CHAPTER III
RESULTS AND DISCUSSION

The present section is devoted to compilation of various results and discussions thereupon obtained from various investigations carried out, following the conveyor belt procedure as a lead, on different plant drugs such as rhizomes of Curculigo orchioides; roots of Inula racemosa; fruits, leaves, roots and stem bark of Moringa pterygosperma; and whole plants of Fumaria indica and Sida species such as Sida acuta, Sida cordifolia and Sida rhombifolia. These plants/parts of plants were selected on the basis of their usage mentioned in the various traditional systems of medicine.

3.1 PHARMACOGNOSTIC STUDIES

Pharmacognostic evaluation is the first and foremost step to determine the identity and to assess the quality and purity of the crude drug. The selected plant drugs, therefore, were first subjected to pharmacognostic evaluation in reasonable details.

The crude drug samples were procured in bulk and were compared with herbarium specimens to confirm the identity of correct botanical sources. The drug samples were further subjected to morphological and microscopic examination at random to assess the quality and purity of the procured plants and the various diagnostic features were recorded for

Fig.6 Rhizomes of Curculigo orchioides

Fig.7 Whole Plant of Fumaria indica

the purpose of authentication.

3.1.1 Macroscopic Characters

The characteristics of feature of diagnostic value observed in the macroscopic examination were recorded for individual drugs in the following manner:

i. Rhizomes of C. orchioides

The dried rhizomes occur as stout, short pieces upto 2.5x1.5 cm in diameter, dumbell shaped, narrower in the middle and broad at the ends. The pieces are dull brown to black in colour and bear leaf scars and a few spongy roots. The apical pieces have hairy bristle like remnants of leaf bases near the conical apex. The transverse face is dull light brown in colour and distinguishable into cortical and an inner cylinder with dotted appearance (Fig.6). The texture is rough and fracture is starchy with no characteristic odour and slightly bitter and mucilaginous taste.

ii. Whole Plant of F. indica

The parts of the whole plant include leaves, flowers, fruits, stems and roots (Fig.7). Leaves are dark green, narrow and segmented with acute apex, symmetrical base and smooth texture. Flowers are whitish pink, leaf opposed racemes. Fruits are globose, one-seeded nuts, 0.2 mm in diameter and pale brown in colour. Stem is pale greenish

Fig.8 Roots of Inula racemosa

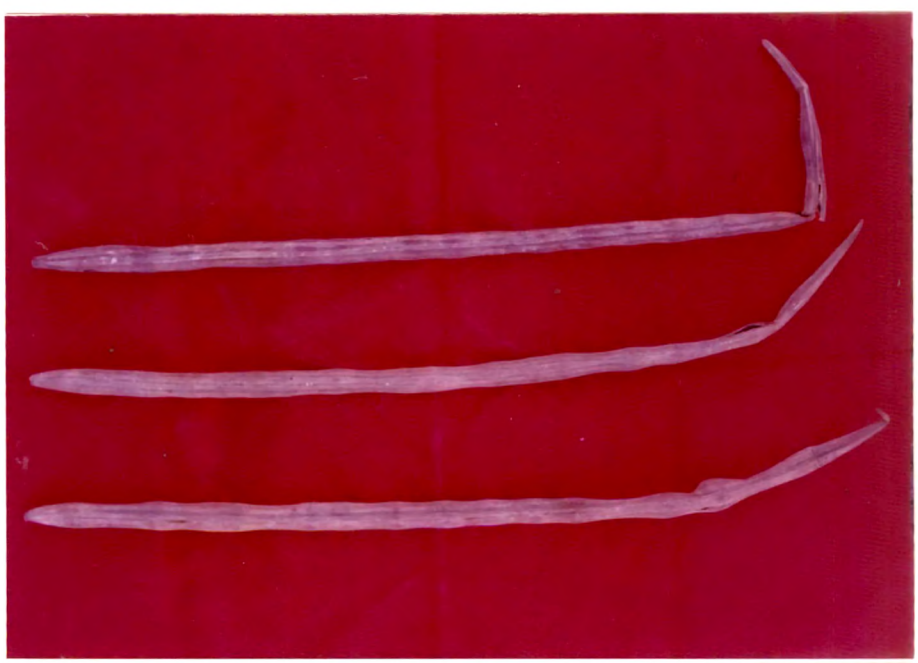


Fig.9 Fruits of Moringa pterygosperma

brown in colour, wrinkled outer surface with nodes and internodes of 2-5 cm, smooth texture and uneven, short fracture. Roots are thickened with rootlets, bitter, slightly acrid and astringent in taste, rough texture and short fracture.

iii. Roots of I. racemosa

These occur as pieces of 9-10 cm x 1.5-2.2 cm, cylindrical and tapers at one end. The outer surface is wrinkled, pale brown in colour with rootlet scars and small rootlets, short fracture and rough texture (Fig.8). The fractured surface is pale brown in colour with cream coloured pith, weak camphoraceous odour and bitter taste.

iv. Different organs of M. pterygosperma

(1) Fruits, (2) leaves (3) roots and (4) stem bark were chosen for the present investigations. Fruits elongated silique, like triquetrous capsules, three valved, nostrate; seeds many, large, ovate, three winged and nonendospermous (Fig.9). Leaves : alternate, 2-3 pinnately compound with opposite pinnae, reticulate venation, obtuse apex and symmetric base. Roots occur as 10-15 cm pieces, pale greenish brown in colour with smooth texture, short and fibrous fracture. Tap roots with rootlet scars. Divided into outer cortical and inner cream coloured cylinder (Fig.10) Stem bark: occurs in pieces of 15-20 cm with irregular outer surface and longitudinal striations on the internal surface.

Fig.10 Leaves and Roots of Moringa pterygosperma

Fig.11 Stem Bark of Moringa pterygosperma

Texture is rough and fracture is brittle and splintery with no characteristic odour and slightly bitter taste (Fig.11).

v. Whole Plant of Sida species

The whole plants of Sida species included S. indica, S. cordifolia and S. rhombifolia

(a) Whole plant of S. acuta: The drug is a shrub of 50 cm high. Leaves are linear, glabrous, acute apex, serrate margin, symmetric base, petiolate and reticulate venation. Flowers are solitary and yellow (Fig.12). Seeds are smooth, black and globular. Stem is hairy, pale greenish brown, cylindrical, smooth texture, short and fibrous in fracture. Thin long and cylindrical tap roots with rough texture and contorted, short fracture.

(b) Whole plant of S. cordifolia: These are shrubs of 50 cm high with long branches. Leaves are petiolate, cordate with obtuse apex, serrate margin, reticulate venation and symmetrical base. Flowers are solitary and yellow (Fig.13) seeds are black, smooth and globular. Stem is hairy, light yellowish brown in colour, smooth texture, short and fibrous fracture. Tap roots with contorted, smooth texture, short fracture and slightly bitter taste.

(c) Whole plant of S. rhombifolia: Shrubs of 60 cm height. Leaves are petiolate, rhomboid, sub-glabrous above and grey

Fig.12 Whole Plant of S. acuta

Fig.13 Whole Plant of S. cordifolia

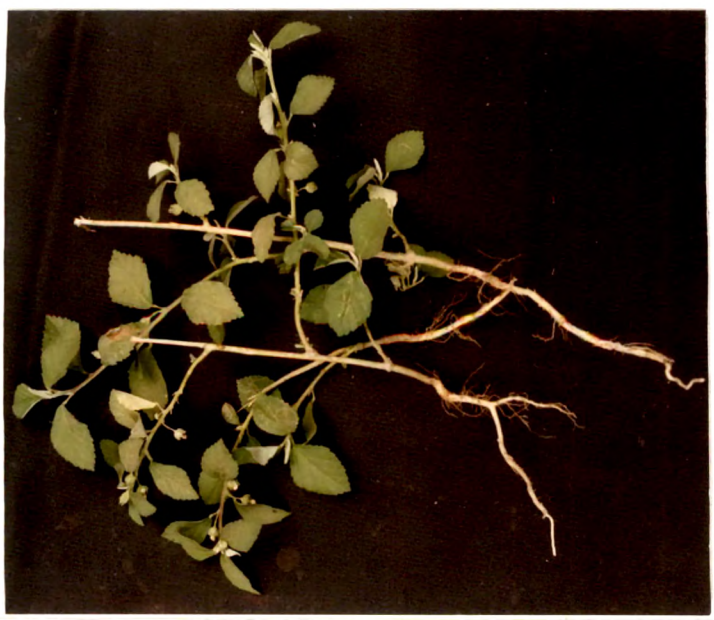


Fig.14 Whole Plant of S. rhombifolia

pubescent beneath, with symmetrical base, reticulate venation, acute apex and serrate margin. Flowers are solitary and yellow (Fig.14). Seeds are smooth, black and globular. Stem is hairy, pale brown with smooth texture, short and fibrous fracture. Tap root with rootlets, contorted, brown in colour. Smooth texture, short and fibrous fracture.

3.1.2 Microscopic characters

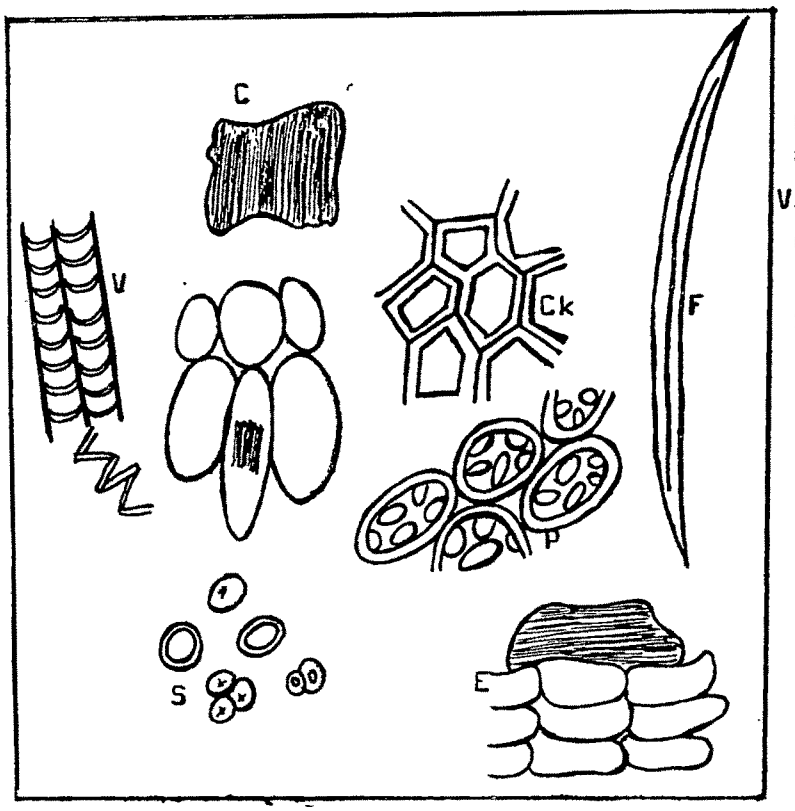
The powdered plant drugs were observed for different diagnostic features as stated below.

i. Rhizomes of C. orchioides

The powdered drug is greenish brown in colour with no characteristic odour and slightly bitter taste. Microscopic examination indicated the presence of simple as well as compound spherical starch grains, groups of acicular calcium oxalate crystals, xylem vessels with scalariform thickenings, unlignified fragments of fibres, parenchymatous cells with pits and cork cells (Fig.15).

ii. Whole Plant of P. indica

The powdered drug is pale greenish brown in colour with no characteristic odour and slightly bitter taste. Microscopic examination show the presence of starch grains, fibres with crystal sheath, epidermal cells, unicellular covering trichomes, paracytic stomata and lignified



C=Calcium oxalate crystals
V=Vessels
Ck=Cork
F=Fiber
S=Starch grain
E=Epidermis
P=Parenchyma
T=Trichome pieces
St=Stone Cells

