

## Toxicological Profiling Of Santha Santhrodhaya Mathirai (SSM) A Siddha Herbomineral Formulation in Rats.

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**Abstract:** The Siddha system of medicine exhibits its glory and significance since time immemorial. It is essentially concerned about utilizing the flora and fauna of the universe for the benefit of the society. Present day treatment modalities for hepatic disorders involve ready use of herbal drugs. Santha santhrodhaya mathirai(SSM) is the widely used Siddha herbo mineral formulation for the treatment of Pitha suram (Disorders of Liver associated with or without fever) . Currently there is no scientific data available for its safety profile and so the present study is to evaluate the toxicological potential if any of SSM with Wistar albino rat. In acute oral toxicity study, SSM was administered at 2000mg/kg orally and animals were observed for toxic signs at 0.5, 1, 4, 24 h and for 14 days. In repeated dose-28 day toxicity study, SSM was administered at 25, 125 and 250 mg/kg body weight/day to 3 groups of rats, respectively. The heavy metal analysis of SSM was done at Regional research institute of Unani (RRIU), Chennai. The results showed that neither the acute toxicity study of SSM at the dose level of 2000mg/kg nor the repeated dose study did not produce any toxic sign or mortality during study. In repeated dose toxicity study, no significant changes were observed in the haematological and biochemical parameters, relative organ weight, gross necropsy and histopathological examination with SSM treatment. The Results of the present study suggest that LD<sub>50</sub> of SSM >2000mg/kg and NOAEL >250mg/kg/day in rats and the heavy metals were within the WHO permissible limits.

**Keywords:** Siddha, Santhasanthrodhayamathirai , Herbomineral, acute oral toxicity, Hepatic disorder .

### I. Introduction

Liver is one of the major metabolic organ and plays a pivotal role in metabolism of food, provision of nutrients to the blood and excretion of toxins. Changes in liver function due to infection or injury due to any cause may alter the metabolic functions and cause irreversible liver diseases. Liver disease deaths in India reached 2.31% of the total deaths according to the latest WHO data published in April 2011. It is estimated that liver diseases are among the top ten killer diseases in India<sup>1</sup>. Liver diseases are caused by toxic chemicals, drugs, viruses (hep A, B, C, D, E), excess alcohol intake etc<sup>2</sup>. The Traditional Siddha system of medicine offers several therapeutic agents like herbal, herbo-mineral, formulations for the treatment of liver diseases. Santha Santhrodhaya Mathirai(SSM) is a significant herbo-mineral formulation with a blend of hepatoprotective and anti-inflammatory ingredients for the treatment of Pitha suram (biliary disease). Sage Yugi describes the symptoms of Pitha suram in Siddha literature as follows, excessive sleep, reddish urine and stools, diarrhoea, vomiting, bitter tastiness, excessive thirst, fatigue, pallor, hiccup<sup>3</sup> which correlates with most of the symptoms of Liver diseases.

The ingredients of SSM consist of Mercurous chloride, Borax, Turmeric and Lemon juice all of which are said to have a positive effect on Liver functions. Mercurous chloride is used for the treatment of fever and Jaundice. Borax is reported to have coolant properties and is recommended for indigestion and loss of appetite which are the main symptoms of Liver diseases<sup>4</sup>. Turmeric, is a potent ingredient for treating liver diseases as it has curcumin as its important active principle. It is also an antioxidant and has anti-inflammatory, antiviral, antibacterial, antifungal, and anticancer properties, etc<sup>5</sup>. Lemon is described as a Minister to the 'Minister' pitham and a duke to the duke, in Siddha literature (Manthirikku manthiri yaai, mannanukku mannanaai). And it is therefore indicated for the treatment of Pitham associated (Bilious) disorders<sup>6</sup>. The Citrus nature of lemon has pharmacological significance as it possesses anti-cancer, antimicrobial, antioxidant, antiulcer, anti-inflammatory, and hypolipidemic and hepatoprotective properties<sup>7</sup>.

Clinically SSM is used as one of the most important herbo-mineral formulations by Siddha practitioners for fevers with Liver diseases. As this formulation contains mercurous chloride, a heavy metal salt as one of the ingredient, this study was conducted to evaluate the safety profile of this herbomineral drug which is the prime step to validate the therapeutic potential of these ancient drugs for further researches.

