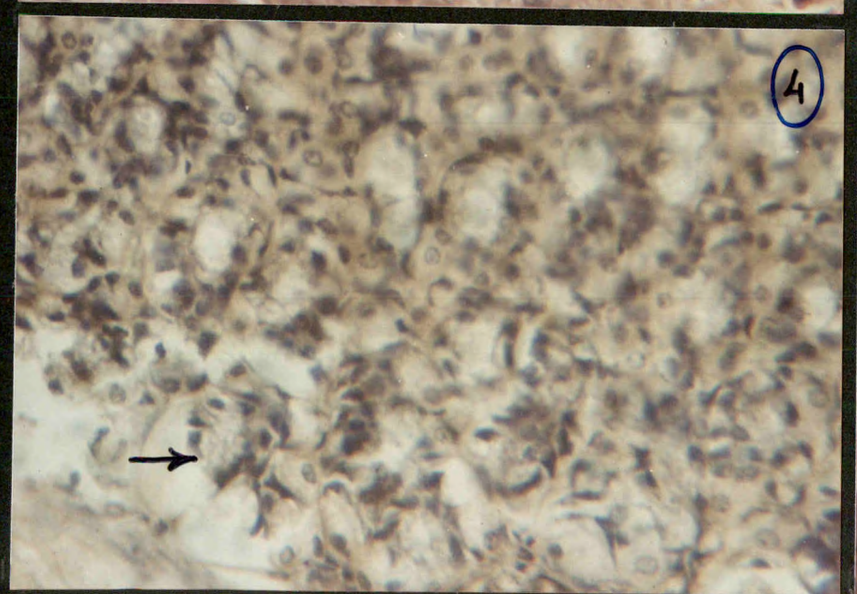
Fig. 2 Section of stomach of rat (control). Note gastric gland (g) x 400. HE.

Fig. 3 Section of stomach of experimental rat S_1P_1 of Set S_1. Note hypertrophy of gastric gland epithelium (arrow) x 400. HE.

Fig. 4 Section of stomach of experimental rat S_1P_2 of Set S_1. Note damage of gastric glands at the base (arrow) x 400. HE.







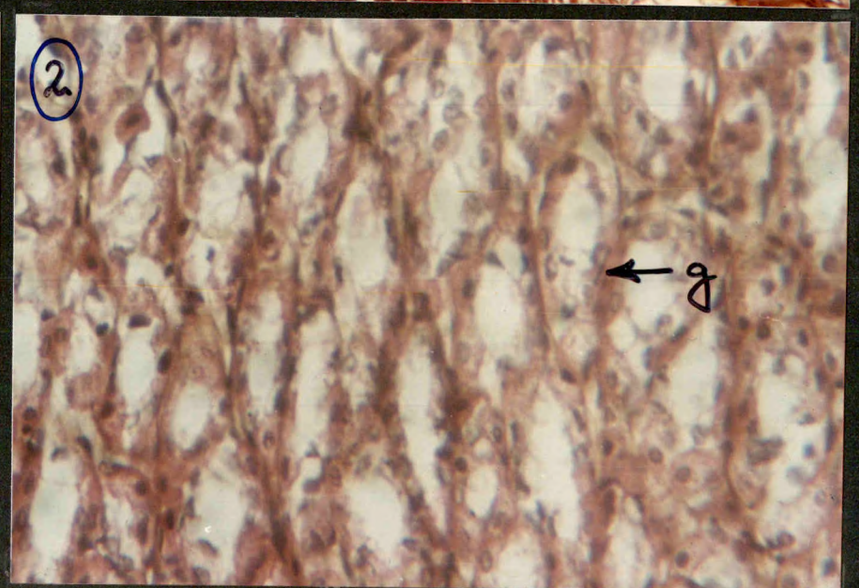


PLATE-VIII

The section of stomach of rat (control) showing normal 4 layers of the stomach that is inner mucosa submucosa muscularis mucosa and serosa (Plate VIII, Fig. 1 and 2).

The histological changes in stomach of experimental rats depicted in Plate VIII, Fig. 3 and 4, Plate IX, Figs. 1 to 4).

Set S_1 (Plate VIII Fig. 3 and 4) :

i. Epithelium of gastric glands showed hypertrophy that is cells enlarged in size as a result there was reduced lumen of gastric glands in rat S_1P_1 (Plate VIII, Fig. 3).

ii. gastric glands at basal region showed damage of cells in rat S_1P_2 (Plate VIII, Fig. 4).

Set S_2 (Plate IX, Fig. 1 and 2)

i. There was damage of gastric gland epithelium (Plate IX, Fig.1).

ii. There was hemorrhage in oblique muscle layer (Plate IX, Fig.2).

Set S_3 (Plate IX, Fig. 3 and 4)

i. There was hypertrophy and hyperplasia of gastric gland epithelial cells in rat S_3P_1 (Plate IX, Fig. 3).