Fig.15 Rhizomes of Curculigo orchioides

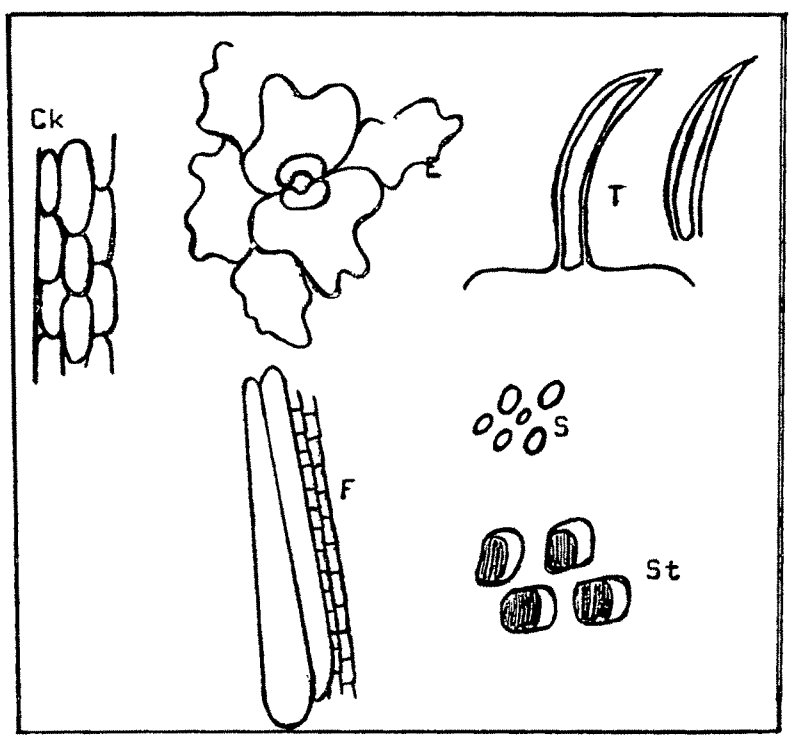


Fig.16 Whole Plant of Fumaria indica

parenchymatous cells (Fig.16).

iii. Roots of I. racemmosa

The powdered drug is pale brown in colour with slight camphoraceous odour and slight bitter taste. Microscopic examination indicated the presence of parenchymatous cells, xylem vessels with scaleriform on pitted walls, tracheids and phloem fibre (Fig.17).

iv. Different Organs of M. pterygosperma

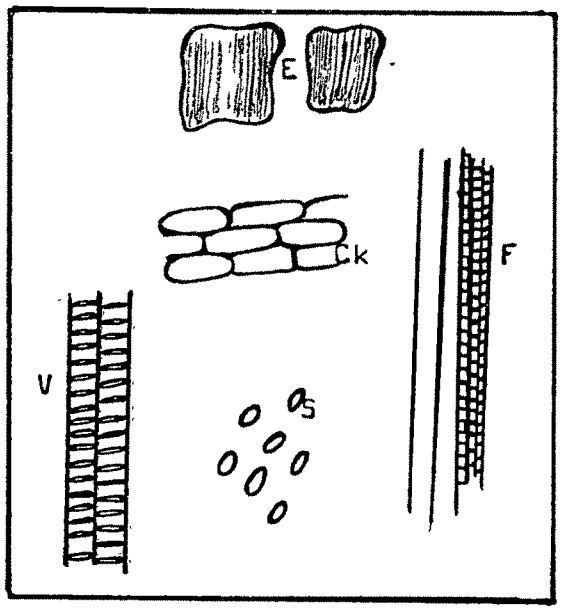
The different organs included fruits, leaves, roots and stem bark (Fig.18)

(a) Fruits: The powdered drug is brown in colour with characteristic odour, sweet and acrid taste. Microscopic studies indicated the presence of epidermal cells, pitted fibres with crystalline sheath, spiral xylem vessels, lignified sclereids starch grains and oil glands.

(b) Leaves: The powdered drug is dark green in colour without any characteristic odour and with slight bitter taste. Microscopic studies showed the presence of unicellular covering trichomes, anomocytic stomata, scaleriform xylem vessels, epidermal cells and fibres with pitted walls.

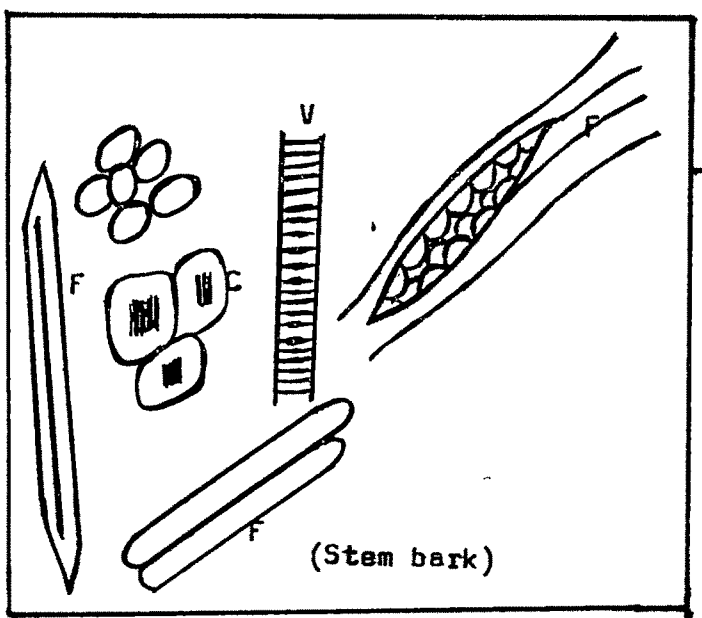
(c) Roots: The powdered drug is pale brown in colour with characteristic odour and slightly bitter, sharp, hot sweet

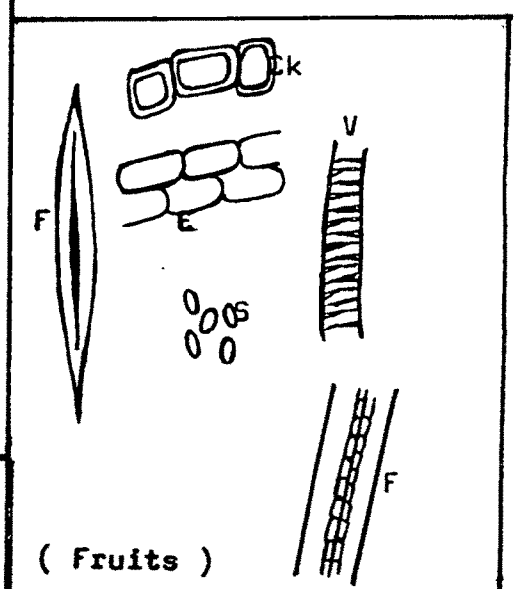
POWDER CHARACTERISTICS

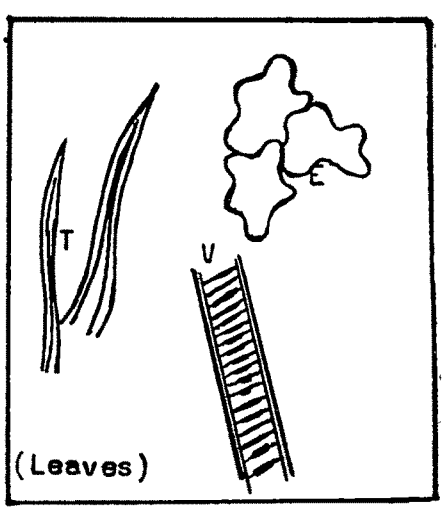


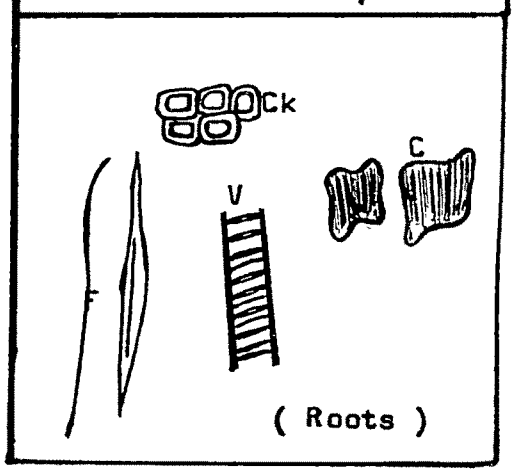
C=Calcium oxalate crystals
Ck=Cork
E=Epidermis
F=Fibers
P=Parenchyma
S=Starch grains
St=Stone cells
T=Trichome pieces

Fig.17 Roots of Inula racemosa









taste. Microscopic studies indicated the presence of sclerenchymatous cells, fibres and xylem vessels with reticulate thickenings.

(d) Stem bark: The powdered drug is cream coloured without any taste and odour. Microscopic examination showed the presence of pitted fibres with crystal sheath, parenchymatous cells, annular xylem vessels, medullary rays and calcium oxalate crystals.

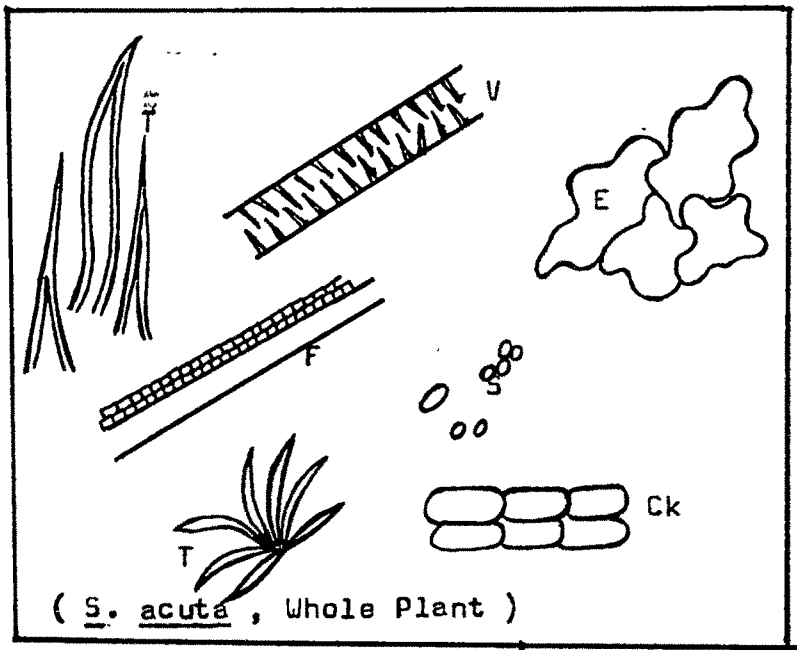
v. Whole Plant of Sida species

Sida species included whole plants of S. acuta, S. cordifolia and S. rhombifolia (Fig.19).

(a) S. acuta: The powdered plant is pale greenish brown in colour without any characteristic odour and taste. Microscopic studies showed the presence of covering trichomes, parenchymatous cells, fibres with crystal sheath and reticulate xylem vessels.

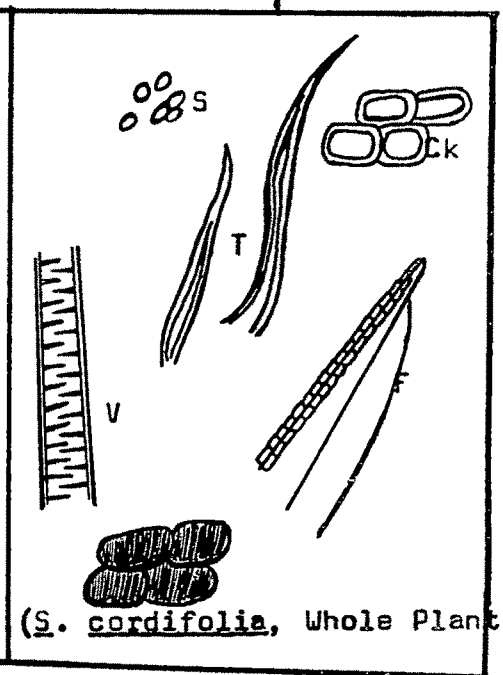
(b) S. cordifolia: The powdered drug is greenish brown in colour with no characteristic odour and with slightly bitter taste. Microscopic studies indicated the presence of pieces of covering trichomes, endosperm, parenchymatous cells, calcium oxalate crystals, epidermal cells and reticulate xylem vessels.