## II. Materials and Methods

### 2.1. Study Drug

The ingredients used for the preparation of the Siddha formulation *SSM* were Purified Mercurous chloride (*Pooram*), Purified Borax (*Vengaram*), Curcuma longa (*Manjal*), and Lemon juice (*Elumichai saaru*). The Herbal and mineral drugs were procured from traditional reputed shops of Erode and authenticated by Geochemist and Botanist respectively. The above drugs were then prepared as pills as per Siddha text<sup>8</sup>.

### 2.2. Estimation Of Heavy Metals

Heavy metals (lead, cadmium, mercury and arsenic) content of the test drug *SSM* were estimated by using Atomic Absorption Spectroscopy (Thermo Fisher M Series, 650902 V1.27 model). The procedures recommended for analysis of heavy metals in WHO, 1998 and AOAC, 2005.

### 2.3. Animals And Husbandary:

Male and female Wistar albino rats weighing 130-160g (initial weight) were used in the study. Animals were housed in groups (3-5/cage) in polypropylene cages in a well ventilated room (air cycles: 15/min; 70:30) under an ambient temperature of 23±2°C and 40–65% relative humidity, with a 12-h light/dark artificial light cycle. They were provided with food (Saimeera foods, Bangalore, India) and purified water *ad libitum*. All the animals were acclimatized at least for 7 days to the laboratory conditions prior to animal study. Guidelines of CPCSEA, Laboratory Animal care was strictly followed throughout the study. This study was carried out with the approval of Institutional Animal Ethics Committee (IAEC), National Institute of Siddha, (IAEC-1248/ac/09/CPCSEA/5 -16/2011).

### 2.4 Methods

Acute oral toxicity study was performed in accordance with Organization for Economic Cooperation and Development (OECD - 423) (adopted – December, 2001) with slight modification. Young adult female (non-pregnant and nulliparous) wistar albino rats of 140-160g body weight were used for the study. Seven days after acclimatization, 12 animals were selected and divided into two groups viz, control and test group. Control group received honey as vehicle at the dose of 10ml/kg b.wt. The test group was treated with *SSM* at the dose level of 2000mg/kg b.wt by oral gavage. All the study animals were observed for their behavioural signs and mortality at 30 minutes, 1, 2, 4 hours upto 24 hours and then followed for further 14 days. At the end of the 14<sup>th</sup> day, the overnight fasted animals except water were sacrificed by using excessive anaesthesia and subjected to gross pathological examination. Maximum tolerated dose was calculated in accordance with Globally harmonised system of classification<sup>9</sup>.

### 2.5. Repeated dose 28-day oral toxicity study

According to OECD 407 (adopted – April 2006) the sub acute toxicity study was conducted with slight modification. 40 Young adult wistar albino rats were selected, which were divided into 4 groups. Each group consists of 10 animals (n=10, 5 males and 5 females). Group I was treated as vehicle control, honey with water, Group II (n=10, 5 males and 5 females) received *SSM* 25 mg/kg, Group III (n=10, 5 males and 5 females) received *SSM* 125mg/kg and group IV (n=10, 5 males and 5 females) *SSM* 250 mg/kg. All the animals in the control and treatment groups were treated once daily for 28 consecutive days. The signs of toxicity and mortality were monitored daily for 28 days. Body-weight changes, food and water intake were monitored once in a week. Rats were overnight fasted, the animals were sacrificed after 28 days blood samples were collected from the retro-orbital puncture under excessive anaesthesia with and without anticoagulant and used for haematological and biochemical parameters.

The Haematological parameters were analysed using fully automated haematology analyser. Plasma was separated and used for the estimation of glucose, triglyceride, cholesterol, creatinine, urea and total protein with standard diagnostic kits using semi-automatic biochemical analyser (Star-21 Plus, India). Enzymes such as alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and other constituents were also estimated.

### 2.6. Histopathology examinations of organs

Vital organs like brain, heart, liver, kidneys and spleen and gonads were observed for gross lesions and organs were weighed for relative organ weights. Tissues were fixed in 10% formalin and sections of 5–6 mm were routinely stained with haematoxylin and eosin (H & E) and examined under a light microscope for the presence of any change in the histopathology of the treatment group and compared with the control group.