PLATE – IX

Caption to Figures 1 to 4

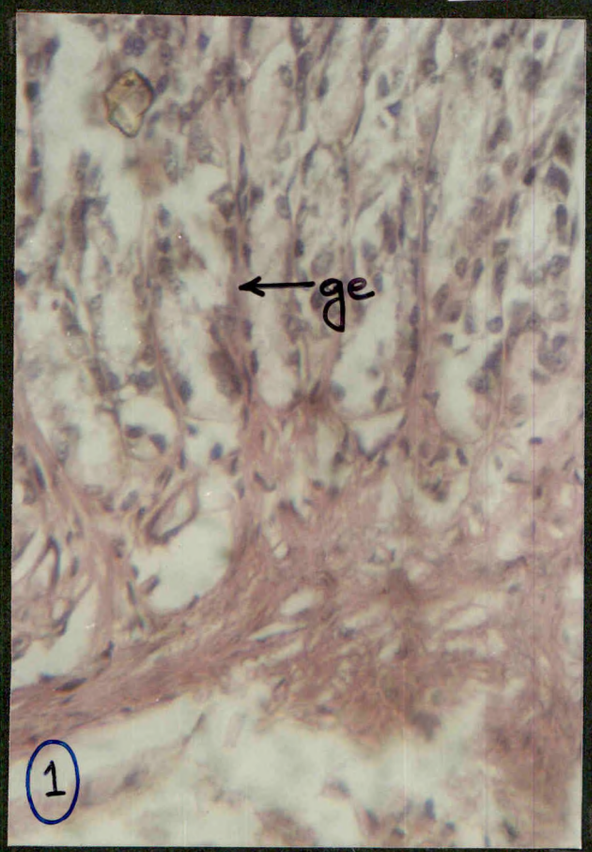
Fig. 1 Section of stomach of experimental rat in S_2. Note damage of gastric gland epithelium (ge) x 400. HE.

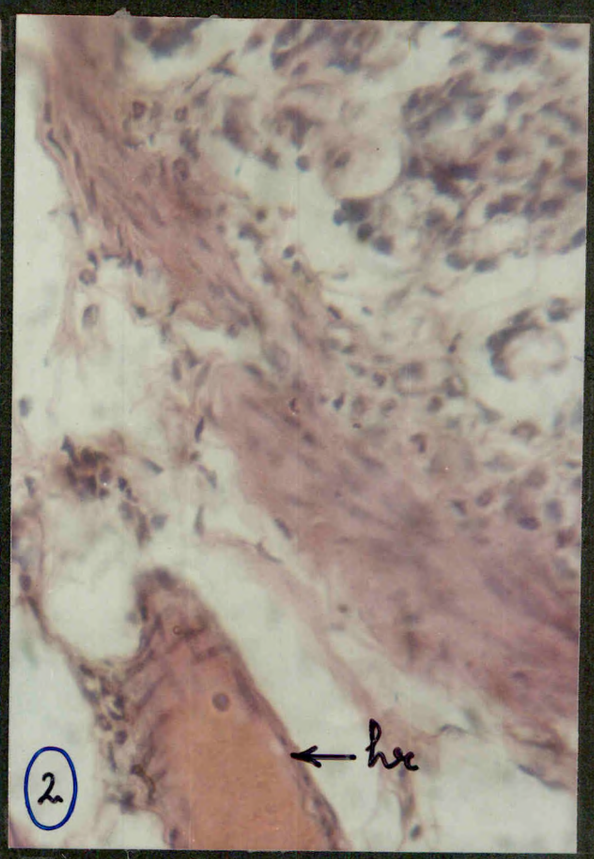
Fig. 2 Section of stomach of experimental rat in Set S_2. Note hemorrhage (hr) in oblique muscle layer x 400. HE.

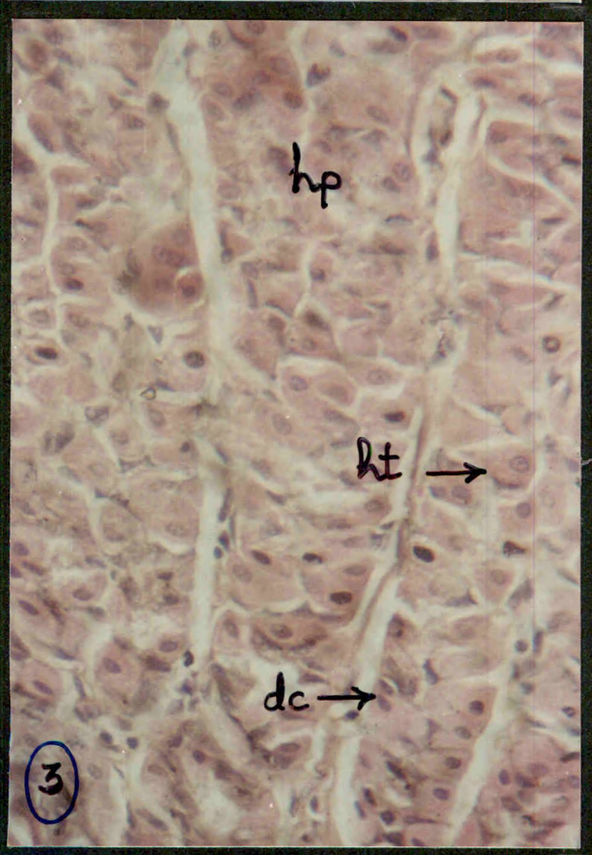
Fig. 3 Section of stomach of experimental rat S_3P_1 of Set S_3. Note hypertrophy (ht) and hyperplasia (hp) of gastric gland epithelial cells and there are number of dividing cells (dc) x 400. HE.