POWDER CHARACTERISTICS

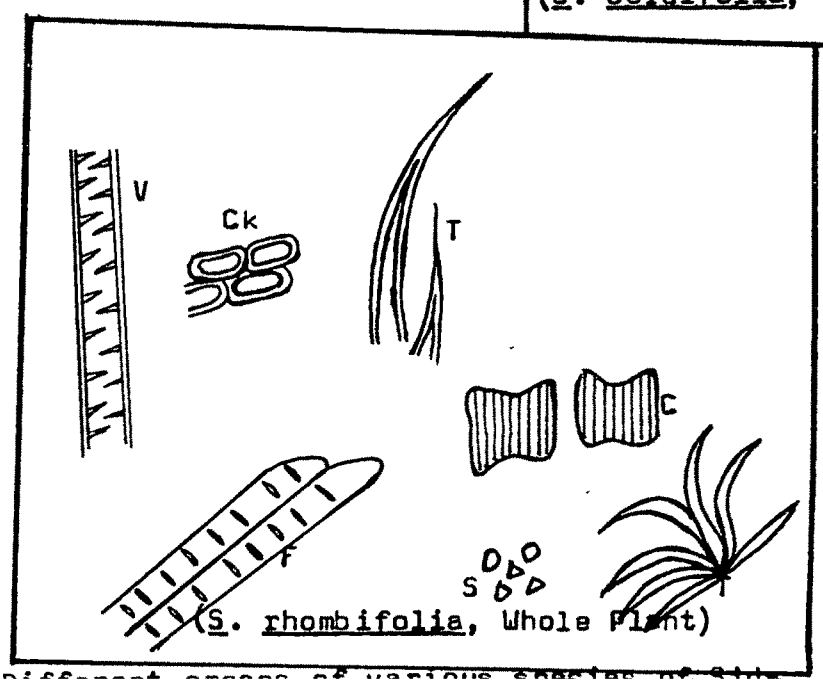


(S. acuta , Whole Plant)

C=Calcium oxalate crystals
Ck=Cork
F=Fibers
E=Epidermis
P=Parenchyma
S=Starch grains
St=Stone cells
T=Trichome pieces



(S. cordifolia, Whole Plant)



(S. rhombifolia, Whole Plant)

Fig. 12 Different organs of various species of Sida

(c) S. rhombifolia: The powdered plant is greenish brown in colour with no characteristic odour and mucilaginous taste. Microscopic examination indicated the presence of medullary rays, fibres, reticulate xylem vessels, covering trichomes, calcium oxalate crystals, sclerenchyma, epidermal cells and parenchymatous cells.

These characteristics for individual plant provide information which could be used for their identification

3.1.3 Proximate Analysis

Proximate analysis aids to set up certain standards for dried crude drugs in order to avoid batch to batch variations and also to judge their quality. These studies also give an idea regarding the nature of phytoconstituents present. The different values obtained from proximate analysis of the selected drugs are recorded in Table 14.

The values of proximate analysis reveal that the foreign organic matter content was highest in case of I. racemosa roots (19.57%) followed by M ptergosperma leaves (11.27%), F. indica whole plants (10.99%) and C. orchioides rhizomes (9.0%) which were also on higher side. The other drugs however, showed considerably low amount of foreign organic matter. The moisture content was on the higher side in case of C. orchioides rhizomes (15.59%), S. acuta aerial parts

TABLE. 14: PROXIMATE ANALYSIS OF SELECTED PLANT DRUGS

PLANT DRUGS	DETERMINATIONS (% W/W)							
	FOREIGN ORGANIC MATTER	MOISTURE CONTENT	TOTAL ASH	ACID INSOLU-BLE ASH	WATER SOLUBLE ASH	SULPHA-TED ASH	ALCOHOL SOLUBLE EXTRACTI-VE	WATER SOLUBLE EXTRACTI-VE
C. ORCHIOIDES (RHIZOMES)	9.28	15.59	9 67	2 67	1.23	8.28	1.48	9 28
F INDICA (WHOLE PLANTS)	10 99	8.27	16.13	1.56	7.15	27.39	4.48	10.02
I. RACEMOSA (ROOTS)	19.57	8.27	6.23	0.81	3.72	8.20	6.08	9.54
M.PTERYGO-SPERMA (FRUITS)	1.02	7 33	4 61	1 09	2.40	7.55	10.20	16.62
M PTERYGO-SPERMA (LEAVES)	11.27	6.01	4.08	1.01	2.17	7.18	7.85	11.60
M PTERYGO-SPERMA (ROOTS)	3.15	6.88	14.03	7.11	2 88	15.60	2.84	7 36
M PTERYGOSPE-RMA (STEMBARK)	2.03	4. 57	9.92	0 66	3.54	11.22	1.84	7.94
S ACUTA (AERIAL PARTS)	1.09	8.75	11 22	5 32	1.87	16.24	2.63	5.72
S. ACUTA (ROOTS)	0.96	7.24	4.94	0.85	2.70	6.35	1.82	4.96
S. CORDIFOLIA (WHOLE PLANTS)	1.23	5.85	7.57	2.14	2.33	12.08	2.80	6.42
S. RHOMBIFOLIA (AERIAL PARTS)	0.85	2.51	9.97	1 60	3.61	20.11	2.87	6.66
S. RHOMBIFOLIA (ROOTS)	2.01	4.91	4.13	0.78	1.14	5.61	3.87	8.32

(8.75%), F. indica whole plant (8.27%) and I. racemosa roots (8.27%). The content of total ash was on the higher side in case of F. indica whole plants (16.13%), M. pterygosperma roots (14.0%) and S. acuta aerial parts (11.22%). The other plants showed moderately low total ash content. The acid-insoluble ash content was considerably high in case of M. pterygosperma roots (7.11%) and S. acuta aerial parts (5.3%). The other drugs did not show values more than 2.0-2.70 %. The water soluble ash content was found highest in case of F. indica whole plant (7.15%) and least in case of S. rhombifolia roots. (1.14%). The sulphated ash which was highest in case of F. indica whole plants (27.39%) followed by S. rhombifolia aerial parts (20.11%) with S. acuta aerial parts and M. pterygosperma roots and S. cordifolia whole plants yielding more than 10%, while the remaining drugs did not exceed 10% sulphated ash values. The alcohol soluble extractive values were highest in M. pterygosperma fruits (10.20%) and least in case of C. orchioides rhizomes (1.48%). The water soluble extractive values were found to be maximum in case of M. pterygosperma fruits (16.62%) and minimum in case of S. acuta roots (4.96%). The others had values between these two values. These determinations provide an idea regarding the conditions of procurement and storage of the drugs and also the probable content of various inorganic metal ions as well as secondary metabolites of different chemical nature.

TABLE.15 ESTIMATION OF DIFFERENT INORGANIC METAL IONS PRESENT IN SELECTED PLANT DRUGS

PLANT DRUGS	INORGANIC METAL ION CONTENT(%W/W)								
	CALCIUM	COBALT	COPPER	LEAD	MAGNESI-UM	NICKEL	POTASSI-UM	SODIUM	ZINC
C. ORCHIOIDES (RHIZOMES)	0.005500	0.000300	0.000034	0.000000	0.002010	0.000000	0.024010	0.007225	0.000000
F. INDICA (WHOLE PLANTS)	0.006000	0.000300	0 000038	0 000000	0.006720	0.000000	0 060280	0.007207	0 010167
I. RACEMOSA (ROOTS)	0.000100	0.000000	0 000025	0.000000	0.001696	0.000000	0 025490	0.002919	0.005995
M PTERYGO-SPERMA (FRUITS)	0.000100	0.000040	0.000021	0.000000	0.002530	0.000000	0.027496	0.007342	0.008523
M PTERYGO-SPERMA (LEAVES)	0.002700	0.000100	0 000022	0.000000	0.003660	0 000000	0 032510	0 004100	0 017820
M. PTERYGO-SPERMA (ROOTS)	0.001900	0.000200	0.000023	0.000000	0.002420	0.000000	0.018093	0 002546	0.022470
M. PTERYGOSPE-RMA (STEMBARK)	0.006000	0.000200	0.000023	0 000000	0 006030	0.000000	0 051941	0.002423	0.027114
S ACUTA (AERIAL PARTS)	0.004400	0.000140	0.000000	0.000000	0.005093	0.000000	0.037136	0.003687	0 022429
S. ACUTA (ROOTS)	0.001800	0.000130	0.000017	0.000000	0.001795	0.000000	0.016966	0.002554	0.000000
S. CORDIFOLIA (WHOLE PLANTS)	0.003200	0.000160	0.000012	0.000000	0.003400	0.000000	0 030040	0.004210	0.008420
S RHOMBIFOLIA (AERIAL PARTS)	0.004700	0.000310	0 000021	0 000000	0.005180	0.000000	0.050619	0.006657	0.008213
S RHOMBIFOLIA (ROOTS)	0.001800	0.000058	0 000011	0.000000	0.001539	0 000000	0.015456	0.003934	0 003046

3.1.4 Estimation of Different Inorganic Metal Ions in Selected Plant Drugs.

Inorganic metal ions are essential for proper development and growth of various structural components of higher plants.[185] Some of these ions like manganese, copper and zinc etc. are also required to act as catalysts and coenzymes in the metabolic reactions of the growing plants. Therefore estimation of various inorganic metal ions present in the crude drugs help not only to fix up the standards for their identification, but also provide means to detect possible adulteration. With this view, the values of different inorganic metal ions were determined for the selected plant drugs and recorded in Table 15. These values reveal that lead and nickel are absent in all these drugs. Comparatively, high amounts of calcium, potassium anbd sodium were found in all these plant drugs, justifying the use of a few of these drugs as food supplement, being rich source of these inorganic ions. So far as other micro nutrients such as zinc, copper, magnesium and cobalt are concerned, C. orchioides rhizomes and S. acuta roots are devoid of zinc, S. acuta aerial parts are devoid of copper and I. racemosa roots are devoid of cobalt.

3.2 PRELIMINARY PHYTOPROFILES OF SELECTED PLANT DRUGS.

The presence of different chemical constituents in the crude drugs can be detected by subjecting them to successive

solvent extraction using solvents in the order of increasing polarity. The successive extracts so obtained are then subjected to qualitative tests for various chemical constituents. The selected drug samples in the present study were also therefore, subjected to successive solvent extraction followed by qualitative chemical tests in order to know the phytoprofile on a preliminary basis of these drugs. The extractive values are expressed as percentage w/w on dry basis. The results are recorded in Table 16. The values expressed in Table 16 reveal that the petroleum ether extractive value is highest in case of M. pterygosperma fruits (2.53%) and lowest in case of M. pterygosperma stem bark (0.47%). The amount in the other drugs were between these two values. The high value in case of M. pterygosperma fruits represents the content of fatty materials in fairly good amount. The benzene extractive values obtained are ranging in between 0.26 - 1.43%, with lowest in case of roots of S. acuta and highest in case of its aerial parts. The values for other drugs were found in between these two values, which indicate the presence of other non polar components in these drugs. The chloroform extractive values ranged from 0.01 to 1.78%, with roots of S. acuta being the lowest and I. racemosa roots being the highest. The other drugs showed fairly low content of chloroform soluble extractives. The acetone soluble extractive values were found highest in case of S. rhombifolia aerial parts (2.17%) and least in case of S. acuta roots (0.46%) indicating the

TABLE 16: PRELIMINARY PHYTOCHEMICAL SCREENING OF SELECTED PLANT DRUGS

PLANT DRUGS	EXTRACTIVE VALUES (% w/w)						PHYTOCONSTI-TUENTS DETECTED BY QUALITATIVE CHEMICAL TESTS
	Petroleum Ether(60-80°C)Ext.	Benzene Ext.	Chloro-form Ext.	Acetone Ext.	Metha-nolic Ext.	Aqueous Ext.	
CURCULIGO ORCHIOIDES (RHIZOMES)	0.57	0.47	0.43	0.50	6.02	13.21	Alk, St, F, S, Pt, G, Cg
FUMARIA INDICA (WHOLE PLANT)	0.86	0.61	0.52	1.26	9.48	17.17	Alk, Cg, St, F, S, Pt, G
INULA RACEMOSA (ROOTS)	1.68	0.74	1.78	0.59	8.00	45.45	Alk, Cg, St, F, S, Pt,Vo
MORINGA PTERYGOSPERMA (FRUITS)	2.53	1.21	0.71	1.45	21.17	16.44	Alk, Cg, F, S, Pt, G
MORINGA PTERYGOSPERMA (LEAVES)	1.23	0.60	0.59	0.90	8.87	11.25	Alk, Cg, S, Pt
MORINGA PTERYGOSPERMA (STEMBARK)	0.47	0.49	0.50	0.72	2.04	8.94	Alk, Cg, St, F, S, Pt, G
MORINGA PTERYGOSPERMA (ROOTS)	0.68	0.09	0.55	0.54	3.41	8.36	Cg, St, F, S, Pt
SIDA ACUTA (AERIAL PARTS)	1.35	1.43	0.63	1.28	4.04	15.22	Alk, Cg, F, S, Pt, G, St
SIDA ACUTA (ROOTS)	0.77	0.26	0.01	0.46	2.10	5.36	Alk, Pt, St, S, Cg, G
SIDA ACUTA (WHOLE PLANT)	1.06	0.85	0.32	0.87	3.07	10.29	Alk, Cg, St, S, Pt, G
SIDA CORDIFOLIA (WHOLE PLANT)	1.06	0.87	0.48	1.47	4.09	6.06	Alk, Cg, St, Pt, G, F
SIDA RHOMBIFOLIA (AERIAL PARTS)	0.78	0.92	0.39	2.17	5.66	10.28	Alk, Cg, St, S, Pt, G
SIDA RHOMBIFOLIA (ROOTS)	1.35	0.85	0.78	1.98	4.57	9.41	Alk, Cg, St, S, Pt, G
SIDA RHOMBIFOLIA (WHOLE PLANT)	1.07	0.89	0.59	2.08	5.12	9.85	Alk, Cg. S, G, Pt

Alk = Alkaloids; F = Fixed Oils and Fats; Pt = Phenolic Compounds and Tannins; St = Steroids; Cg = Carbohydrates and Glycocides; G = Gums and Mucilages; Vo = Volatile Oil; S = Saponins.

presence of moderately polar type of constituents. The values of methanolic extractives are highest in case of M. pterygosperma fruits (27.12%) and least in case of its stem bark (2.04%). These values were found moderately higher than the other extractive values in all the drugs indicating the presence of moderately semipolar type of components in a fairly good amount. The aqueous extractive values, however, are on higher side in practically all the selected drugs indicating the presence of good amount of polar components in these drugs.