## 2.7. Statistical analysis

Data were presented as mean  $\pm$  standard error mean. Data were subjected to statistical analysis by oneway ANOVA followed by Dunnet's test using GraphPad prism.4.0. Significant between the mean values of test groups were compared with control group.  $P < 0.05$  was considered as significant.

## III. Results

### 3.1. Heavy metal analysis

Heavy metal analysis of *SSM* reveals the presence of mercury and lead within permissible limits (Table 1).

### 3.2. Acute toxicity study

Acute toxicity of *SSM* does not produce any toxicity signs and mortality at the dose level of 2000mg/kg, b.wt in the animals during 14 days of the study. Further, the gross necropsy revealed no abnormalities in the internal organs of the experimental animals.

### 3.3. Repeated dose 28 days study

There was no behavioural abnormality and mortality throughout the study period. Body weight was gradually gained in *SSM* administered rats when compared with the vehicle treated rats but it is not statistically significant (**Figure 1**). No significant difference in food and water consumption was observed between the vehicle and *SSM* treated animals throughout the study.

### 3.4 Measurement of haematological, serum electrolytes, biochemical parameters and relative organ weights.

Haematological results were summarised in the **Table 2,3**. No significant difference in any of the tested haematological parameters was observed between the control and the *SSM* treated rats. There were no significant changes in the serum Na, K, Ca, Cl, and pH between the control and *SSM* treated animals (**Table 4**). Administration of *SSM* for a period of 28 days did not produce any significant changes in the plasma biochemical parameters such as glucose, cholesterol, triglyceride, bilirubin and liver marker enzymes like aspartate amino transferase, alanine amino transferase, alkaline phosphatase, urea, creatinine, albumin and total protein at any of the tested dose levels when compared to the vehicle control (**Table 5**). Effects of *SSM* on relative organ weights were shown in **Table 6**. No statistically significant changes in the relative organ weights were observed between the vehicle and *SSM* treated rats.

### 3.5 Histopathology

At autopsy, macroscopic and pathological examination of the organs did not reveal any abnormal changes. Histopathological examinations of the tissues revealed no abnormalities in control and high dose *SSM* treated experimental animals. Histopathological photographs of brain, heart, liver, kidneys and spleen of control, mid dose, high dose *SSM* treated were shown in Figure 2.

## IV. Discussion

This study involved the testing of the safety profile of *SSM*, a Siddha herbo mineral formulation which is used for the treatment of fevers associated with liver disorders by quantification of heavy metals and evaluation of acute and sub acute oral toxicity and the results were analysed. The heavy metal analyses of *SSM* showed the presence of lead and mercury but they were under their respective permissible limits (Table-1). Heavy metals in elemental form are reported to be persistent and universal pollutants that affect the structure and function of several organs particularly the liver by generating oxidative stress<sup>10</sup>. Herbomineral formulations mentioned in Siddha system of medicine involves a great deal of processing that renders the elemental metals to be converted into assimilable and excretable metallic salt complexes. Hence they are not as toxic as their elemental form as described by the conventional toxicity data. Therefore this Siddha formulation is considered to be safe from heavy metal toxicity as it contains them within the permissible limits. The possible reason for safety of *SSM* from heavy metal toxicity may be due to the fact of grinding it with lemon juice along with turmeric as treating the metals with herbal juices leads to reduction in particulate size even upto nano levels making them effective in low doses and enabling increased potency<sup>11</sup>.

The results of Acute oral toxicity did not show any significant change in the body weight, food and water intake of control and *SSM* treated group. There were no *SSM* treatment related mortalities recorded in animals. There were no clinical signs in the skin and fur, eyes and mucus membrane (nasal), respiratory rate, circulatory signs (heart rate and blood pressure), autonomic effects (salivation, perspiration, piloerection, urinary incontinence and defecation) and central nervous system (ptosis, drowsiness, gait, tremors and convulsion) among rats administered 2000 mg kg<sup>-1</sup> body weight of *SSM*. Repeated dose 28 days study (sub

acute toxicity) of low(25 mg/kg b.wt), mid(125mg/Kg b.wt) and high (250mg/Kg b.wt) dose(fig-1) reveals that there was no alteration in food and water consumption and there was an obvious weight gain in the *SSM* when compared to the control groups of the experimental animals, therefore it is crystal clear that the basic metabolic process of the rats remain conserved without any catabolism<sup>12</sup>.