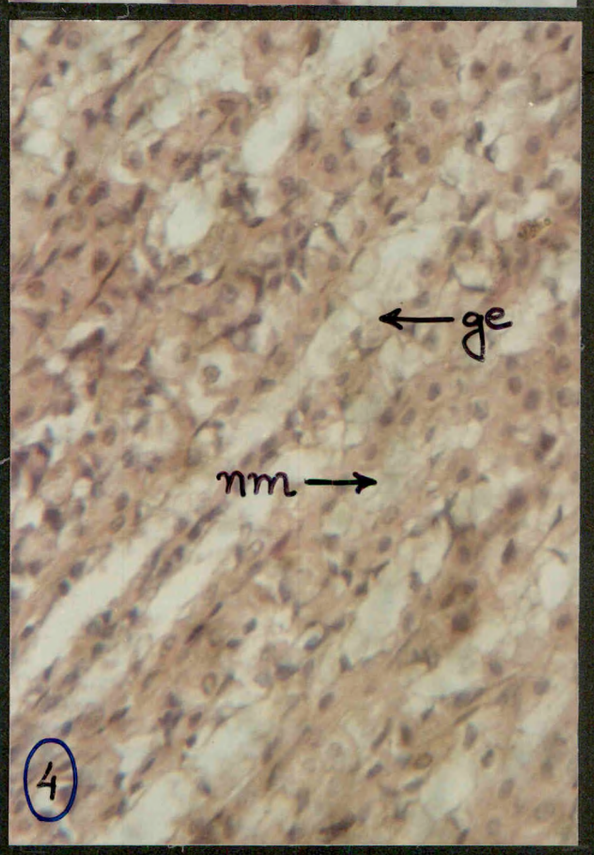
Fig. 4 Section of stomach of experimental rat S_3P_3 of Set S_3. Note damage of gastric gland epithelium (ge) and gastric pit filled with necrotic mass (nm) x 400. HE.

PLATE- IX









ii. Chief cells and parietal cells become tall and there were number of dividing cells observed in rat S_3P_2 (Plate IX, Fig. 3).

iii. Gastric gland epithelium damaged in rat S_3P_3 (Plate IX, Fig.4).

Thus rats exposed to the stresses in powerloom sector initially showed hypertrophy then gradually damage and again hypertrophy and hyperplasia of mucosal gland cells.

b) Alteration in Protein Content of Stomach :

Of the four major classes of high molecular weight compounds proteins are most important component of the tissues. They have important biological functions. They act as structural elements, enzymes and as components of biological defence and transport system. Proteins are the most important integral part of structure as well as of secretions of the stomach. Structural integrity of the stomach is maintained by proteins. Proteins form the major constituent of the gastric secretion. Gastric secretion includes proteins, enzymes, serum proteins and the portion of glycoproteins, constitute 60-80% of nodialyzable substance of gastro-intestinal tract secretion. The principle mucosubstances in gastric secretions and in gastric mucosa are glycoproteins. Glycoproteins performing the functions like protection of

mucosa, lubrication and transport. Various factors cause the quantitative changes in gastric mucosal glycoproteins. Okuba *et al.* (1986) examined quantitative changes in gastric mucosal glycoproteins during restrain and water immersion stress in rat. In present study total protein content of stomach of rat exposed to the powerloom environment was estimated.

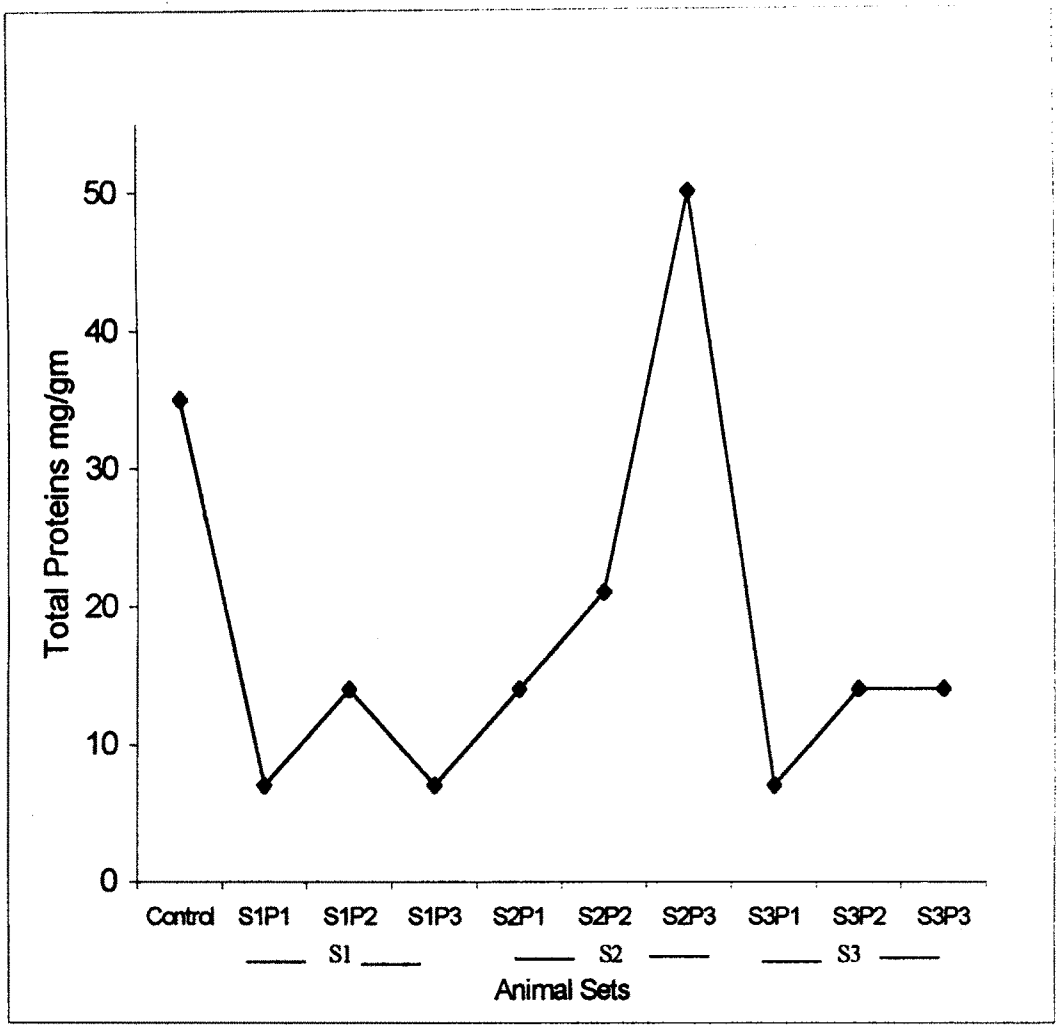
In present study following results were obtained regarding total protein content in stomach of rat (*R. norvegicus*), exposed to the powerloom environment and these results are shown in Table No. 2 and figure 4.

