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Research Article

Experimental Evaluation of Garlic (*Allium sativum* Linn) for Toxicity w. s. r. to Adverse Drug Reaction

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Abstract

Herbal pharmacovigilance is the need of the day. Though 70% of Indian population is relying on traditional system like Ayurveda (Pandey M.M., Rastogi S., Rawat A.K.S.), there is need for proper evidence for the recording of adverse drug reactions and monitoring the same in different way. Drug (*Dravya*) being the second in treatment limb (*chikitsa chatushpada*) and one among three pillar (*triskanda*) has almost importance in prevention and management. Medicine is also one of the factors, a Physician has to consider for success of treatment. When it is administered for a long time or in improper doses, it can result in giving untoward effects, which is evidenced through the sayings of classics like Black pepper induces burning sensation (*Maricha daahakruth*), Anacardium induces inflammations (*Bhallataka shophakruth*). The use of Garlic as food stuff was considered as unholy, there is a reference from *Mahabharatha* that Garlic was not used by respected persons of the society. In the later period people started using Garlic as a food stuff considering its medicinal properties. As garlic is having antiplatelet aggregation activity it is to be strictly contraindicated in bleeding disorder like thrombocytopenia and related diseases. The present study titled experimental evaluation of Garlic for its Toxicity with special reference to adverse drug reaction was carried out. The assessment of toxicity of the drug was based on serum biochemical parameters such as SGOT, SGPT, Serum Creatinine, BUN, Total Bilirubin, weight of the animals before and after the study and Histopathological studies of liver, kidney, spleen, gastric mucosa and intestinal mucosa in turn indicates organ toxicity.

Keywords: *Garlic; Adverse Drug Reaction; Toxicity; Ayurveda; Phytobiotics; Wistar Albino Rats; Experimental Study*

Introduction

Ayurveda, the eternal science dates back its utility for mankind. It is a perfect material science which helps in achieving total health including social, mental, physical and spiritual. The affluent knowledge in the science gives pivotal importance to preventive and curative aspects.

Natural health products are being used worldwide for prevention and treatment of the various ailments, safety and efficacy of the natural products are always a cause of concern to promote and rationalize their use. Traditionally, the products are evolved through experiential knowledge. In the current global scenario the implication of pharmacovigilance has almost importance in the utility of *Ayurvedic*

medicine. In pharmacotherapeutics of Ayurveda, untoward effects and adverse drug reaction are rare but when drug (*Dravya*) is not used in proper way it may give rise to side effects (ADR). Apart from the assurance of safety and efficacy of the *Ayurvedic* medicines, it is a must to carry out toxicity profiling, quality control and standardization.

Herbal pharmacovigilance is the need of the day. Though 80% of Indian population is relying on traditional system like *Ayurved*a, there is need for proper evidence for the recording of adverse drug reactions and monitoring the same in different way. Drug (*Dravya* or *Bheshaj*a) being the second in treatment limb (*chikitsa chatushpada*) and one among three pillar (*triskanda*) has almost importance in prevention and management. Medicine is also one of the factors, a Physician has to consider for success of treatment. When it is administered for a long time or in improper doses, it can result in giving untoward effects, which is evidenced through the sayings of classics like Black pepper induces burning sensation (*Maricha daahakruth*), Anacardium induces inflammations (*Bhallataka shophakruth*).

Thus, proper pharmacovigilance of all phytotherapeutic claims in the classically used Ayurvedic medicines is essential for the treatment and evaluation of the *Ayurvedic* health care around the globe.

Experimental study is necessary and it is important to have the knowledge of Adverse Drug Reaction (ADR) and also to rule out organotoxicity. Garlic is one such drug which is having reference in Ayurveda literatures [1] and commonly used in Nutraceuticals. Knowingly or unknowingly with the therapeutic dose for longer period can give rise to burning sensation, delirium, giddiness and bleeding disorders**,** etc. as mentioned in the classics. Hence this drug is selected to evaluate its toxicity with special reference to adverse drug reactions.

Objectives of the Study

- To evaluate acute and sub-acute toxicity study of juice (*swarasa*) and alcoholic extract of garlic in wistar albino rats with special reference to adverse drug reaction.
- To compare the acute and sub-acute toxicity study with special reference to adverse drug reaction of above two forms with a control group.