There was also no significant changes in hematological parameters (WBC, RBC, Hb, HCT,MCV, MCHC, PLT,MPV, DC, PLT CRIT, PDW%) in the test groups (Table 2&3). Analysis of haematological parameters can be associated with the safety in human body system and has a higher significance of toxicity forecast of the test drug. The results therefore indicate that *SSM* is a safe drug which shows no toxicity that is reflected in the haematopoiesis.

The biochemical parameters are indicators of intactness of liver cells and function which holds an important role in determining the drug toxicity. The transaminases AST and ALT are considered to be “biomarkers” of liver injury. Data analyses of *SSM* treated experimental rats show that the test drug is safe as it did not cause any significant rise of these enzymes ensuring that it did not cause any damage to the liver parenchyma cells<sup>13,14</sup>(Table-5).

The estimation of Serum electrolytes (Total calcium, potassium, Sodium, chloride ), pH, urea and creatinine are sensitive indicators of nephrotoxicity. The results show that there was no significant alteration in serum electrolytes when compared with the control. Since this formulation contains mercurous chloride which is advocated and widely being used for Liver disorders in Siddha system, it is imperative to prove its renal safety. *SSM* therefore can be considered as a safe drug to administer as it does not have nephrotoxicity<sup>15</sup>.

Also the relative organ weight of brain, heart, liver, kidney, spleen, testis and ovaries did not show any remarkable change indicating that the drug does not cause any tissue damage.

Histopathological analyses of Liver, brain, lungs, spleen, kidney, heart, femoro-tibial joint did not exhibit any pathological changes except a very minimal infiltration of mononuclear cells of liver at a high dose of 250 mg/kg but it is considered as insignificant because there was no elevation of AST /ALT or both of the biochemical parameters supporting any evidence of liver tissue damage .

From the above results it can be assured that the accuracy of purification process, ratio and combination of ingredients proposed by ancient Siddhars accounts for its safety and efficacy. The preparation of *SSM* consist of purified mercurous chloride, curcuma longa and borax ground with lemon juice for about 12 hours after which they are made into pepper sized pellets and dried well before administration. Mercurous chloride (calomel) is less toxic than mercuric form and is clinically insignificant<sup>16</sup>. Further the synergistic action of mixture of compounds and the potent purification process also accounts for diminished toxicity.

Borax (Sodium tetra borate decahydrate) is not acutely toxic according to one study<sup>17</sup>. Its LD50 (Medium lethal dose) score is tested at 2.66g/Kg in rats. However Borax dust on sufficient exposure and ingestion causes GI distress, nausea, persistent vomiting, abdominal pain, diarrhoea, headache and lethargy<sup>18</sup>.

Toxic manifestations of metals are attributed primarily to oxidative stress<sup>19</sup>.As lemon is rich in ascorbic acid it is highly bioavailable and is consequently the most important water soluble antioxidant vitamin in cells, effectively scavenging reactive oxygen species(ROS)<sup>20</sup> Also there was noteworthy ameliorating effect of the fruit extract of citrus lemon on carbofuran pre treated rats in which the metabolism of carbofuran generated high concentration of free radicals and oxidative stress. Pre treatment with lemon extract caused significant recovery in the levels of activities of the key enzymes AST,ALT and LDH<sup>21</sup>.The hepatoprotection of the lemon-ogi mixture against paracetamol-induced hepatotoxicity in rats could be attributed to its ability to restore the antioxidant enzymes SOD, catalase, and peroxidases of liver cytosol or to the free radical scavenging activity of the mixture<sup>22</sup>.

Curcumin an important phytochemical present in curcuma longa has become one of the most cited antioxidants with beneficial health effects<sup>23</sup>.Pre and post treatment with curcumin had a protective effect on oxidative stress in liver, kidney and brain of rats treated with mercuric chloride which is relatively more toxic than mercurous chloride used in *SSM* and reversed the mercury induced liver and kidney injury markers. Also curcumin chelates mercury by reducing its concentration in tissues<sup>10</sup>. Curcumin was found to be an effective antioxidant and show stronger antioxidative efficiency when compared to standard antioxidant compounds such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT),  $\alpha$ - tocopherol and trolox in vitro<sup>24</sup>. Curcumin has a very good protective effect against nicotine-induced Liver toxicity<sup>25</sup>.