The amount of total proteins in the stomach of rat (control) was 35 mg/gm of stomach. In experimental rat the total protein content of stomach decreased as compared to the control except in rat P_3 of Set S_2.

In Set S_1, there was decrease in total protein content of stomach in rat S_1P_1, it was 7 mg/gm of stomach, while it is increased to 14 mg/gm in rat S_1P_2. Then again decreased to 7 mg/gm in rat S_1P_3.

In Set S_2 there was increase in total protein content of stomach as compared with the set S_1 but not than control (except S_2P_3). In rat S_2P_1 it was 14 mg/gm, in rat S_2P_2 it was 21 mg/gm.

Figure 4
Changes in Total Protein Content in Stomach in Rat Exposed to Textile Environment



In rat S_2P_3 there was increase in amount of protein as compared with that of control and Set S_1 and it was 50 mg/ gm of stomach.

In Set S_3 again there was decrease in protein amount as compared to the control. In rat S_3P_1 it was 7 mg/gm of stomach while in rat S_3P_2 and S_3P_3 it was 14 mg/ gm of stomach.

Thus the overall observations indicating significant alterations in stomach of rat exposed to the powerloom sector, in histology as well as in protein content.

B. Duodenum :

The small intestine is the longest part of the digestive tube based on structural and topographical differences it is divided into duodenum, jejunum and ileum. In duodenum the gastric chyme is mixed with the pancreatic and biliary secretions and there is a passage of water and electrolytes in both direction across the wall. The main absorption of iron and calcium occurs here in addition to large quantities of sugars and aminoacids. These functions of the intestine may affect by different kinds of toxins and bacteria. These factors directly stimulates excessive secretion of electrolytes and fluids, enhance the bicarbonate, chloride exchange mechanism. Certain psychogenic factors, nervous tensions, anxiety states leads to disorders in intestine. In present study following significant changes were observed in the

duodenum of the rats (*R. norvegicus*) exposed to the stresses in powerloom sector. The weight of the duodenum in the control rat was 0.95 gms. there was significant increase in weight of duodenum in Set S_1. The weight was increased to 2.317 gms in rat S_1P_1 while in rat S_1P_2 it was decreased than S_1P_1 to 2.00 gms. It was again decreased in rat S_1P_3 to 1.330 gms but not less than that of the rat (control). In Set S_2 there was also increase in weight of duodenum in rats S_2P_1 and S_2P_3 as compared to the control and this increase was 1.075 gm and 1.00 gms respectively. While in rat S_2P_2 there was decrease in weight of duodenum as compared to the control and it was about 0.852 gms. In Set S_3 there was decrease in the weight of duodenum as compared to the control. In rat S_3P_1 the weight was 0.864 gms in S_3P_2 0.706 gm and in S_3P_3 it was 0.887 gms. Thus in Set S_1 and Set S_2 there was increase in the weight of duodenum as compared to the control but decrease in weight in Set S_3 than that of control (Table No.1).

There was increase in the size (diameter) of intestine as compared to that of intestine of rat (control). The colour of intestine of the rat (control) was fresh-creamy white, while in experimental rats it becomes dirty and dull white.

a) Histologic Changes in Duodenum :

The wall of the intestine in duodenum is thick and composed of mucosa, submucosa, muscularis externa and serosa. The intestine absorbs water and on together with a wide range of nutrients. The mucous membrane is characterised by several structures such as intestinal villi, intestinal glands, lamina propria and muscularis mucosae. The intestinal villi covered by a simple columnar epithelium, composed of mucous cells (goblet cells), absorptive cells and occasional small lymphocytes. The mucus represents an essential part of the intestinal juice. It consists of glycoproteins and sulfated aminopolysaccharides. It protects the surface epithelium against abrasion by coarse intestinal material, lubricates the lumen and helps to form the faces. The absorptive cells provided with numerous microvilli. The surface epithelial cells are directly involved in the absorption of carbohydrates, proteins and fats from the lumen. The intestinal glands (Crypt's of Liberkuhn) are relatively large, and appear to be connected with the secretion of digestive enzymes and some hormones. The glands are lined by undifferentiated cells, absorptive cells, paneth cells, mucous cells and endocrine cells. The undifferentiated cells serve as a source of replacement for other cell types. The paneth cells secrete peptidages. They also contain zinc, which functions as a specific activator for peptidages. Mucous cells

secrete mucus. The endocrine cells are of two types; argentaffin and argyrophill cells. These cells produce serotonin, secretion and nor-adrenaline. The lamina propria consists of many more lymphoid elements, and is a potential site for accumulation of lymphoid elements in response to the immunological challenge, represented by the invasion of many foreign proteins either as a result of normal absorptive process or the invasion of bacteria and viruses. Muscularis mucosae consists of outer longitudinal and inner circular layers of smooth muscles. Contraction of these layers aid in emptying the intestinal glands. The submucosa consists of Brunner's glands which secret mucus to protect intestinal epithelium against pancreatic enzymes, and erosion by the gastric juice. Muscularis externa consists inner circular and outer longitudinal muscle layers. Serosa consists squamous mesothelium and submesothelial connective tissue.

In present study following histological alterations were observed in duodenum of experimental rat (*R. norvegicus*), exposed to the industrial stresses.

The section of duodenum of rat (control) include normal histological elements of duodenum such as mucosa, submucosa, muscularis externa, serosa, Brunner's glands, intestinal villi (Plate X, Figs. 1, 2 and 3).