So far as the detection of phytoconstituents is concerned, each drug showed the presence of normal phytoconstituents except the presence of volatile oil in case of roots of I. racemosa. These studies provide the lead to select the extracts obtained with nonpolar, semipolar and polar nature of solvents for further detailed investigation and correspondingly the selected drugs were subjected to selective solvent extraction.

3.2.1 Preparation of Selective Extracts

The crude drugs are incorporated in the form of either powder or extracts using water or self generated alcohol in various formulations available in traditional systems of medicine. The utlity of different extracted forms, whether alcoholic or aqueous, is based on the nature of

phytoconstituents which is responsible for the desired biological activity. In present studies, therefore, the successive extracts were selected on the basis of polarity of solvents for further studies. The total aqueous extracts of all drugs were also prepared separately and used along with the successive selected extracts. The selection of these extracts was dependent on their availability and content from individual drugs. In case the content was meagre that extract was not taken up. In all, four extracts i.e. petroleum ether (60-80°C), methanolic, successive aqueous and total aqueous extracts were selected for further studies. In case of Sida species as well as M. pterygosperma, the content of petroleum ether extract was very low, hence the studies were restricted to other three extracts. In case of the leaves of M. pterygosperma, only the total aqueous extract has been studied. The values of total aqueous extract from all the plant samples were found as follows: C. orchioides rhizomes (12.51%); F. indica whole plants (14.54%), I. racemosa roots (63.53%); M. pterygosperma fruits (38.63%), leaves (25.01%), roots (13.43%) and stem bark (8.33%); S. acuta whole plant (12.61%); S. cordifolia whole plant (5.56%); S. rhombifolia whole plant (13.31%).

3.2.2 Chromatographic Studies on Selected Extracts

All the selected extract of each drug were subjected to thin layer chromatographic studies using various solvent

TABLE:17 THIN LAYER CHROMATOGRAPHIC PATTERN OF DIFFERENT EXTRACTS OF THE SELECTED PLANT DRUGS

SOLVENT SYSTEM USED	C ORCHIOIDES(RHIZOMES)				F INDICA(WHOLE PLANT)				I RACEMOSA(ROOTS)				DETECTING REAGENT	PROBABLE PHYTOCONSTITUENT
	NUMBER OF SPOTS (Rf VALUES)													
	P E Ext	MeOH Ext	Aq Ext.	T.Aq Ext	P E Ext	MeOH Ext	Aq Ext	T Aq Ext	P.E Ext	MeOH Ext	Aq Ext	T Aq Ext		
A	One (0 91)	Three(0 28 0 63,0 78)	One (0 19)	Two(0 41, 0.77)	One(0 97)	One(0 97)	One (0 99)	One(0 99)	One(0 93)	Three(0 05 0 29,0.96)	Two(0 06, 0.29)	Two(0.06, 0 32)	5% Ethanolic Sulphuric Acid	Carbohydrates
B	(-)	Two(0 23, 0 36)	(-)	Five(0.13, 0.28,0 55, 0 66,0 79)	(-)	Two (0 45, 0 95)	Three(0 13 0 36,0 88)	Three(0 13 0 42,0 86)	One(0 85)	One(0 87)	One(0 87)	One(0 87)	Ninhydrin	Amino Acids
B	One(0 92)	One(0 84)	(-)	One(0 76)	One(0 85)	Three(0 25 0 63,0 93)	Two(0 25, 0 58)	Two(0 26, 0 80)	Two(0 58, 0 91)	One(0 98)	One(0 85)	One(0 84)	5 % Methanolic Ferric Chloride	Phenolic Compounds & Flavonoids
C	Two(0 25, 0 95)	Four(0 07, 0 15,0 26, 0 97)	One (0 95)	Three(0 15 0 77,0 95)	One(0 91)	Two(0 06, 0 95)	Two(0 13, 0 95)	Two(0 17, 0 96)	Two(0.23, 0 90)	One(0 97)	(-)	(-)	Dragendorff Reagent	Alkaloids
D	Two (0 58, 0 90)	One (0 93)	One (0 93)	One (0 59)	Two(0 19, 0 92)	One(01 8)	One(0 13)	One(0 14)	Three(0 57 0 87,0 95)	One(0 95)	(-)	(-)	Iodine Vapours	Unsaturated Compounds
D	Two (0 30, 0 92)	One (0 95)	(-)	One (0 23)	Two(0 18, 0 87)	Two(0 14, 0 86)	One (0 98)	One (0 95)	Two(0 50, 0 89)	Three(0 49 0 74,0 98)	(-)	(-)	Vanillin – Sulphuric Acid Reagent	Terpenes

M PTERYGOSPERMA

SOLVENT SYSTEM USED	FRUITS				LEAVES (T.Aq Ext)	STEM BARK				ROOTS			DETECTING REAGENT	PROBABLE PHYTOCONSTITUENT
	P E Ext	MeOH Ext	Aq Ext.	T.Aq Ext	T.Aq Ext	P E Ext	MeOH Ext	Aq Ext	T Aq Ext	MeOH Ext	Aq Ext	T Aq Ext		
A	One(0 82)	Two(0.71, 0 90)	One(0.84)	One(0.93)	One(0 94)	(-)	One(0 91)	(-)	One(0 82)	Two(0 65, 0 82)	(-)	(-)	5 % ETHANOLIC SULPHURIC ACID	CARBOHYDRATES
B	One(0 51)	One(0 51)	(-)	(-)	Four(0 35, 0 49,0 84, 0 94)	(-)	One(0 66)	Two(0 36, 0 64)	One(0 83)	Two(0 35, 0 52)	Two(0 39, 0 58)	(-)	NINHYDRIN	AMINO ACIDS
B	Two(0 58, 0 95)	One(0 30)	One(0 15)	Three(0 16 0.25,0 44)	(-)	One(0 47)	One(0 47)	(-)	Two(0.20, 0 57)	Three(0 23 0 53,0 74)	One(0.24)	One(0 23)	5 % METHANOLIC FERRIC CHLORIDE	PHENOLIC COMPOUNDS & FLAVONOIDS
C	Two(0.21, 0 93)	Two(0 05, 0.29)	Two(0.05, 0.16)	(-)	Three(0.05 0 20,0.96)	Two(0.21, 0.98)	Two(0 04, 0.24)	(-)	Tewo(0 05, 0 21)	Three(0 04 0 20,0 96)	(-)	(-)	DRAGENDORFF REAGENT	ALKALOIDS
D	Two(0 25, 0 94)	One(0 05)	One(0.05)	One(0 05)	One(0 05)	Two(0 50, 0 87)	One(0 06)	(-)	One(0 06)	One(0 05)	One(0 95)	(-)	IODINE VAPOURS	UNSATURATED COMPOUNDS
D	One(0 30)	Two(0 10, 0 76)	One(0 35)	One(0 96)	One(0 15)	One(0 86)	One(0 97)	(-)	One(0 94)	Two(0 18, 0 96)	(-)	(-)	VANILLIN SULPHURIC ACID REAGENT	TERPENES

SOLVENT SYSTEM USED	S.ACUTA					S CORDIFOLIA			S RHOMBIFOLIA					DETECTING REAGENT	PROBABLE PHYTOCONSTITU
	AERIAL PARTS		ROOTS		WHOLE PLANT	WHOLE PLANT			AERIAL PARTS		ROOTS		WHOLE PLANT		
	MeOH Ext.	Aq.Ext.	MeOH Ext.	Aq.Ext.	T.Aq.Ext.	MeOH Ext	Aq.Ext	T.Aq.Ext.	MeOH Ext	Aq.Ext.	MeOH Ext.	Aq Ext.	T.Aq.Ext.		
A	One(0.81)	(-)	One(0.75)	(-)	One(0.84)	One(0.82)	One(0 76)	One(0 91)	One(0.81)	(-)	One(0.73)	One(0 82)	One(0.79	5% Ethanolic Sulphuric Acid	Carbohydrates
B	Three(0.33 0.58,0 95)	One(0.35)	Two(0.37, 0 89)	(-)	One(0.92)	One(0 98)	(-)	One(0 98)	(-)	Seven(0.1 0 24,0 32, 0.47,0 62, 0 80,0 96)	One(0.98)	(-)	(-)	Ninhydrin	Amino Acids
B	One(0 33)	(-)	One(0.33)	(-)	(-)	One(0 30)	One(0 27)	One(0.27)	One(0 72)	(-)	(-)	Two(0.25, 0 45)	(-)	5% Methanolic Ferric Chloride	Phenolic Compounds & Flavonoids
C	(-)	(-)	One(0.32)	(-)	(-)	One(0 30)	One(0 30)	One(0 30)	Two(0 12, 0 71)	(-)	(-)	(-)	(-)	Dragendorff Reagent	Alkaloids
D	Three(0.27 0 49,0 90)	(-)	Three(0.30 0 50,0 94)	(-)	(-)	Two(0 42, 0 55)	(-)	(-)	Three(0 27 0 46,0 95)	(-)	Three(0 30 0 47,0 94)	(-)	(-)	Iodine Vapours	Unsaturated Compounds
D	Two(0 51, 0 94)	(-)	Five(0.06, 0.12,0.34, 0 56,0 95)	(-)	Two(0 09, 0 41)	Three(0 11 0 32,0 52)	(-)	Two(0 10, 0 50)	Two(0 55, 0 98)	(-)	Two(0 54, 0 98)	(-)	(-)	Vanillin-Sulphuric Acid	Terpenes

A = n BUTANOL , GLACIAL ACETIC ACID : WATER (4 . 1 . 5) , B = n BUTANOL ETHYL ACETATE ISOPROPANOL GLACIAL ACETIC ACID WATER (7 20 12 7 6) , C = TOULENE ETHYL ACETATE DIETHYL AMINE (7 2 1) D = TOLUENE DIOXANE (8 2)

systems and the detecting reagent reported for the purpose. These studies indicated the presence of different types of phytoconstituents in a qualitative manner. The various thin layer chromatographic profiles are recorded in Table 17. These can serve as the means of identification of these plant drugs, as whole and also when incorporated in various formulations, using finger print technique.

3.3 BIOLOGICAL STUDIES

The selected crude drugs appear as articles of value for a variety of disorders and diseases in the cited literature. Majority of these have been placed in traditional systems of medicine for having activity against liver disorders. Claims of variable degrees have been made for their efficacy in the literature. These claims, at times, seem to be of exaggerated nature for the want of supportive studies performed on scientific and acceptable basis. It has become therefore, a desirous task to evaluate these crude drugs in modern scientific manner and grade them according to their biological activity. The biological screening was, therefore, planned on the selective extracts as well as the powders of each drug using reported techniques for the purpose in the following manner. The extracts were first subjected to acute toxicity studies and determination of lethal dose, followed by the assessment of anti-inflammatory and hepatoprotective activities.

3.3.1 Acute Toxicity Studies

These studies were carried out in order to know the absorption pattern of drugs on sudden exposure to biological systems.

Powdered drug as well as extracts of the rhizomes of C. orchioides was found to be practically non-toxic since no mortality was observed even at a dose of 10 g/kg,p.o. in rats.

Powdered drug as well as all other extracts of whole plant of F. indica, except methanolic extract was found to be practically non-toxic. The LD_{50} value of methanolic extract was found to be 5 g/kg, p.o. in rats.

The powder and extracts of roots of I. racemosa except petroleum ether extract were found to be practically non-toxic. The petroleum ether extract was found to be slightly toxic, the LD_{50} value being 1.5 g/kg,p.o. in rats.

The powder and the selective extracts of different organs of M. pterygosperma like fruits, leaves, roots and stem bark were found to be practically non-toxic, since no mortality was observed even at a dose of 10 g/kg, p.o. in rats.