## V. Conclusion

The in-vivo acute toxicity study of Siddha formulation *SSM* showed that a single dose of 2000 mg/kg b.wt did not induce any clinical signs of toxicity classifying *SSM* under catalogue-5 according to the Globally harmonised system of classification of drugs and labelling of chemicals. Also the subacute toxicity study ensured the safety of *SSM* after repeated oral administration for 28 consecutive days. Therefore *SSM* can be considered to be a safe drug. Further researches on sub chronic toxicity may be necessary to confirm the safety of this ancient ,cost effective and efficient herbomineral formulation for prolong usage among hepatic disorders.

### **Conflict Of Interest**

The author(s) declared no conflicts of interest with respect to the authorship and/or publication of this article

### **Acknowledgment**

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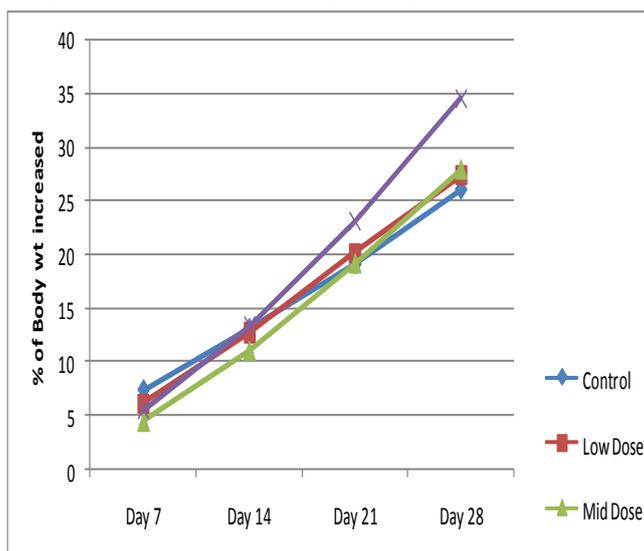
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**Fig.1 Effect of SSM in Body weight changes of Wistar Albino rats**



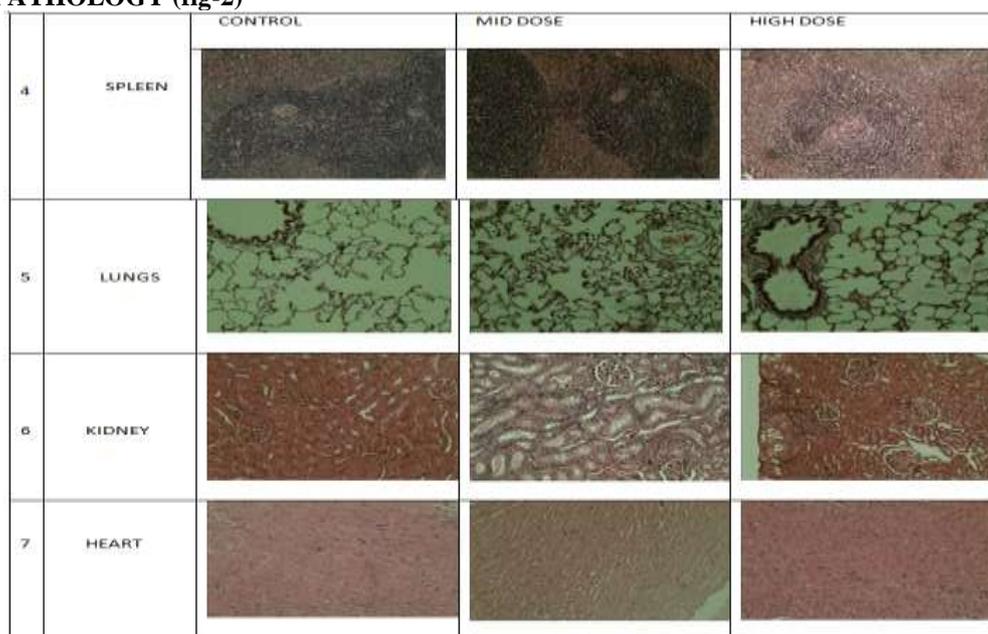
**Table. 1. Heavy Metals Content of Santhasanthrodhaya Mathirai**

| Heavy Metals Limit | SSM          | Maximum Permissible |
|--------------------|--------------|---------------------|
| Lead               | 0.7686ppm    | 10 ppm (WHO)        |
| Cadmium            | Not detected | 0.3ppm (WHO)        |
| Mercury            | 0.9015ppm    | 1 ppm (API, 2008)   |
| Arsenic            | Not detected | 3 ppm (API, 2008)   |