Following histologic alterations were observed in duodenum animals exposed to textile environment as compared to control animals.

Set S_1 (Plate X, Fig. 4 and Plate XI, Fig. 1) :

i. There was swelling of muscularis externa (Plate X, Fig. 4).

ii. Large number of goblet cells observed in the lumen of intestinal glands (Plate XI, Fig. 1).

Set S_2 (Plate XI, Fig. 2) :

i. Epithelial cells of the intestinal glands not distinct (Plate XI, Fig.2).

ii. Lumen of intestinal glands consists of large number of goblet cells (Plate XI, Fig. 2).

Set S_3 (Plate XI, Fig. 3 and 4) :

i. Lumen of intestinal glands showed large number of granulated goblet cells and dividing cells (Plate XI, Fig. 3).

ii. Lumen of Brunner's gland also filled with goblet cells and number of dividing cells (Plate XI, Fig. 4).

Thus most significant changes were observed in the histology of mucosa layer of duodenum of experimental rat as compared to that of rat (control).

PLATE – X

Caption to Figures 1 to 4

Fig. 1 Section of duodenum of rat (control). Note mucosa (m), submucosa (sm), muscularis externa (me), serosa (s), Brunner's gland (bg), Crypts of Liberkuhn (cl), intestinal villi (v) x 100. HE.

Fig. 2 Section of duodenum of rat (control). Note intestinal villi with absorptive cells (ac), goblet cells (gc) and lamina propria (lp) x 400. HE.

Fig. 3 Muscularis externa of rat (control). Note inner circular and outer longitudinal muscle layer (arrow) x 400. HE.

Fig. 4 Muscularis externa of experimental rat in Set S_1. Note swelling of muscularis externa (arrow) x 400. HE.

PLATE – XI

Caption to Figures 1 to 4

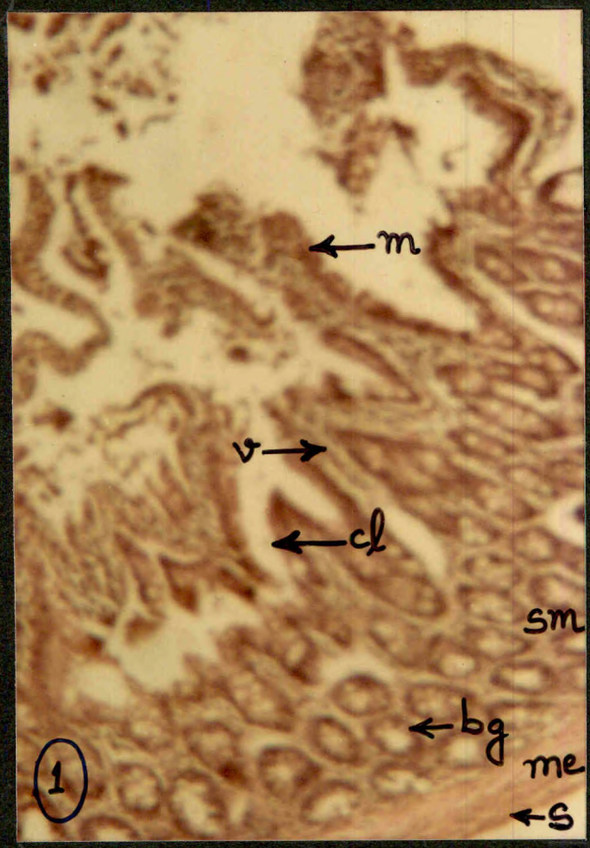
Fig. 1 Intestinal gland of experimental rat in Set S_1. Note increased number of goblet cells (gc) x 400. HE.

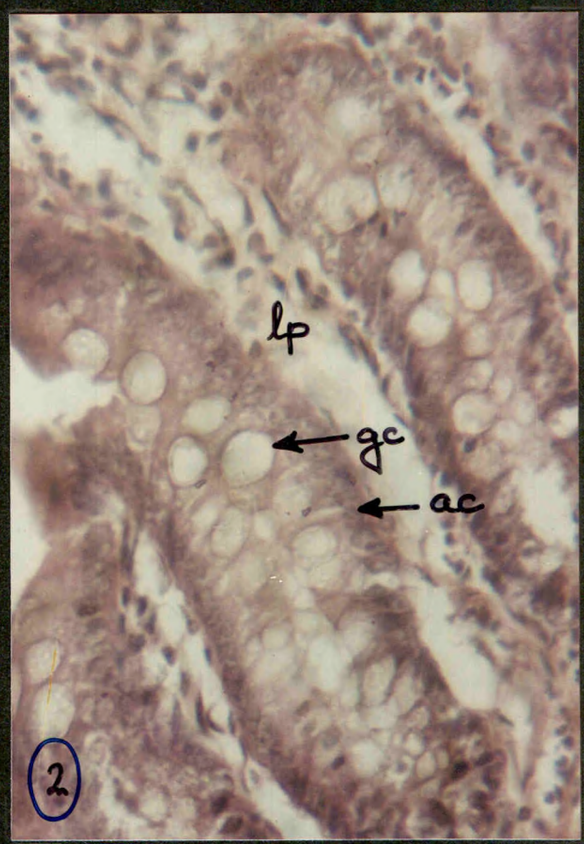
Fig. 2 Intestinal glands of experimental rats of Set S_2. Note indistinct epithelium and increase number of granulated goblet cells (gc) in the lumen of intestinal glands x 400. HE.