The history of Garlic (*Allium sativum linn*) dates back to 4500 B.C as described by Lloyd Harris in the book of Garlic. It was used in China, Egypt and by Buddhist Monks as medicine for various ailments. It came into use in India only 200 years later. There are no direct references in Vedas about this drug. Mostly foreign invaders brought this drug to India hence it has the name *Mlecchakanda*. The use of Garlic as food stuff was considered as unholy, there is a reference from *Mahabharatha* that Garlic was not used by respected persons of the society. In the later period people started using Garlic as a food stuff considering its medicinal properties.

Ayurvedic literature like *Charaka, Sushrutha, Kashyapa* and *Vaghbhata* indicate Garlic as a useful medicine and food. The later works like *Nighantus* also describes the utility of Garlic as food and medicine.

Allium sativum is a is a perennial herb with narrow flat leaves and bears small white flowers and bulbils [2], bulbs white to pink in colour, characteristic of aromatic odour, pungent taste, about 1.5 - 2.5 cms size (Flora of British India, T.D Hooker).

The active principle of garlic is an acid volatile oil, starch, mucilage, albumen, sugar etc. volatile essential oil (0.25%) obtained by distilling the bruised bulbs contain allyl, propyl disulphide and other organic sulphides or sulphur compounds. It is a clear limpiol liquid of dark brown or yellow color of very repulsive and intense garlic and of repugnant taste [3,4].

Garlic is much used in India cookery as a condiment or spice it contains

Moisture	62.8%	Protein	6.3 mg
Fat	0.1 mg	Carbohydrate	29.0 mg
Calcium	0.03 mg	Phosphorous	0.311 mg
Iron	1.3 mg	Thiamine	0.06 mg
Riboflavin	0.23	Mucin	0.4 mg
Folic acid	6.15	Iodine	0.07 mg/100g
Calori value	145 cal/100g	Vit C	13 mg/100g

Table 1

Pharmacological action

Anti-bacterial, Uterine stimulant, Anti-fungal, Anti-inflammatory, Hypoglycemic, Anti-arthritic, Hypolipaedemic, Anti-coagulant, Hypoproteinemic, Hypocholesteremic, Anti-hypertenssive, Fibrinolytic, Anti-diabetic, Anti-cancer, Anti-rickettisal, Anti-tumour, Anti-tubercular, Anti-oxidant, Anti-ageing, cardioprotective, Cardiovascular depressant, Larvicidal [5].

Drug interactions

- **Antiplatelet medications:** Garlic may exaggerate the activity of medications that inhibit the action of platelet in the body including Aspirin, Dipyridamole and Indomethacin.
- **Blood thinning medication:** Large quantities of garlic either fresh or commonly prepared may increase the risk of bleeding
- including Aspirin and Warfarin.
- **Sulfonylureas:** A class Diabetic medications garlic may lower blood sugar considerably so when using garlic with these medications blood sugar level should be monitored include, Chlorpropamide, Glimepiride and Glyburide.
- **Protease inhibitors:** A medication used to treat people with Human Immuno Virus deficiency (HIV) garlic may reduce blood levels of protease inhibitors including Indinavir, Ritonavir and Saquinavir.
- **Statins:** A class of cholesterol lowering Medication, garlic may behave similar to statins including Atorvastatin and Lovastatin.
- **ACE inhibitors:** A class of blood pressure lowering medications - Garlic may behave similarly to Ace inhibitors so it is recom
- mended not to take large quantities of garlic with any and these medications including, Captopril, Enalapril and Lisinopril.

Contraindications

As garlic is having antiplatelet aggregation activity it is to be strictly contraindicated in bleeding disorder like thrombocytopenia and related diseases.

Adverse drug reaction

Any response to a drug that is noxious and unintended and that occurs at doses used in man for prophylaxis, diagnosis or therapy of disease or modification of physiological function - WHO, ADR results from complex interaction between the drug, patient, the illness and a number of known or unknown extrinsic factors that can modify drug responses.

Toxicity studies

In order to assess the safety of a drug, various toxicity studies are carried out in animals such as mice, rats, guinea pigs, dogs and monkeys under conditions of drug administration. Systemic toxicity studies are single dose or repeated dose. It also may be Local toxicity studies or Specialized toxicity studies.

Toxicity studies are classified into acute toxicity test, subacute toxicity test and chronic or long term toxicity test.