The powders as well as the selective extracts of aerial parts and roots of S. acuta and only total aqueous extract of whole plant were found to be practically non-toxic. However, LD_{50} value of aqueous extract of aerial parts of S. acuta was found to be 9 g/kg,p.o. in rats while the aqueous extract of roots did not show any mortality at the dose of 5 g/kg,p.o. but showed 100% mortality when administered at a dose of 10 g/kg,p.o. in rats.

The powdered drug and the selective extracts of whole plant of S. cordifolia were found to be practically non-toxic. However, the LD_{50} value for methanolic and total aqueous extract was found to be 10 g/kg, p.o in rats.

Powders and the selective extracts of aerial parts and roots of S. rhombifolia and only the total aqueous extract of whole plant were found to be practically non-toxic. However, LD_{50} value of the aqueous extract of roots was found to be 8.5 g/kg, p.o. in rats.

Thus, the acute toxicity studies indicate that the petroleum ether extract of the roots of I. racemosa might be absorbing rapidly on sudden exposure, thereby leading to fatality. Therefore care was taken in utilisation of petroleum ether extract of I. racemosa roots. All other drugs and tested extracts, however, were found to be practically safe. These studies have also provided a lead to decide the

dosage regimen for individual drug/extracts as 500 mg/kg, p.o. in case of powders and 100 mg /kg,p.o. in case of extracts.

3.3.2 Assessment of Anti-inflammatory Activity

Drugs claimed to possess anti-inflammatory activity can be evaluated either by their ability to reduce one or more of inflammatory phenomena in an experimentally induced inflammation or arthritis in albino rats. However, for routine screening, acute carrageenan induced artificial oedema test is used. Carrageenan induced rat paw oedema is considered as a prototype of exudative biphasic inflammation. The initial phase comprises of oedema, hyperemia and hyperalgesia, due to the release of histamine, 5-hydroxytryptamine and serotonin from mast cell degradation during the first hour of carrageenan injection, and increased vascular permeability maintained by kinin release upto 2½ hrs. The second phase, after 2½ to 6 hrs consists of migration of leucocytes into the inflammed site due to the release of prostaglandin, being the mediator. Most of the steroidal and NSAIDs[186] suppress this second phase and therefore this model is employed in the search of new NSAIDs.

i. Effect of Selected Plant Drugs on Carrageenan Induced Artificial Rat Paw Oedema

Carrageenan induced artificial rat paw oedema was significantly reduced by standard drugs like indomethacin,

ibuprofen and ketoprofen which were presently used as reference standards.

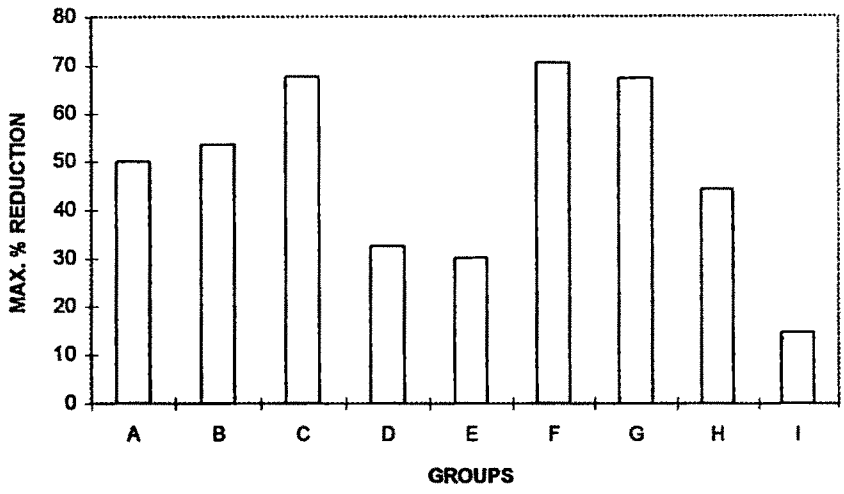
(a) Effect of rhizomes of C. orchioides: Effect of the powdered drug, extracts and marketed preparation of the rhizomes of C. orchioides on carrageenan induced artificial rat paw oedema revealed the following information (Table 18, Fig.20). The rats treated with methanolic, aqueous and total aqueous extracts exhibited significant oedema inhibitory effects ($P < 0.01$) like those of standard drugs when compared to that of control group. The methanolic and aqueous extracts showed significant reduction in oedema compared to that of indomethacin. Further, the methanolic extract also showed significant oedema reductions ($P < 0.01$) even upto third hour when compared to ketoprofen. The powder and petroleum ether extract showed significant reduction ($P < 0.01$) only upto the first hour of carrageenan administration when compared to control. The marketed preparation did not show any significant reduction. The powder, petroleum ether, aqueous and total aqueous extracts showed significant ($P < 0.01$) peak oedema inhibitory effects like that of ibuprofen. The methanolic extract and marketed preparation showed peak oedema reductions like those of indomethacin and ketoprofen. However, all extracts and powder of C. orchioides showed significant peak reductions ($P < 0.01$) like those of standard drugs within two hours of carrageenan administration. Out of these, the methanolic extract showed the maximum significant

TABLE. 18: EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM				
	1 HR	2 HR	3 HR	4 HR	5 HR
CONTROL	0.43 ± 0.01	0.68±0.04	0.73 ± 0.02	0.75 ± 0.03	0.77± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0.02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04* (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03* (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02*** (67.1)	0.27 ± 0.03*** (64.0)	0.39 ± 0.03*** (49.4)
POWDER	0.29±0.03* (32.6)	0.58±0.03 (14.7)	0.60±0.02* (17.8)	0.68±0.02 (9.3)	0.78±0.03 (-)
PET. ETHER EXTRACT	0.30±0.02* (30.2)	0.62±0.02 (8.8)	0.73±0.02 (0.0)	0.78±0.01 (-)	0.82±0.02 (-)
METHANOLIC EXTRACT	0.14±0.01** (67.4)	0.20±0.01*** (70.6)	0.33±0.02*** (54.8)	0.48±0.05* (36.0)	0.61±0.04* (20.8)
AQUEOUS EXTRACT	0.14±0.01** (67.4)	0.28±0.01* (58.8)	0.46±0.02* (37.0)	0.54±0.02* (28.0)	0.56±0.02* (27.3)
TOTAL AQUE-OUS EXTRACT	0.24±0.02* (44.2)	0.50±0.03* (26.5)	0.53±0.03* (27.4)	0.55±0.03* (26.7)	0.59±0.03* (23.4)
MARKETED PREPARATION	0.42±0.02 (2.3)	0.58±0.03 (14.7)	0.80±0.02 (-)	0.87±0.02 (-)	1.13±0.02 (-)
$F_{calculated}$	*33.33*	*51.17*	*75.40*	*35.19*	*52.08*
5%Allowance	*0.08*	*0.12*	*0.10*	*0.14*	*0.14*

*$F_{CRITICAL}$ = 2.80(P<0.01); SIGNIFICANT REDUCTIONS COMPARED TO : CONTROL : *; INDOMETHACIN : **, IBUPROFEN : ***; KETOPROFEN : ****

Fig 20: EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON CARRAGEENAN INDUCED PAW OEDEMA



A = INDOMETHACIN
B = IBUPROFEN
C = KETOPROFEN
D = POWDER
E = PET. ETHER EXTRACT
F = METHANOLIC EXTRACT
G = AQUEOUS EXTRACT
H = TOTAL AQUEOUS EXTRACT
I = MARKETED PREPARATION

($P < 0.01$) oedema inhibitory activity when compared to ketoprofen. The methanolic and aqueous extracts showed almost similar significant inhibitory activities ($P<0.01$) like that of ketoprofen and indomethacin but at different time intervals. The petroleum ether extract and marketed preparation of C. orchioides rhizomes did not show any oedema suppressant activities between 2-5 hrs duration. The powdered drug did not show any oedema inhibitory activity at fifth hour after carrageenan administration. Thus, this indicates that the rat paw oedema suppressant activity of the rhizomes of C. orchioides might be due to the inhibitory activity on the release of histamine, 5-HT, serotonin and kinin like substances.

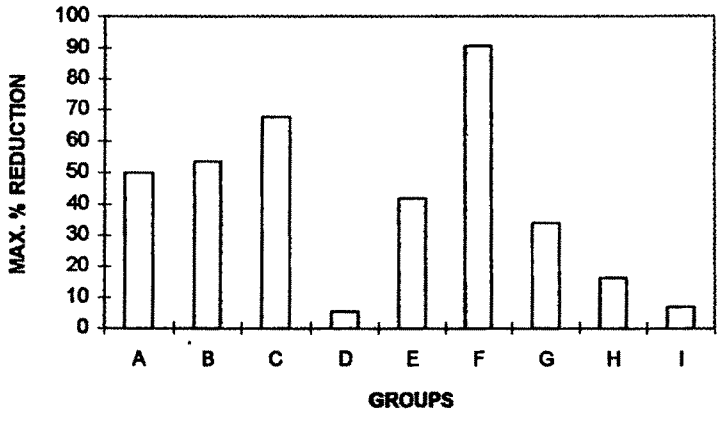
(b) Effect of whole plant of F. indica: The effects of the powdered drug, extracts and marketed preparation (whole plant of F. indica) on carrageenan induced rat paw oedema is recorded (Table 19, Fig.21). The methanolic extract of whole plant of F. indica showed significant ($P < 0.01$) oedema suppressant effect like that of ibuprofen. The petroleum ether extract, methanolic extract and marketed preparation showed peak oedema inhibitions at first hour of carrageenan administration like that of ibuprofen. The aqueous and total aqueous extracts showed significant peak oedema reductions ($P< 0.01$) like those of indomethacin and ketoprofen. The powder and marketed preparation did not show any significant peak oedema inhibitory activity. The methanolic extract was found

TABLE.19: EFFECT OF FUMARIA INDICA WHOLE PLANT ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM				
	1 HR	2 HR	3 HR	4 HR	5 HR
CONTROL	0.43 ± 0.01	0.68±0.04	0.73 ± 0.02	0.75 ± 0.03	0.77± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0.02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04* (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03* (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02*** (67.1)	0.27 ± 0.03*** (64.0)	0.39 ± 0.03*** (49.4)
POWDER	0.50 ± 0.02 (-)	0.65 ± 0.03 (4.4)	0.70 ± 0.03 (4.1)	0.71 ± 0.03 (5.3)	0.76 ± 0.03 (1.3)
PET. ETHER EXTRACT	0.25 ± 0.02* (41.9)	0.47 ± 0.01* (30.9)	0.60 ± 0.03* (17.8)	0.62 ± 0.04 (17.3)	0.70 ± 0.03 (9.1)
METHANOLIC EXTRACT	0.04 ± 0.01**** (90.7)	0.19 ± 0.02*** (72.1)	0.33 ± 0.03* (54.8)	0.43 ± 0.03* (42.7)	0.48 ± 0.03* (37.7)
AQUEOUS EXTRACT	0.33 ± 0.01* (23.3)	0.45 ± 0.02* (33.8)	0.58 ± 0.04* (20.6)	0.58 ± 0.02* (22.7)	0.68 ± 0.02 (11.7)
TOTAL AQUE-OUS EXTRACT	O.38 ± 0.01 (11.6)	0.57 ± 0.02* (16.2)	0.76 ± 0.01 (-)	0.81 ± 0.01 (-)	0.88 ± 0.01 (-)
MARKETED PREPARATION	0.40 ± 0.01 (6.9)	0.70 ± 0.01 (-)	0.80 ± 0.04 (-)	0.88 ± 0.03 (-)	1.01 ± 0.03 (-)
$F_{calculated}$	***61.11***	***65.63***	***47.73***	***30.77***	***35.19***
5%Allowance	***0.08***	***0.11***	***0.13***	***0.14***	***0.14***

*$F_{CRITICAL}$ = 2 80(P<0.01); SIGNIFICANT REDUCTIONS COMPARED TO : CONTROL : *; INDOMETHACIN . **, IBUPROFEN : ***; KETOPROFEN : ****

Fig 21: EFFECT OF FUMARIA INDICA WHOLE PLANT ON CARRAGEENAN INDUCED PAW OEDEMA



A = INDOMETHACIN
B = IBUPROFEN
C = KETOPROFEN
D = POWDER
E = PET. ETHER EXTRACT
F = METHANOLIC EXTRACT
G = AQUEOUS EXTRACT
H = TOTAL AQUEOUS EXTRACT
I = MARKETED PREPARATION

to exhibit significantly better oedema suppressant activity ($P < 0.01$) compared to those of standard drugs. Since all the extracts exhibited peak oedema inhibitory actions within 2 hrs of carrageenan injection, the anti-inflammatory activity of the whole plant of F. indica might be due to its inhibitory activity on the release of histamine like substances.