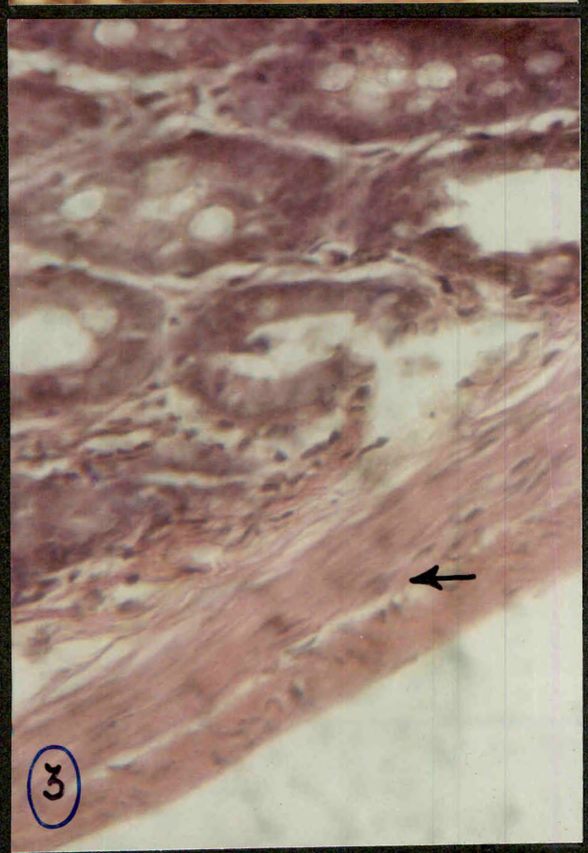
Fig. 3 Intestinal glands of experimental rat of Set S_3. Note goblet cells (gc) and dividing cells (dc) x 400. HE.

Fig. 4 Brunner's gland of experimental rat of Set S_3. Note goblet cells (gc) and dividing cells in the lumen x 400. HE.