**HISTOPATHOLOGY (fig-2)**

|   |                 | CONTROL | MID DOSE | HIGH DOSE |
|---|-----------------|---------|----------|-----------|
| 1 | LIVER           |         |          |           |
| 2 | BRAIN, CEREBRUM |         |          |           |
| 3 | STOMACH         |         |          |           |

**HISTOPATHOLOGY (fig-2)**



Histopathological examinations of the tissues revealed no abnormalities in control, mid and high dose SSM treated experimental animals. Very minimal infiltration of mononuclear cells of liver at a high dose of 250 mg/kg is noted.

**Fig-2**

**Table. 2:** Effect of SSM in haematological parameters in Wistar albino rats – 28 days repeated oral toxicity study

| Treatment       | Haematological Parameters    |                              |            |            |             |             |                |                              |             |
|-----------------|------------------------------|------------------------------|------------|------------|-------------|-------------|----------------|------------------------------|-------------|
|                 | WBC<br>(10 <sup>3</sup> /uL) | RBC<br>(10 <sup>6</sup> /uL) | Hb<br>(%)  | HCT<br>(%) | MCV<br>(fL) | MCH<br>(pg) | MCHC<br>(g/dl) | PLT<br>(10 <sup>3</sup> /uL) | MPV<br>(fL) |
| Control (Honey) | 9.12±1.88                    | 10.05±0.54                   | 16.93±0.77 | 51.02±2.62 | 50.79±0.58  | 16.76±0.35  | 33.08±0.01     | 82.80±0.95                   | 6.21±0.18   |
| SSM(25mg/kg)    | 6.86±0.78                    | 5.95±0.28                    | 10.01±0.49 | 31.03±1.27 | 51.31±0.59  | 16.74±0.14  | 32.62±0.43     | 169.20±5.9                   | 5.91±0.14   |
| SSM(125mg/kg)   | 6.53±1.43                    | 5.62±0.60                    | 9.60±0.86  | 28.57±2.70 | 51.31±0.19  | 17.05±0.11  | 33.37±0.27     | 129±1.30                     | 6.38±0.04   |
| SSM(250mg/kg)   | 10.38±1.14                   | 7.04±0.27                    | 12.02±0.37 | 36.16±1.36 | 51.49±1.06  | 17.11±0.15  | 33.32±0.46     | 149.50±5.13                  | 6.01±0.00   |

Values were expressed as mean±SEM for n=10 rats in each group, Oneway ANOVA followed by Dumet's test.

**Table. 3:** Effect of SSM in haematological parameters in Wistar albino rats – 28 days repeated oral toxicity study

| Treatment       | Haematological Parameters |               |                    |            |                  |            |
|-----------------|---------------------------|---------------|--------------------|------------|------------------|------------|
|                 | LYMPHOCYTE<br>%           | MONOCYTE<br>% | GRANULOCYTE<br>(%) | RDW<br>(%) | PLATELET<br>CRIT | PDW<br>%   |
| Control (Honey) | 4.02±0.03                 | 0.25±0.04     | 4.68±2.12          | 11.49±0.79 | 0.05±0.00        | 15.69±0.64 |
| SSM(25mg/kg)    | 4.46±0.33                 | 0.17±0.03     | 2.15±0.40          | 11.04±0.06 | 0.10±0.01        | 15.23±0.04 |
| SSM(125mg/kg)   | 4.17±1.06                 | 0.02±0.02     | 2.16±0.69          | 11.50±0.01 | 0.08±0.00        | 15.49±0.02 |
| SSM(250mg/kg)   | 6.92±0.85                 | 0.31±0.00     | 3.28±0.39          | 13.59±3.99 | 0.09±0.00        | 15.09±0.09 |

Values were expressed as mean±SEM for n=10 rats in each group, Oneway ANOVA followed by Dumet's test.