Materials and Methods

The experimental evaluation of Garlic (*Allium sativum)* for toxicity with special reference to adverse drug reaction is designed under two headings:

- Drug analysis (Garlic).
- Experimental study.

The study was carried out in the Department of Pharmacology and Toxicology, Veterinary College, Hebbal, Bangalore. The juice of Garlic (*Allium sativum*) was prepared at the Department of Pharmacology and Toxicology, Veterinary College, Hebbal, Bangalore. The methanolic extract of Garlic (*Allium sativum*) was prepared at GREEN CHEM. HAL Bangalore. Physico-chemical analysis was carried out at lab of Dravya Adhyayana Vibhaga, Government Ayurvedic Medical College, Bangalore, TLC Study was carried out at Bangalore Test House, Vijayanagar, Bangalore. Microscopic study was carried out at Drug Testing Laboratory, Jayanagar, Bangalore. Histopathological study was carried at, Dept of Pathology Veterinary College, Hebbal, Bangalore.

Procurement of plant material

The bulbs of Garlic (*Allium sativum*) purchased from the market in Bangalore. The genuinity of the sample was confirmed at FRLHT, Bangalore. 20 fresh Garlic bulbs were taken daily and pounded in mortar pestle and straining through the cloth. The methanolic extract was prepared by using methanol in soxhlet apparatus. For 5 kg of Garlic bulbs 600 gm of extract was yielded.

The therapeutic dose for juice was 0.5 ml/rat and Methanolic extract is 1000 mg/rat as taken for the study.

Study design for toxicity

Group	Dosage form	No of rats	Dose
I	Control Acute (CA)	06	2 ml Distilled water
II	Control Sub acute (CS)	06	2 ml Distilled water
III	Juice (*swarasa*) single dose (SS)	06	0.5 ml/rat
IV	Juice (*swarasa*) daily dose acute (SDA)	06	0.5 ml/rat
V	Juice (*swarasa*)daily dose sub acute (SDSA)	06	0.5 ml/rat
VI	Methanolic extract single dose (MES)	06	1000 mg/rat
VII	Methanolic extract daily dose acute (MEDA)	06	1000 mg/rat
VIII	Methanolic extract daily dose sub acute (MEDSA)	06	1000 mg/rat

Table 2

The rats were fasted overnight prior to administration of the juice and methanolic of Garlic (*Allium sativum* Linn). The bulbs are pounded in mortar pestle and stained through cotton cloth. The quantity should not exceed two ml for the easy administration. The juice (*swarasa*) was gavaged daily. A study was conducted using, 0.5 ml/rat of juice (*swarasa*) of Garlic (*Allium sativum Linn*) per day. Control group received 2 ml of distilled water. The rats were observed for a period of 14 days for clinical signs. In each group, the behavioral study and clinical signs of the toxicity or the death were observed at least twice a day.

Acute toxicity study

Acute toxicity study was conducted to determine the median lethal dose for rats, study duration was 14 days. Three groups consisting of six rats in each group separately were administered juice (*swarasa*) of Garlic (*Allium sativum*) orally by gavage at the dosage of 0.5 ml/rat for 14 days and the results were recorded. Three groups consisting of six rats in each group separately were administered methanolic extract of Garlic (*Allium sativum*) orally by gavage at the dosage of 0.5 ml/rat for 14 days and the results wererecorded.

Sub acute toxicity study

Three groups consisting of six rats in each group separately were administered juice (*swarasa*) of Garlic (*Allium sativum* Linn) orally by gavage at the dosage of 0.5 ml/rat for 28 days and the results were recorded. Three groups consisting of six rats in each group separately were administered methanolic extract of Garlic (*Allium sativum* Linn) orally by gavage at the dosage of 0.5 ml/rat for 28 days and the results were recorded

General clinical observations were made at three times a day and considering the peak period of anticipated effect after dosing. The health condition of the all the animals were recorded. At least thrice daily, all animals were observed for morbidity and mortality.

Clinical biochemistry

Serum biochemical parameters were estimated from the serum samples collected from the animals on day 0, 7, 14, 21 and 28 in sub-acute toxicity study to investigate the toxic effect if any on organs and tissues using semi automatic biochemical analyzer on the following parameters:

1. Serum glutamic-oxaloacetic transaminase (SGOT)
2. Serum glutamic pyruvic transaminase (SGPT)
3. Serum total bilirubin
4. Serum creatinine
5. Blood urea nitrogen (BUN).