PLATE- X







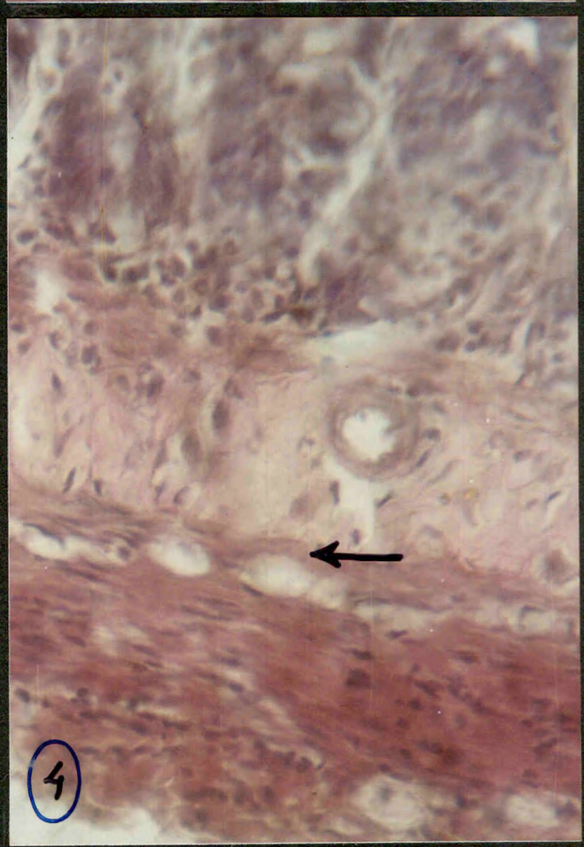
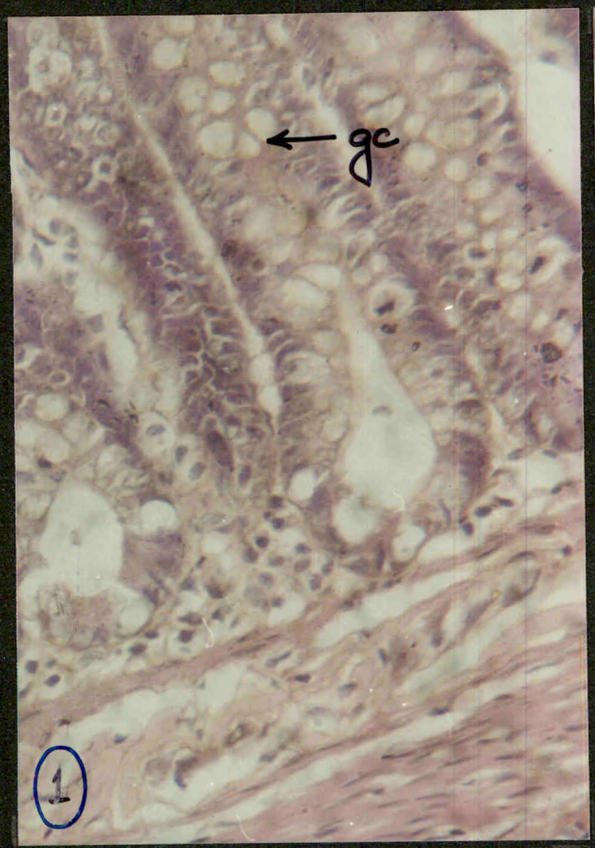
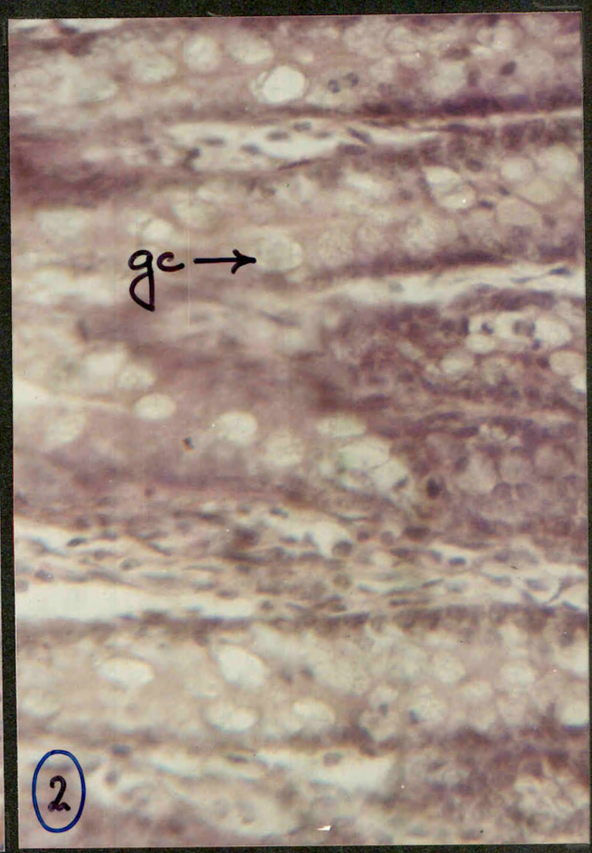
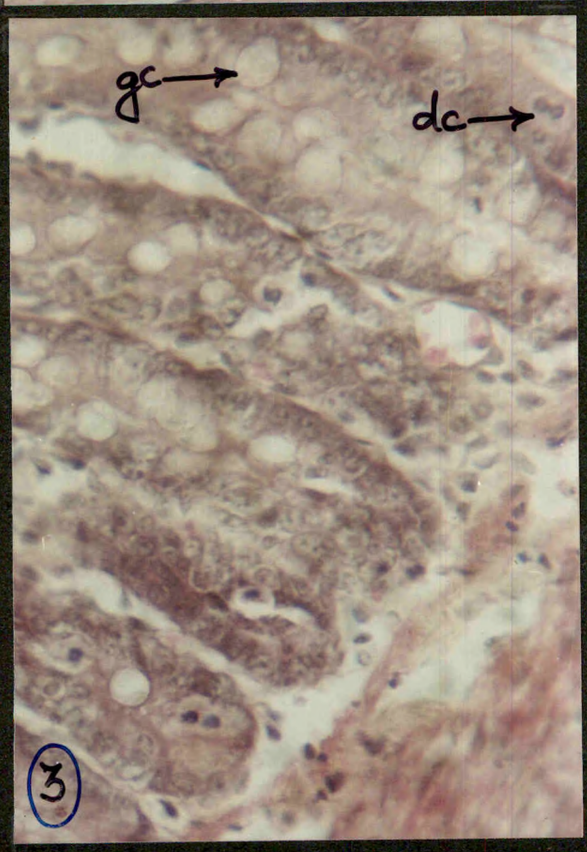
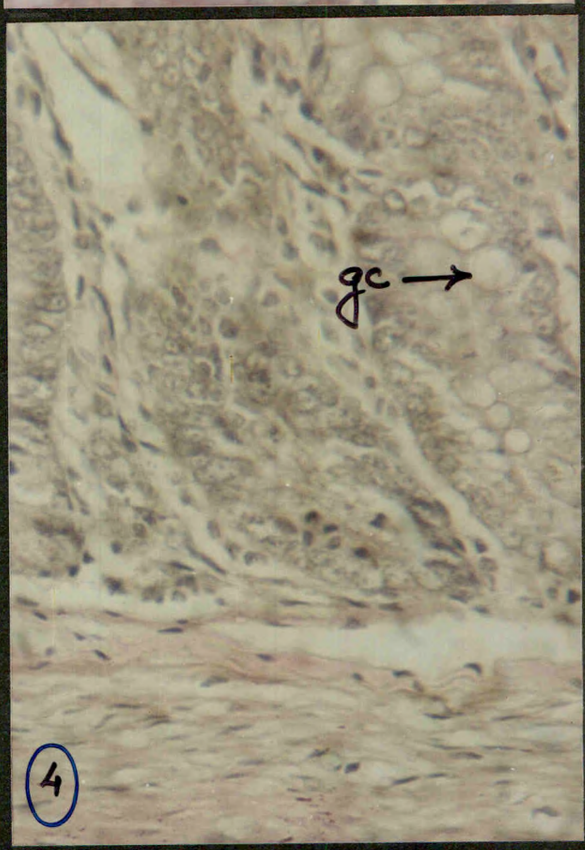


PLATE- XI









b) Alterations in Protein Content :

Proteins are the most important structural component of the duodenum. Most of the enzymes in duodenum are proteinous in nature. The major component of Brunner's gland juice is of proteins, in the form of mucoproteins. The proteins play important role in functions of duodenum. Any change in duodenum structure may causes change in total protein content, so in present study total proteins were estimated by Lowry's method to observe changes if any. In present study following results were obtained regarding total proteins in the duodenum of experiment rats (*R. norvegicus*), exposed to the stresses in powerloom sector. The protein content in duodenum of control and experimental animals is shown in Table No. 2 and figure 5.

Amount of the total protein in the duodenum of rat (control) was 35 mg/gm of duodenum. In experimental rats the amount of total protein in the duodenum was decreased in Set S_1 and Set S_3 as compared to the control except in set S_2.

In Set S_1, there was decrease in protein content in the duodenum in rat S_1P_1 it was 7 mg/gm, in rat S_1P_2 it showed significant increase as compared to S_1P_1 and it was 14 mg/ gm but again it was decreased to 7 mg/gm in rat S_1P_3.

In Set S_2, there was increase in protein content of duodenum as compared with the Set S_1, Set S_3 and the control. In rat S_2P_1 it was 57 mg/gm in rat S_2P_2 it was 35 mg/ gm and in rat S_2P_3 it was 42 mg/gm.

In Set S_3, there was decrease in the protein content of duodenum as compared to the control. In rat S_3P_1 it was 7 mg/gm and in rat S_3P_2 and S_3P_3 it was 14 mg/ gm.