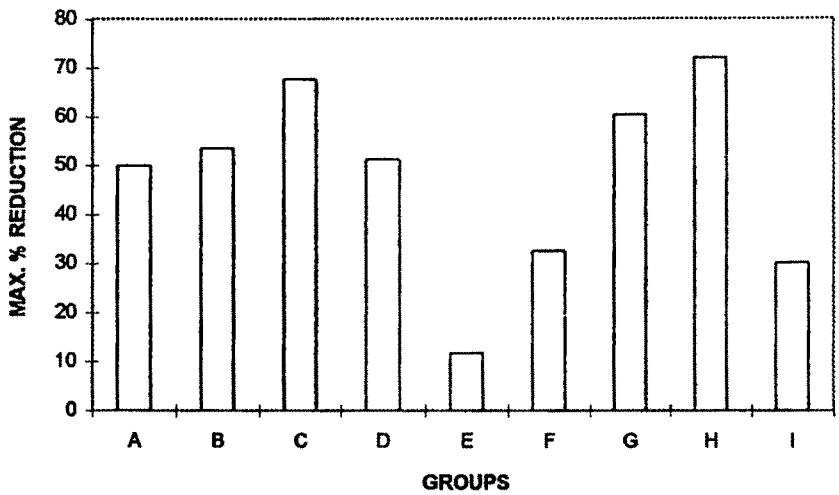
(c) Effect of roots of I. racemosa: The effect of the powdered drug, extracts, and marketed preparation of the roots of I racemosa against carrageenan induced paw oedema revealed the following information (Table 20, Fig.22). The rats treated with the powdered drug, extracts and marketed preparation of the roots of I. racemosa showed peak oedema inhibitory activity at the first hour of carrageenan injection like that of ibuprofen. All the other test samples, except petroleum ether extract, showed significant oedema inhibition ($P < 0.01$) at the first hour of carrageeenan injection. The aqueous and total aqueous extracts exhibited significantly better ($P < 0.01$) oedema suppressant activity compared to indomethacin and ketoprofen respectively at first hour. The total aqueous extract exhibited maximum oedema inhibitory activity, followed by the aqueous extract and the powdered drug. Out of these, the petroleum ether extract showed minimum oedema inhibitory activity. The powdered drug and petroleum ether extract did not exhibit any oedema suppressant activity after first hour. Since all extracts

TABLE: 20 EFFECT OF INULA RACEMOSA ROOTS ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM (% REDUCTION)				
	1 Hr	2 Hr	3 Hr	4 Hr	5 Hr
CONTROL	0.43 ± 0.01	0.68 ± 0.04	0.73 ± 0.02	0.75 ± 0.03	0.77 ± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0.02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04* (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03* (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02*** (67.1)	0.27 ± 0.03*** (64.0)	0.39 ± 0.03*** (49.4)
POWDER	0.21 ± 0.01** (51.2)	0.84 ± 0.03 (-)	1.01 ± 0.04 (-)	1.03 ± 0.03 (-)	1.07 ± 0.04 (-)
PET. ETHER EXTRACT	0.38 ± 0.01 (11.6)	0.73 ± 0.03 (-)	0.77 ± 0.02 (-)	0.79 ± 0.02 (-)	0.82 ± 0.02 (-)
METHANOLIC EXTRACT	0.29 ± 0.01* (32.6)	0.53 ± 0.01* (22.1)	0.63 ± 0.01 (13.7)	0.82 ± 0.02 (-)	0.88 ± 0.03 (-)
AQUEOUS EXTRACT	0.17 ± 0.01** (60.5)	0.40 ± 0.02* (41.2)	0.49 ± 0.03* (32.9)	0.50 ± 0.02* (33.3)	0.53 ± 0.02* (31.2)
TOTAL AQUE-OUS EXTRACT	0.12±0.01**** (72.1)	0.33 ± 0.02* (51.5)	0.55 ± 0.01* (24.7)	0.60 ± 0.01* (20.0)	0.73 ± 0.01 (5.2)
MARKETED PREPARATION	0.30 ± 0.01* (30.2)	0.55 ± 0.02* (19.1)	0.63 ± 0.02 (13.7)	0.65 ± 0.02 (13.3)	0.68 ± 0.03 (11.7)
$F_{calculated}$	*50.00*	*65.79*	*82.35*	*60.87*	*52.27*
5%Allowance	*0.07*	*0.12*	*0.11*	*0.13*	*0.80*

*$F_{CRITICAL}$ = 2.80(P<0.01); SIGNIFICANT REDUCTIONS COMPARED TO : CONTROL : *; INDOMETHACIN : **, IBUPROFEN : ***; KETOPROFEN : ****

Fig 22: EFFECT OF INULA RACEMOSA ROOTS ON CARRAGEENAN INDUCED PAW OEDEMA



A = INDOMETHACIN
B = IBUPROFEN
C = KETOPROFEN
D = POWDER
E = PET. ETHER EXTRACT
F = METHANOLIC EXTRACT
G = AQUEOUS EXTRACT
H = TOTAL AQUEOUS EXTRACT
I = MARKETED PREPARATION

exhibited activity against carrageenan induced artificial rat paw oedema within one hour of carrageenan injection, the oedema suppressant activity of the roots of I. racemosa might be due to the inhibitory activity on the release of histamine like substances.

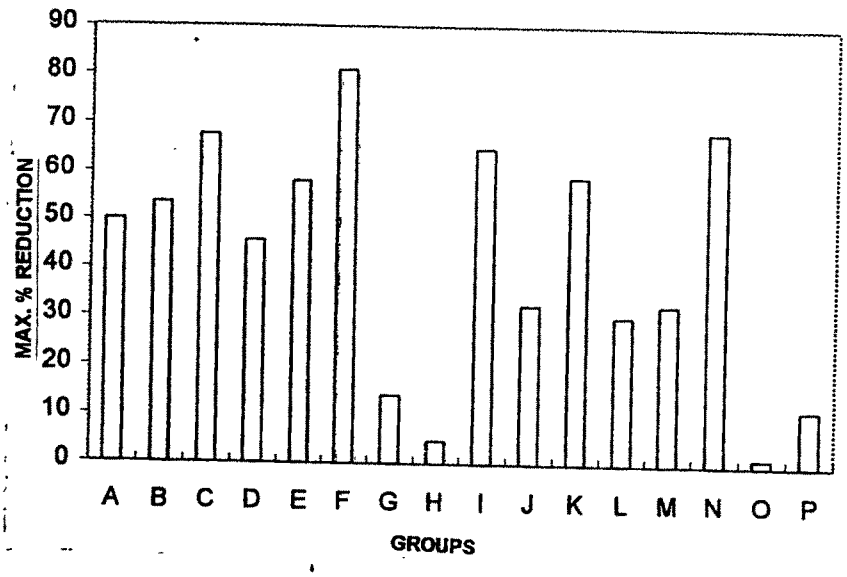
(d) Effect of different organs of M. pterygosperma: Effect of powdered drugs, extracts and marketed preparation of different organs of M. pterygosperma on carrageenan induced rat paw oedema revealed the following information (Table 21, Fig.23). All the powdered drugs, extracts and marketed preparation showed peak oedema inhibitory activity within two hours of carrageenan injection, except the methanolic extract of roots, which showed activity at the third hour. The powdered drugs including the aqueous and total aqueous extracts of roots did not show any oedema suppressant activity. The aqueous extract of fruits and methanolic extract of roots showed significant ($P < 0.01$) oedema inhibitory activity like that of standard drugs. Out of all these test samples, the aqueous extract of fruits exhibited maximum significant oedema suppressant activity followed by the methanolic extract of roots, total aqueous extract of leaves and methanolic extracts of stem bark and fruits. The total aqueous extract of fruits, powder of leaves, aqueous extract of roots and marketed preparation did not exhibit any significant oedema inhibitory activity. Oedema inhibitory activity of all the other test samples except methanolic

TABLE: 21 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM (% REDUCTION)				
	1 Hr	2 Hr	3 Hr	4 Hr	5 Hr
CONTROL	0.43 ± 0.01	0.68 ± 0.04	0.73 ± 0.02	0.75 ± 0.03	0.77 ± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0.02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04 (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03 (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02* (67.1)	0.27 ± 0.03*** (64.0)	0.39 ± 0.03*** (49.4)
M. PTERYGOSPERMA (FRUITS)					
POWDER	0.71 ± 0.02 (-)	0.81 ± 0.02 (-)	0.90 ± 0.03 (-)	0.95 ± 0.02 (-)	1.13 ± 0.02 (-)
PET. ETHER EXTRACT	0.32 ± 0.02* (25.6)	0.37 ± 0.02* (45.6)	0.63 ± 0.02 (13.7)	0.67 ± 0.02 (10.7)	0.75 ± 0.03 (2.6)
METHANOLIC EXTRACT	0.18 ± 0.02** (58.1)	0.29 ± 0.02* (57.4)	0.50 ± 0.02* (31.5)	0.60 ± 0.03 (20.0)	0.63 ± 0.02* (18.2)
AQUEOUS EXTRACT	0.10±0.01**** (76.7)	0.13 ± 0.02*** (80.9)	0.31± 0.02* (57.5)	0.40 ± 0.04* (46.7)	0.48 ± 0.03* (37.7)
TOTAL AQUE-OUS EXTRACT	0.37 ± 0.02 (14.0)	0.71 ± 0.02 (-)	0.78 ± 0.02 (-)	0.78 ± 0.01 (-)	0.80 ± 0.02 (-)
M. PTERYGOSPERMA (LEAVES)					
POWDER	0.41 ± 0.01 (4.7)	1.01 ± 0.01 (-)	1.06 ± 0.02 (-)	1.11 ± 0.02 (-)	1.21 ± 0.01 (-)
TOTAL AQUE-OUS EXTRACT	0.15 ± 0.01** (65.1)	0.53 ± 0.04* (22.1)	0.71 ± 0.04 (2.7)	0.78 ± 0.03 (-)	0.80 ± 0.04 (-)
M. PTERYGOSPERMA (STEMBARK)					
POWDER	0.52 ± 0.02 (-)	0.84 ± 0.01 (-)	0.91 ± 0.02 (-)	0.94 ± 0.02 (-)	1.01 ± 0.02 (-)
PET. ETHER EXTRACT	0.42 ± 0.01 (2.3)	0.46 ± 0.02* (32.4)	0.70 ± 0.01 (4.1)	0.81 ± 0.01 (-)	0.88 ± 0.02 (-)
METHANOLIC EXTRACT	0.22 ± 0.01** (48.8)	0.28 ± 0.03* (58.8)	0.64 ± 0.02 (12.3)	0.83 ± 0.02 (-)	1.11 ± 0.04 (-)
AQUEOUS EXTRACT	0.30 ± 0.03* (30.2)	0.50 ± 0.02* (26.5)	0.72 ± 0.01 (1.4)	1.03 ± 0.02 (-)	1.24 ± 0.02 (-)
TOTAL AQUE-OUS EXTRACT	0.29 ± 0.02* (32.6)	0.64 ± 0.04 (5.9)	0.69 ± 0.04 (5.5)	0.77 ± 0.04 (-)	0.83 ± 0.04 (-)
M. PTERYGOSPERMA (ROOTS)					
POWDER	0.49 ± 0.02 (-)	0.79 ± 0.02 (-)	0.90 ± 0.02 (-)	1.09 ± 0.04 (-)	1.12 ± 0.04 (-)
METHANOLIC EXTRACT	0.16 ± 0.02** (62.8)	0.22 ± 0.02** (67.7)	0.23 ± 0.05* (68.5)	0.38 ± 0.03* (49.3)	0.48 ± 0.03* (37.7)
AQUEOUS EXTRACT	0.45 ± 0.01 (-)	0.67 ± 0.01 (1.5)	0.75 ± 0.02 (-)	0.78 ± 0.03 (-)	0.81 ± 0.02 (-)
TOTAL AQUE-OUS EXTRACT	0.43 ± 0.01 (0.0)	0.78 ± 0.01 (-)	0.91 ± 0.02 (-)	0.96 ± 0.02 (-)	0.98 ± 0.03 (-)
MARKETED PREPARATION	0.38 ± 0.02 (11.6)	0.63 ± 0.02 (7.4)	0.81 ± 0.05 (-)	0.84 ± 0.05 (-)	0.91 ± 0.03 (-)
$F_{calculated}$	*66.00*	*105.71*	*71.11*	*20.31*	*82.61*
5%Allowance	*0.09*	*0.12*	*0.14*	*0.26*	*0.14*

*$F_{CRITICAL}$ = 2.07(P<0.01); SIGNIFICANT REDUCTIONS COMPARED TO : CONTROL : *; INDOMETHACIN : **, BUPROFEN : ***; KETOPROFEN . ****

Fig. 23 : EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON CARRAGEENAN INDUCED PAW OEDEMA.