Histopathological study

At the end of the test period (on day 14 in acute toxicity study and on day 28 in sub-acute toxicity study), after overnight fasting, the rats were sacrificed under ether anesthesia. Gross lesions if any were observed. The organs were cleared off from the adnexal tissues using normal saline and placed on a blotting paper and gently pressed to remove excess saline adhering to the organ. The representative samples from the organs like liver, spleen, gastric mucosa, intestinal mucosa and kidney were collected in neutral buffered formalin

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(NBF) for histopathological study. The representative tissue samples were processed for histopathology by cutting sections of 5µ thickness and staining with haematoxylin and eosin (Luna, 1968).

Observations and Results

The experimental study carried out to evaluate the toxicity, the toxicity was observed based on SGOT, SGPT, Serum Creatinine, BUN and Total Bilirubin values, in turn indicates the organotoxicity that is hepato and nephrotoxicity.

Statistical methods: Descriptive statistical analysis has been carried out in the present study. ANOVA has been used to find the significant changes of parameters within each group.

Study results

Comparison of SGOT between groups

SGOT	Group I		Group II		Group III		Group IV		Group V		Group VI		Group VII		Group VIII		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1st day	116.89	49.9	155.36	66.5	133.01	50.8	175.02	40.2	93.68	7.0	165.29	10.6	128.36	39.3	181.66	8.8	0.005**
7th day	204.02	62.8	200.35	61.7	229.80	45.1	217.56	63.8	241.83	22.1	181.79	48.9	186.29	13.9	209.21	47.8	0.405
14th day	141.68	25.4	176.51	30.8	169.39	29.6	147.23	4.8	147.23	4.8	136.41	39.6	181.83	37.1	246.00	37.6	<0.001**
21st day	-	-	198.52	27.1	-	-	-	-	209.11	57.4	-	-	-	-	185.69	23.4	0.617
28th day	-	-	236.61	25.2	-	-	-	-	266.35	14.8	-	-	-	-	229.91	78.3	0.206
%Change from 1st day																	
7th	+74.5%		+28.9%		+72.8%		+24.3%		+158.1%		+9.9%		+45.1%		+15.2%		-
14th	+21.2%		+13.6%		+27.4%				+57.2%		-17.5%		+41.7%		+35.4%		-
21st	-		+27.8%		-		-15.9%		+123.2%		-		-		+2.2%		-
28th	-		+52.3%		-		-		+184.3%		-		-		+26.6%		-
P value	F = 7.381 P = 0.011*		F = 0.980 P = 0.454		F = 8.669 P = 0.007**		F = 2.113 P = 0.200		F = 20.640 P<0.001**		F = 2.597 P = 0.124		F = 5.525 P = 0.024*		F = 1.558 P = 0.337		-

Table 3

Comparison of SGPT between groups

SGPT	Group I		Group II		Group III		Group IV		Group V		Group VI		Group VII		Group VIII		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1st day	48.50	11.2	73.63	16.5	58.13	6.3	56.77	19.7	56.41	5.9	55.70	7.8	59.03	6.8	45.61	10.2	0.016*
7th day	50.99	13.0	51.21	4.1	48.85	9.6	44.71	17.0	48.09	8.1	57.15	8.8	46.60	6.9	49.91	8.8	0.588
14th day	84.21	12.1	77.70	19.7	82.21	23.5	61.05	2.0	61.05	2.0	63.92	13.3	73.87	21.5	72.70	8.8	0.147
21st day	-	-	53.82	17.5	-	-	-	-	55.71	8.2	-	-	-	-	54.96	9.6	0.966
28th day	-	-	60.95	2.8	-	-	-	-	64.39	23.8	-	-	-	-	60.68	35.6	0.946
%Change from 1st day at																	
7th day	+5.1%		-30.4%		-15.9%		-21.2%		-14.7%		+2.6%		-21.1%		+9.4%		-
14th day	+73.6%		+5.5%		+41.4%		+7.5%		+8.2%		+14.8%		+25.1%		+59.4%		-
21st day	-		-26.9%		-		-		-1.2%		-		-		+20.5%		-
28th day	-		-17.2%		-		-		+14.1%		-		-		+33.1%		-
P value	F = 26.406 P<0.001**		F = 75.356 P<0.001**		F = 6.184 P = 0.018*		F = 0.751 P = 0.571		F = 0.621 P = 0.660		F = 20.397 P<0.001**		F = 5.330 P = 0.027*		F = 75.356 P<0.001**		