Thus in stomach and duodenum the amount of total protein was decreased in set S_1 and S_3 but increased in set S_2 as compared to that of control.

Figure 5

Changes in Total Protein Content in Duodenum in Rat Exposed to Textile Environment

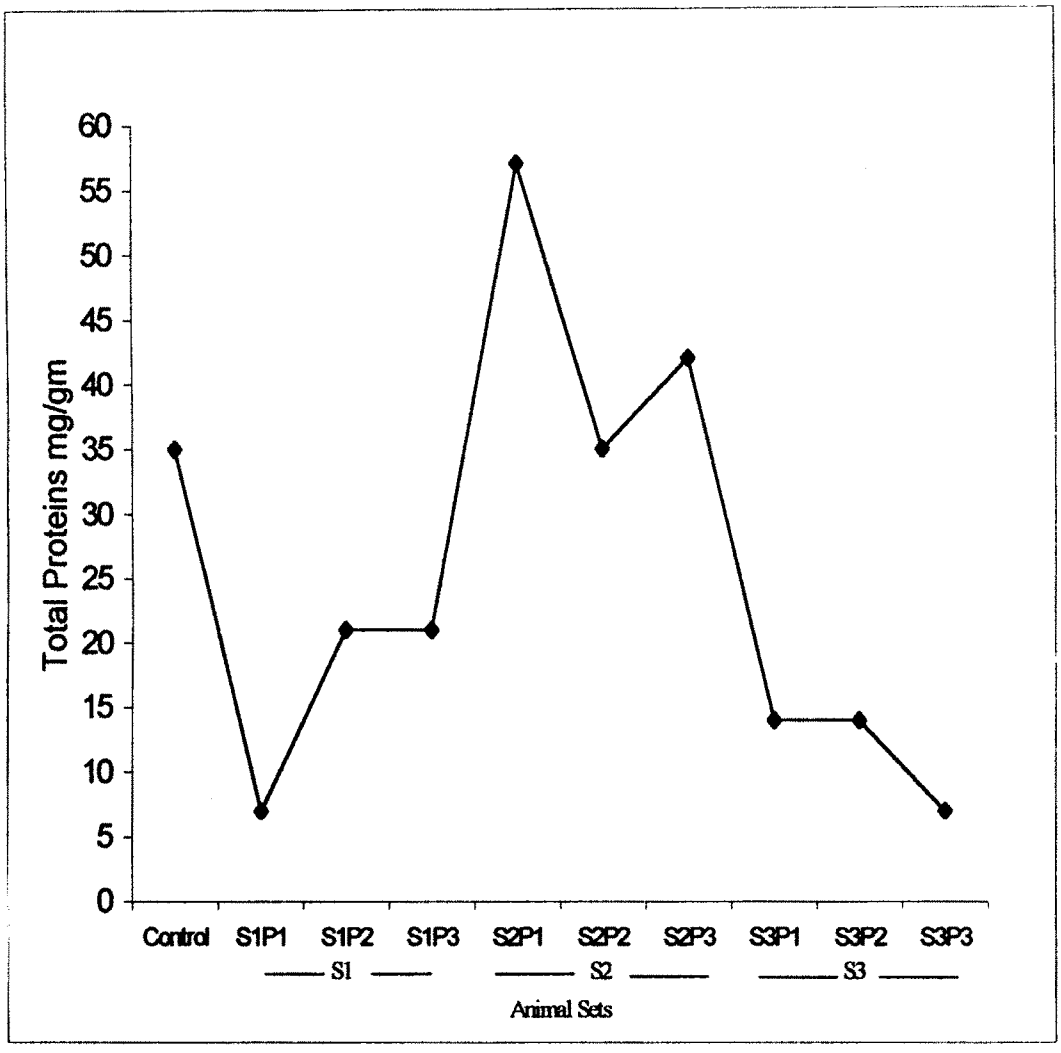


Table No. 1

CHANGE IN WEIGHT OF RAT ORGANS EXPOSED TO TEXTILE ENVIRONMENT

Sr. No.	Name of the Organs	Weight (in gms) in control rats	Weight (in gms) in experimental rats								
			Set S_1			Set S_2			Set S_3		
			S_1P_1	S_1P_2	S_1P_3	S_2P_1	S_2P_2	S_2P_3	S_3P_1	S_3P_2	S_3P_3
1.	Adrenals	0.0040	0.0093	0.010	0.0065	0.00631	0.0064	0.080	0.068	0.050	0.057
2.	Kidney	0.640	0.9890	2.576	1.1550	0.8549	0.8400	1.456	2.200	1.160	1.1516
3.	Heart	0.600	0.800	0.932	1.260	1.210	1.213	1.212	0.836	0.886	1.091
4.	Stomach	1.950	3.573	3.220	2.030	4.450	2.210	5.210	6.422	6.120	8.735
5.	Duodenum	0.9562	2.317	2.000	1.330	1.075	0.852	1.00	0.864	0.706	0.887

Table No. 2

TOTAL TISSUE PROTEIN OF RATS EXPOSED TO TEXTILE ENVIRONMENT

Sr. No.	Name of the Organs	Control	Proteins in mg/gm of (wet) tissue								
			Set S_1			Set S_2			Set S_3		
			S_1P_1	S_1P_2	S_1P_3	S_2P_1	S_2P_2	S_2P_3	S_3P_1	S_3P_2	S_3P_3
1.	Adrenals	28	28	35	21	35	21	42	35	21	21
2.	Kidney	35	14	14	14	7	28	42	21	21	14
3.	Heart	35	7	21	7	35	14	21	21	14	7
4.	Stomach	35	7	14	7	14	21	50	7	14	14
5.	Duodenum	35	7	21	21	57	35	42	14	14	7