A = INDOMETHACIN
B = IBUPROFEN
C = KETOPROFEN
D = PET. ETHER EXTRACT(FRUITS)
E = METHANOLIC EXTRACT
F = AQUEOUS EXTRACT
G = TOTAL AQUEOUS EXTRACT
H = POWDER (LEAVES)
I = TOTAL AQUEOUS EXTRACT
J = PET. ETHER EXTRACT (STEM BARK)
K = METHANOLIC EXTRACT
L = AQUEOUS EXTRACT
M = TOTAL AQUEOUS EXTRACT
N = METHANOLIC EXTRACT (ROOTS)
O = AQUEOUS EXTRACT
P = MARKETED PREPERATION

extract of roots might be due to their inhibitory activity on the release of histamine like substances. The oedema suppressant activity of the methanolic extract of roots might be due to the inhibitory activity on the release of prostaglandin like substances as the peak activity was shown at the third hour of carrageenan injection.

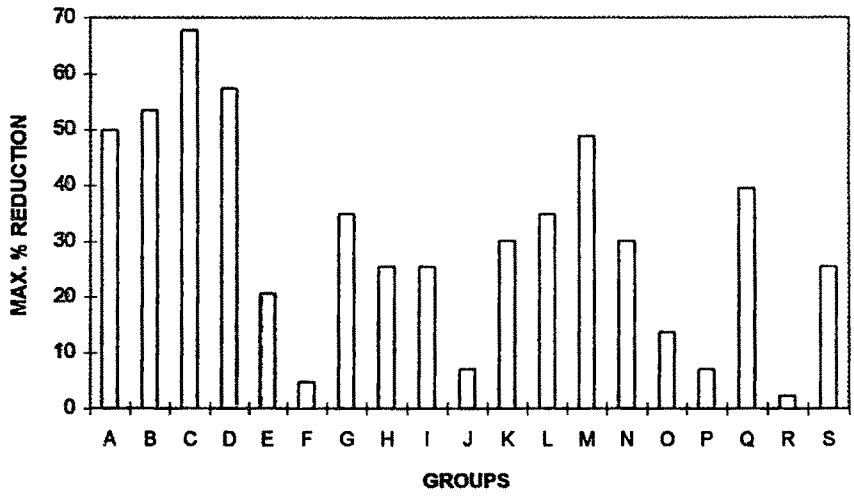
(e) Effect of different organs of various species of Sida: The effects on different groups of rats treated with powdered drugs, extracts and marketed preparation of different organs of various species of Sida on carrageenan induced artificial rat paw oedema are recorded in Table 22, Fig.24. All the powdered drugs, extracts and marketed preparation of different organs of various species of Sida exhibited peak oedema inhibitory activity within two hours of carrageenan injection like that of ibuprofen, indomethacin and ketoprofen. The rats treated with the powdered roots of S. rhombifolia showed no significant ($P<0.01$) oedema inhibitory activity at the third hour of carrageenan injection. The powdered drug of aerial parts of S. acuta showed maximum significant ($P<0.01$) oedema inhibitory activity followed by methanolic extract of aerial parts and aqueous extract of roots of S. rhombifolia. The powdered aerial parts and roots of S. acuta, aqueous extract of roots of S. acuta, total aqueous extract of whole plant of S. acuta, powdered drug and total aqueous extract of whole plant of S. cordifolia; powdered drug methanolic and aqueous extracts of aerial parts

TABLE 22: EFFECT OF DIFFERENT ORGANS OF VARIOUS SIDA SPECIES ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM (% REDUCTION)				
	1 Hr	2 Hr	3 Hr	4 Hr	5 Hr
CONTROL	0.43 ± 0.01	0.68 ± 0.04	0.73 ± 0.02	0.75 ± 0.03	0.77 ± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0.02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04 (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03 (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02*** (67.1)	0.27 ± 0.03 (64.0)	0.39 ± 0.03** (49.4)
S. ACUTA					
(AERIAL PARTS) POWDER	0.21 ± 0.01** (51.2)	0.29 ± 0.02* (57.4)	0.39 ± 0.01* (46.6)	0.50 ± 0.01 (33.3)	0.54 ± 0.02* (29.9)
METHANOLIC EXTRACT	0.43 ± 0.02 (0.0)	0.73 ± 0.01 (-)	0.88 ± 0.02 (-)	0.90 ± 0.02 (-)	1.00 ± 0.03 (-)
AQUEOUS EXTRACT	0.55 ± 0.03 (-)	1.00 ± 0.01 (-)	1.03 ± 0.03 (-)	1.25 ± 0.03 (-)	1.29 ± 0.03 (-)
(ROOTS) POWDER	0.43 ± 0.01 (0.0)	0.54 ± 0.01* (20.6)	0.86 ± 0.01 (-)	0.88 ± 0.01 (-)	0.98 ± 0.02 (-)
METHANOLIC EXTRACT	0.41 ± 0.01 (4.7)	0.89 ± 0.02 (-)	0.98 ± 0.02 (-)	1.00 ± 0.03 (-)	1.01 ± 0.03 (-)
AQUEOUS EXTRACT	0.28 ± 0.01* (34.9)	0.70 ± 0.02 (-)	0.95 ± 0.02 (-)	0.96 ± 0.04 (-)	0.98 ± 0.02 (-)
(WHOLE PLANT) TOTAL AQUE-OUS EXTRACT	0.32 ± 0.01* (25.6)	0.58 ± 0.02 (14.7)	0.80 ± 0.02 (-)	0.84 ± 0.02 (-)	0.88 ± 0.03 (-)
S. CORDIFOLIA					
(WHOLE PLANT) POWDER	0.32 ± 0.01* (25.6)	0.66 ± 0.03 (2.9)	0.74 ± 0.03 (-)	0.93 ± 0.03 (-)	0.96 ± 0.05 (-)
METHANOLIC EXTRACT	0.40 ± 0.02 (7.0)	0.67 ± 0.01 (1.5)	1.02 ± 0.01 (-)	1.10 ± 0.01 (-)	1.13 ± 0.01 (-)
AQUEOUS EXTRACT	0.59 ± 0.01 (-)	0.75 ± 0.03 (-)	1.01 ± 0.03 (-)	1.07 ± 0.03 (-)	1.10 ± 0.03 (-)
TOTAL AQUE-OUS EXTRACT	0.30 ± 0.01* (30.2)	0.77 ± 0.03 (-)	0.93 ± 0.04 (-)	1.07 ± 0.04 (-)	1.11 ± 0.04 (-)
S. RHOMBIFOLIA					
(AERIAL PARTS) POWDER	0.28 ± 0.02* (34.9)	0.85 ± 0.03 (-)	0.88 ± 0.03 (-)	0.98 ± 0.03 (-)	1.14 ± 0.04 (-)
METHANOLIC EXTRACT	0.22 ± 0.02** (48.8)	0.58 ± 0.02 (14.7)	0.90 ± 0.03 (-)	1.00 ± 0.01 (-)	1.06 ± 0.01 (-)
AQUEOUS EXTRACT	0.30 ± 0.01* (30.2)	0.57 ± 0.03 (16.2)	0.70 ± 0.03 (4.1)	0.83 ± 0.04 (-)	0.99 ± 0.04 (-)
(ROOTS) POWDER	0.52 ± 0.01 (-)	0.61 ± 0.02 (10.3)	0.63 ± 0.02 (13.7)	0.71 ± 0.02 (-)	0.73 ± 0.02 (5.2)
METHANOLIC EXTRACT	0.40 ± 0.02 (7.0)	0.82 ± 0.04 (-)	1.05 ± 0.04 (-)	1.12 ± 0.04 (-)	1.16 ± 0.04 (-)
AQUEOUS EXTRACT	0.26 ± 0.02* (39.5)	0.80 ± 0.00 (-)	0.83 ± 0.02 (-)	0.96 ± 0.02 (-)	0.98 ± 0.03 (-)
(WHOLE PLANT) TOTAL AQUE-OUS EXTRACT	0.42 ± 0.01 (2.3)	0.75 ± 0.02 (-)	0.78 ± 0.03 (-)	0.98 ± 0.03 (-)	0.98 ± 0.02 (-)
MARKETED PREPARATION	0.32 ± 0.01* (25.6)	0.56 ± 0.01* (17.7)	0.83 ± 0.01 (-)	0.88 ± 0.02 (-)	0.91 ± 0.02 (-)
$F_{calculated}$	*38.84*	*68.57*	*81.08*	*61.11*	*58.49*
5% Allowance	*0.09*	*0.12*	*0.12*	*0.15*	*0.15*

*$F_{CRITICAL} = 2.01 (P<0.01)$; SIGNIFICANT REDUCTIONS WHEN COMPARED TO : CONTROL : *; INDOMETHACIN : **; IBUPROFEN : ***; KETOPROFEN : ****

Fig 24: EFFECT OF DIFFERENT ORGANS OF VARIOUS SIDA SPECIES ON CARRAGEENAN INDUCED PAW OEDEMA



A = INDOMETHACIN
B = IBUPROFEN
C = KETOPROFEN
S. ACUTA:
D = POWDER(Aerial parts)
E = POWDER(Roots)
F = METHANOLIC EXTRACT
G = AQUEOUS EXTRACT
H = TOTAL AQUEOUS EXTRACT(Whole plant)
S. CORDIFOLIA
I = POWDER(Whole plant)
J = METHANOLIC EXTRACT
K = TOTAL AQUEOUS EXTRACT
S. RHOMBIFOLIA
L = POWDER(Aerial parts)
M = METHANOLIC EXTRACT
N = AQUEOUS EXTRACT
O = POWDER (Roots)
P = METHANOLIC EXTRACT
Q = AQUEOUS EXTRACT
R = TOTAL AQUEOUS EXTRACT(Whole plant)
S = MARKETED PREPARATION

and aqueous extract of roots of S. rhombifolia; and marketed preparation showed significant ($P < 0.01$) reduction in oedema compared to control group. The oedema suppressant activity of different organs of various Sida species might be due to their inhibitory activity on the release of histamine like substances while that of S. rhombifolia powdered roots might be due to their inhibitory activity on the release of prostaglandin like substances.

Thus these studies substantiate the utilization of these drugs as anti-inflammatory agents as claimed in traditional remedies, when screened on preliminary basis.

3.3.3 Effect of Selected Plant Durgs on Normal Hepatic Functions:

The acute toxicity studies indicated that all these drugs are practically non-toxic except the petroleum ether extract of roots of I. racemosa. The powdered drugs and extracts of these drugs were also studied for their effects on normal liver functions by determining serum and urinary biochemical parameters. The objective of these studies was to confirm the safety of these drugs on normal liver functions at the selected dose regimen. The effect of powdered drugs as well as selected extracts on serum and urinary biochemical markers are recorded in Table 23-27. These values revealed that all these drugs were found to increase urine output except the

TABLE . 23 EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON NORMAL HEPATIC FUNCTIONS