Table 4

Comparison of Total Bilirubin between groups

Total Bilirubin	Group I		Group II		Group III		Group IV		Group V		Group VI		Group VII		Group VIII		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1st day	1.26	0.9	0.50	0.2	0.45	0.3	0.54	0.3	0.98	0.5	0.55	0.3	0.71	0.2	0.67	0.2	0.029*
7th day	0.55	0.2	0.42	0.1	0.65	0.3	0.55	0.1	0.39	0.2	0.35	0.1	0.43	0.1	0.46	0.1	0.066
14th day	0.30	0.2	0.55	0.1	0.43	0.2	0.55	0.1	0.55	0.1	0.42	0.4	0.67	0.3	0.55	0.2	0.198
21st day	-	-	0.88	0.2	-	-	-	-	0.77	0.2	-	-	-	-	0.79	0.2	0.652
28th day	-	-	0.67	0.3	-	-	-	-	0.67	0.2	-	-	-	-	0.88	0.1	0.466
%Change from 1st day at																	
7th day	-56.3%		-16.0%		+44.4%		+1.9%		-60.2%		-36.4%		-39.4%		-31.3%		-
14th day	-76.2%		+10.0%		-4.4%		+1.9%		-43.8%		-23.6%		-4.0%		-17.9%		-
21st day	-		+76.0%		-		-		-21.4%		-		-		+17.9%		-
28th day	-		+34.0%		-		-		-31.6%		-		-		+31.3%		-
P value	F = 4.914 P = 0.073+		F = 5.238 P = 0.005**		F = 0.811 P = 0.472		F = 1.680 P = 0.263		F = 2.523 P = 0.124		F = 0.711 P = 0.520		F = 3.306 P = 0.079+		F = 1.206 P = 0.430		-

Table 5

Comparison of Creatinine between groups

Creati- nine	Group I		Group II		Group III		Group IV		Group V		Group VI		Group VII		Group VIII		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1st day	0.63	0.1	0.65	0.2	0.63	0.1	0.51	0.2	0.53	0.2	0.84	0.3	0.82	0.1	0.85	0.5	0.160
7th day	0.43	0.2	0.57	0.3	0.86	0.3	0.49	0.1	0.84	0.6	1.06	0.7	1.16	0.3	1.32	0.5	0.010*
14th day	0.51	0.3	0.30	0.2	0.30	0.1	1.15	1.1	1.15	1.1	0.30	0.2	0.32	0.2	0.70	0.1	0.022*
21st day	-	-	0.32	0.1	-	-	-	-	0.41	0.3	-	-	-	-	0.22	0.0	0.570
28th day	-	-	0.44	0.2	-	-	-	-	0.71	0.4	-	-	-	-	0.50	0.1	0.271
%Change from 1st day at																	
7th day	-29.9%		-12.3%		+36.5%		-3.9%		+58.5%		+26.2%		+41.5%		+55.3%		-
14th day	-23.9%		-53.8%		-44.4%		+125.5%		+116.9%		-64.3%		-60.9%		-17.6%		-
21st day	-		-50.8%		-		-		-22.6%		-		-		-74.1%		-
28th day	-		-52.5%		-		-		+33.9%		-		-		-41.2%		-
P value	F = 0.933 P = 0.432		F = 1.720 P = 0.306		F = 13.967 P = 0.006**		F = 0.819 P = 0.550		F = 0.554 P = 0.709		F = 3.211 P = 0.095*		F = 30.228 P = 0.001**		F = 2.450 P = 0.203		-