**Table. 4:** Effect of SSM on serum electrolyte in Wistar albino rats

| Treatment       | Serum electrolytes (mmol/l) |           |             |             |           |
|-----------------|-----------------------------|-----------|-------------|-------------|-----------|
|                 | Total calcium               | Potassium | Sodium      | Chloride    | pH        |
| Control (HONEY) | 2.53±0.09                   | 4.58±0.13 | 144.26±1.12 | 105.12±1.12 | 7.63±0.01 |
| SSM (25mg/kg )  | 2.52±0.01                   | 4.42±0.90 | 143.29±0.39 | 105.14±0.39 | 7.67±0.01 |
| SSM(125mg/kg )  | 2.36±0.06                   | 3.86±0.07 | 143.36±1.09 | 96.17±1.40  | 7.68±0.01 |
| SSM(250mg/kg )  | 2.48±0.01                   | 4.59±0.10 | 148.09±2.43 | 92.89±2.40  | 7.55±0.01 |

Values were expressed as mean±SEM. for n=10 rats in each group, Oneway ANOVA followed by Dunnet's test.

**Table. 5:** Effect of SSM on biochemical parameters in Wistar albino rats

| Treatment       | Biochemical parameter |                     |                       |                   |              |             |              |              |                    |                       |                 |
|-----------------|-----------------------|---------------------|-----------------------|-------------------|--------------|-------------|--------------|--------------|--------------------|-----------------------|-----------------|
|                 | Glucose (mg/dl)       | Cholesterol (mg/dl) | Triglycerides (mg/dl) | Bilirubin (mg/dl) | AST (IU/l)   | ALT (IU/l)  | ALP (IU/L)   | Urea (mg/dl) | Creatinine (mg/dl) | Total protein (gm/dl) | Albumin (gm/dl) |
| Control (HONEY) | 79±1.70               | 63.60±3.02          | 177.60±13.09          | 0.52±0.02         | 179.70±3.55  | 80.30±4.57  | 339.70±9.81  | 39.60±0.63   | 1.44±0.06          | 6.8±0.08              | 1.85±0.09       |
| SSM (25mg/kg )  | 100.23±6.85           | 107.78±10.20        | 121.23±31.32          | 0.84±0.04         | 187.23±0.12  | 40.43±4.31  | 331.43±16.65 | 47.27±0.80   | 0.57±0.00          | 7.3±0.56              | 2.13±0.18       |
| SSM (125mg/kg ) | 88±1.96               | 104.20±4.85         | 116.10±6.23           | 0.77±0.00         | 155.80±24.25 | 61.30±3.52  | 274.70±32.14 | 47.60±0.03   | 0.52±0.08          | 7.18±0.71             | 1.98±0.11       |
| SSM (250mg/kg ) | 99.90±11.36           | 125.10±2.22         | 94.40±0.38            | 0.79±0.01         | 167.00±7.91  | 59.40±16.58 | 305.10±10.54 | 49.40±0.60   | 0.72±0.08          | 7.2±0.81              | 2.04±0.16       |

Values were expressed as mean±SEM. for n=10 rats in each group, Oneway ANOVA followed by Dunnet's test.

**Table. 6:** Effect of SSM on relative organ weights in Wistar albino rats

| Treatment           | Brain     | Heart     | Liver     | Kidney    | Spleen    | Testis    | Ovaries   |
|---------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Control (Honey)     | 0.96±0.05 | 0.46±0.02 | 4.21±0.38 | 0.80±0.03 | 0.49±0.06 | 1.25±0.04 | 0.05±0.02 |
| SSM (25mg/kg b,wt)  | 1.16±0.07 | 0.47±0.03 | 4.28±0.26 | 0.72±0.20 | 0.63±0.15 | 1.26±0.26 | 0.06±0.03 |
| SSM (125mg/kg b,wt) | 1.21±0.04 | 0.44±0.02 | 4.52±0.16 | 0.71±0.12 | 0.52±0.23 | 1.52±0.06 | 0.06±0.02 |
| SSM (250mg/kg b,wt) | 1.02±0.03 | 0.42±0.03 | 4.38±0.30 | 0.82±0.22 | 0.54±0.07 | 1.23±0.04 | 0.07±0.01 |