Table 6

Comparison of BUN between groups

BUN	Group I		Group II		Group III		Group IV		Group V		Group VI		Group VII		Group VIII		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1st day	16.32	2.8	15.30	2.4	13.20	3.6	11.64	3.7	18.72	6.1	15.88	5.1	14.67	3.4	18.74	5.6	0.156
7th day	19.30	9.3	15.66	2.2	20.07	4.4	24.73	4.1	21.94	3.5	23.27	6.9	21.83	11.4	14.67	2.7	0.097
14th day	21.66	9.6	15.66	2.2	20.07	3.9	24.73	4.1	24.73	4.1	23.27	6.9	21.83	11.4	14.67	2.7	0.085
21st day	-	-	16.18	2.1	-	-	-	-	16.91	2.4	-	-	-	-	13.50	1.2	0.136
28th day	-	-	16.14	6.0	-	-	-	-	18.55	3.0	-	-	-	-	34.85	0.5	0.001**
%Change from 1st day at																	
7th day	+18.2%		+2.4%		+52.1%		+112.5%		+17.2%		+46.5%		48.8%		-21.7%		-
14th day	+32.7%		+2.4%		+52.1%		+112.5%		+32.1%		+46.5%		48.8%		-21.7%		-
21st day	-		+5.8%		-		-		-9.7%		-		-		-27.9%		-
28th day	-		+5.5%		-		-		-0.9%		-		-		+85.9%		-
P value	F = 0.598 P = 0.580		F = 1.546 P = 0.251		F = 6.607 P = 0.021*		F = 5.548 P = 0.070+		F = 4.259 P = 0.039*		F = 7.916 P = 0.013*		F = 1.054 P = 0.429		F = 35.578 P = 0.002**		-

Table 7

Observation and Interpretation

Acute study

In acute single dose group juice (*swarasa*) is more toxic compare to methanolic extract, having P values, SGOT (AST) p = 0.007*, SGPT (ALT) p = 0.018*, Creatinine P = 0.006* and BUN P = 0.002*.

In acute daily dose group methanolic extract is more toxic than juice (*swarasa*) having P values, SGOT P = 0.024*, SGPT P = 0.027*, Creatinine P = 0.001** and B Total P = 0.079+, having nephrotoxicity because creatinine and BUN is statistically significant in extract groups.

Subacute study

In subacute groups juice (*swarasa*) is more toxic than methanolic extract, having P values SGOT, P = 0.001**, BUN, P = 0.039* having hepatotoxicity and nephrotoxicity by increased serum biochemical parameter indicating juice (*swarasa*) is heavy (*guru*) having potential physico chemical properties (*rasapanchakas*) and probably due to phytoconstituents like thiosulphates, allicin and alliin are in maximum limits.

The sulphur compounds are potential to modulate the activity of drug metabolizing enzymes (Notably cytochrome P450 isoemzymes and the drug transport P-glycoprotein) which in turn increase the serum biochemical parameters(Journal of oncology, sep1 2008, 14(3), 123-130).

There is raise in total bilirubin concentration but not significant in both the groups this may be due to the cholagogue action of Garlic.

Histopathology analysis reveals that there is haemorrhage in all the organs in the groups, i.e. juice (*swarasa*) as well as extract groups, this may be due to the blood thinning action of Garlic and also due to inhibition of platelet aggregation activity. This in turn decreases the fibrinogen level and thus leading to haemmorrhage, which is probably due to the irritation activity of mucous membrane, due to high content of pungent volatile oil in it.

The presence of flavanoids is probably responsible in capillary permeability and fragility, wherein though which can initiate bleeding, which substantiate the statement mentioned in our classics bleeding tendencies (*Rakthpithasrakruth*). There is necrosis in intestinal mucosa of methanolic extract sub-acute group this may be due to the continuous irritation of mucous layer along with ischemia of intestine. There is necrosis of kidney glomerulus in methanolic extract daily dose group and also necrosis in liver of MES group. This clearly indicates that extract is highly organotoxic than juice (*swarasa*).

Conclusion

The current study titled "Experimental evaluation of Garlic (*Allium sativum* Linn) for its toxicity with special reference to adverse drug reaction" was beneficial in assessing the acute and subacute toxicity of *Allium sativum* Linn in both dosage forms (Juice and Extract).

The phyto chemical analysis of Garlic reveals that it is a rich source of flavonoids, essential oils and sulphur compounds. The study revealed that methanol extract at the dose of 1000 mg/rat b.wt and juice (*swarasa*) at the dose of 0.5 ml/rat were extremely toxic and upholds the toxic property of Garlic as mentioned in the classical references for its Aggravation of *pitta* humor and Blood (*Pittasravruddida karma*). Juice (*swarasa*) is more potential because of its heaviness (*gurutva*).

Histopathological studies were contributory in assessing organotoxicity in specific to Liver, Kidney, Spleen, Gastric and Intestinal mucosa. Behavioral study was supportive in assessing toxicity of the test drug. Thus, it can be concluded that test drug Garlic proves to be toxic in raising serum biochemical parameters, organotoxic and decreasing the weight of the animal.

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