BIOCHEMICAL PARAMETERS	GROUP						STATISTICAL PARAMETERS (P < 0.01)	
	CONTROL	POWDER	PET. ETHER Ext.	MeOH Ext.	AQUEOUS Ext.	T.Aq. Ext.	Fcalculated	5% Allowance
SERUM PARAMETERS, MEAN ± SEM								
SGPT (U/ml)	56.96 ± 3.24	39.49 ± 1.37**	33.10 ± 2.57**	54.34 ± 3.84*	42.59 ± 1.81**	53.51 ± 1.97*	13.60	12 30
SGOT (U/ml)	137.53 ± 12.28	108.77 ± 2.04*	131.59 ± 6.78*	13.74 ± 7.90*	162.85 ± 8.04*	110.41 ± 3.96*	7.68	35.64
ALKP (U/l)	169.05 ± 4.66	80.03 ± 1.27**	72.67 ± 4.90**	193.33±11.34*	130.10 ± 17.15*	183.33 ± 6.50*	32.26	43.52
T Bil (mg / dl)	1.23 ± 0.03	0.98 ± 0.02*	1.37 ± 0.05*	1.23 ± 0.04*	1.62 ± 0.12**	1.16 ± 0.02*	13.14	0 28
D Bil (mg / dl)	0.20 ± 0.01	0.52 ± 0.03	0.20 ± 0.01 *	0.18 ± 0.01*	0.19 ± 0.02*	0.14 ± 0.01**	120 00	0 06
URINARY PARAMETERS , MEAN ± SEM								
URINE VOLUME (ml)	14.83 ± 0.48	17.88 ± 0.13	18.88 ± 0.27	24.25 ± 0.40	23.00 ± 0.37	18.75 ± 0.11	115.31	1.52
ASCORBIC ACID (g/dl)	0.19 ± 0.00	0.11 ± 0.00**	0.09 ± 0.00**	0.09 ± 0.00**	0.09 ± 0.00**	0.18 ± 0.00*	46.67	0.03
CHOLESTEROL (mg/dl)	6.17 ± 0.04	5.47 ± 0.01**	3.36 ± 0.04**	4.35 ± 0.03**	2.70 ± 0.04**	5.86 ± 0.04**	1711.43	0.16
GLUCOSE (mg / dl)	3.47 ± 0.16	3.28 ± 0.03*	2.38 ± 0.05**	2.18 ± 0.03**	2.10 ± 0.03**	3.62 ± 0.03*	92.26	0.34
T Bil (mg / dl)	0.63 ± 0.02	0.50 ± 0.01**	0.32 ± 0.01**	0.45 ± 0.00**	0.55 ± 0.01**	0.85 ± 0.01	295.52	0.05
D Bil (mg /dl)	0.15 ± 0.00	0.04 ± 0.00**	0.03 ± 0.00**	0.04 ± 0.00**	0.03 ± 0.00**	0.08 ± 0.00**	32.50	0.07
TOTAL PROTEIN(g/dl)	0.12 ± 0.02	0.10 ± 0.00**	0.08 ± 0.00**	0.10 ± 0.00**	0.10 ± 0.00**	0.20 ± 0.00	145.71	0.02

Fcritical = 3.70 (P < 0.01) ; NOT SIGNIFICANT REDUCTION = * ; SIGNIFICANT REDUCTION = **

TABLE .24 EFFECT OF FUMARIA INDICA WHOLE PLANT ON NORMAL HEPATIC FUNCTIONS

BIOCHEMICAL PARAMETERS	GROUP						STATISTICAL PARAMETERS (P < 0.01)	
	CONTROL	POWDER	PET. ETHER Ext.	MeOH Ext.	AQUEOUS Ext.	T.Aq. Ext.	Fcalculate	5% Allowance
SERUM PARAMETERS, MEAN ± SEM								
SGPT (U/ml)	56.96 ± 3.24	32.82 ± 1.26**	33.14 ± 2.42**	89.69 ± 5.73	33.00 ± 2.29**	32.63 ± 1.27**	56.47	14.60
SGOT (U/ml)	137.53 ± 12.28	80.56 ± 2.09**	107.17 ± 3.76*	120.82 ± 7.66	112.77±8.77*	54.67 ± 0.94**	17.50	33.62
ALKP (U/l)	169.05 ± 4.66	124.27 ± 2.75**	207.30 ± 3.40	103.50 ± 3.32**	137.50±10.91**	216.87 ± 3.07	70.10	25.81
T Bil (mg / dl)	1.23 ± 0.03	0.86 ± 0.00**	1.35 ± 0.11*	1.03 ± 0.04*	1.23 ± 0.06*	0.81 ± 0.01**	16.27	0.26
D Bil (mg / dl)	0.20 ± 0.01	0.39 ± 0.01	0.21 ± 0.01*	0.18 ± 0.01*	0.22 ± 0.02*	0.21 ± 0.01*	36.00	0.06
URINARY PARAMETERS, MEAN ± SEM								
URINE VOLUME (ml)	14.83 ± 0.48	16.92 ± 0.30 *	17.25 ± 0.28*	15.67 ± 0.31*	23.75 ± 0.31	25.17 ± 1.51	40.15	3.26
ASCORBIC ACID (g/dl)	0.19 ± 0.00	0.19 ± 0.01*	0.20 ± 0.00*	0.14 ± 0.00**	0.13 ± 0.00**	0.11 ± 0.01	27.50	0.03
CHOLESTEROL (mg/dl)	6.17 ± 0.04	2.72 ± 0.05**	2.90 ± 0.06**	1.46 ± 0.02**	0.91 ± 0.00**	1.98 ± 0.13**	867.92	0.30
GLUCOSE (mg / dl)	3.47 ± 0.16	8.18 ± 0.21	8.75 ± 0.20	2.38 ± 0.05**	0.95 ± 0.02**	2.53 ± 0.10**	519.56	0.68
T Bil (mg / dl)	0.63 ± 0.02	0.52 ± 0.02**	0.45 ± 0.01**	0.27 ± 0.01**	0.27 ± 0.01**	0.43 ± 0.02**	72.94	0.08
D Bil (mg /dl)	0.15 ± 0.00	0.05 ± 0.01**	0.06 ± 0.00**	0.08 ± 0.00**	0.14 ± 0.01*	0.15 ± 0.02*	12.00	0.06
TOTAL PROTEIN(g/dl)	0.12 ± 0.02	0.06 ± 0.01*	0.07 ± 0.01*	0.03 ± 0.00*	0.00 ± 0.00**	0.04 ± 0.01**	3.33	0.11

Fcritical = 3.70 (P < 0.01) ; NOT SIGNIFICANT REDUCTION = * ; SIGNIFICANT REDUCTION = **

TABLE .25 EFFECT OF INULA RACEMOSA ROOTS ON NORMAL HEPATIC FUNCTIONS

BIOCHEMICAL PARAMETERS	GROUP						STATISTICAL PARAMETERS (P < 0.01)	
	CONTROL	POWDER	PET. ETHER Ext.	MeOH Ext.	AQUEOUS Ext.	T.Aq. Ext.	Fcalculate	5 % Allowance
SERUM PARAMETERS, MEAN ± SEM								
SGPT (U/ml)	56.96 ± 3.24	34.20 ± 0.92 **	59.98 ± 1.20 *	108.01 ± 2.00	41.30 ± 0.36 **	30.45 ± o.67 **	279.95	8.02
SGOT (U/ml)	137.53 ± 12.28	138.27 ± 0.61 *	185.90 ± 3.33	140.08 ± 1.18 *	101.4 ±1.34 **	61.50 ± 1.11 **	63.48	24.82
ALKP (U/l)	169.05 ± 4.66	66.50 ± 0.93 **	133.1±2.19 **	115.18±0.46 **	115.50±1.26 **	100.13±1.43 **	216.35	10.73
T Bil (mg / dl)	1.23 ± 0.01	1.18 ± 0.02 *	1.60 ± 0.03	2.16 ± 0.03	1.37 ± 0.01	0.97 ± 0.02 **	388.89	0.10
D Bil (mg / dl)	0.20 ± 0.01	0.47 ± 0.00	0.82 ± 0.02	0.64 ± 0.01	0.33 ± 0.01	0.25 ± 0.01	519.40	0.05
URINARY PARAMETERS, MEAN ± SEM								
URINE VOLUME (ml)	14.83 ± 0.48	19.33 ± 0.88	22.75 ± 0.21	23.25 ± 0.21	20.13 ± 0.20	20.92 ± 1.00	25.67	2.82
ASCORBIC ACID (g/dl)	0.19 ± 0.00	0.13 ± 0.01**	0.11 ± 0.01 **	0.10 ± 0.00 **	0.14 ± 0.00 **	0.17 ± 0.01 *	8.57	0.05
CHOLESTEROL (mg/dl)	6.17 ± 0.04	3.76 ± 0.06 **	4.09 ± 0.04 **	4.33 ± 0.03 **	4.57 ± 0.03 **	3.98 ± 0.07 **	404.07	0.20
GLUCOSE (mg / dl)	3.47 ± 0.16	3.63 ± 0.04 *	6.65 ± 0.06	3.28 ± 0.07 *	3.70 ± 0.04 *	4.93 ± 0.07	235.58	0.40
T Bil (mg / dl)	0.63 ± 0.02	0.53 ± 0.01 **	0.58 ± 0.01 **	0.52 ± 0.01 **	0.43 ± 0.01 **	0.50 ± 0.01 **	42.86	0.05
D Bil (mg /dl)	0.15 ± 0.00	0.07 ± 0.01 **	0.11 ± 0.00 *	0.04 ± 0.00 **	0.03 ± 0.00 **	0.04 ± 0.01 **	20.00	0.05
TOTAL PROTEIN(g/dl)	0.12 ± 0.02	0.10 ± 0.01*	0.17 ± 0.00 *	0.10 ± 0.00 *	0.08 ± 0.00 *	0.08 ± 0.01 *	8 00	0.06

Fcritical = 3.70 (P < 0.01) ; NOT SIGNIFICANT REDUCTION = * ; SIGNIFICANT REDUCTION = **

TABLE:26 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON NORMAL HEPATIC FUNCTIONS

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM					URINARY BIOCHEMICAL PARAMETERS, MEAN ± SEM						
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	TBil (mg/dl)	DBil (mg/dl)	URINE VOLUME (ml)	ASCORBIC ACID (g/dl)	CHOLESTEROL (mg/dl)	GLUCOSE (mg /dl)	TBil (mg/dl)	DBil (mg/dl)	TOTAL PROTEIN (g/dl)
CONTROL	56.96 ± 3.24	137.53 ± 12.28	169.05 ± 4.66	1.23 ± 0.03	0.20 ± 0 01	14 83 ± 0.48	0.19 ± 0.00	6.17 ± 0 04	3.47 ± 0.16	0.63 ± 0.02	0 15 ± 0 00	0 12 ± 0 02
FRUITS												
POWDER	24.59 ± 1.04**	94.92 ± 1.53**	120.67 ± 2.10**	0.97 ± 0 01**	0 40 ± 0 01	17 08 ± 0 30	0.15 ± 0 01**	4.80 ± 0 07**	4 08 ± 0.11	0.43 ± 0 01**	0 09 ± 0 01**	0 14 ± 0 01*
PET ETHER EXTRACT	59 07 ± 0.38*	107 44±0 33**	133.30 ± 0.71**	1 05 ± 0 02**	0 33 ± 0 00	17 00 ± 0.37	0 11 ± 0 00**	2 85 ± 0.04**	3 07 ± 0.02*	0.27 ± 0 00**	0.03 ± 0 00**	0 07 ± 0 00
METHANOLIC EXTRACT	50.48 ± 0.71**	119.94±0.32**	124.50 ± 1.28**	1.15 ± 0.01*	0.30 ± 0.00	20 25 ± 0 21	0 16 ± 0.00**	5.01 ± 0 04**	4.52 ± 0.06	0.47 ± 0.01**	0 10 ± 0 00**	0.17 ± 0 01
AQUEOUS EXTRACT	56.02 ± 0.31*	142.23 ± 0.49*	113.85 ± 1.49**	1.18 ± 0.01*	0.28 ± 0.01	22.50 ± 0.22	0.15 ± 0.00**	4.74 ± 0 03**	3.22 ± 0.05*	0 53 ± 0.00**	0 11 ± 0 00**	0 17 ± 0 01
TOTAL AQUEOUS EXTRACT	27.14 ± 1.01**	48.97 ± 1.25**	125.70 ± 1.24**	1.09 ± 0.01*	0.25 ± 0.01	22 75 ± 0 38	0 16 ± 0 01**	4.91 ± 0 05**	3 42 ± 0 06*	0.48 ± 0 02**	0.14 ± 0 01*	0 14 ± 0 01*
LEAVES												
POWDER	25 96 ± 1.17**	79.03 ± 2 21**	81.57 ± 1.78**	0.87 ± 0.03**	0 34 ± 0.01	11 50 ± 0 29**	0.13 ± 0 01**	4.03 ± 0 06**	4 93 ± 0.04	0 62 ± 0 02*	0 10 ± 0 01**	0 19 ± 0 01
TOTAL AQUEOUS EXTRACT	65 84 ± 2 74	226 46 ± 2 29	221.97 ± 5 85	1.24 ± 0 02*	0 27 ± 0 01	11 88 ± 0 20**	0 15 ± 0.00**	4.52 ± 0.04**	5 17 ± 0.07	0 61 ± 0 01**	0 09 ± 0 00**	0 19 ± 0 01
STEM BARK												
POWDER	44.98 ± 1.08**	96.46 ± 1.96**	106.33 ± 3.13*	0.91± 0.02**	0.39 ± 0.01	16.75± 0.38	0.15 ± 0.00**	3.06 ± 0.05**	6.08 ± 0.04	0.51 ± 0.01**	0.06 ± 0 00**	0 07 ± 0.01**
PET ETHER EXTRACT	47.41 ± 0.39**	125.05 ± 1.62*	103 33 ± 1.34*	1.03 ± 0.01**	0 26 ± 0 00	16 42 ± 0 20*	0.17 ± 0 00**	3 26 ± 0 04**	6 95 ± 0.27	0 50 ± 0.02**	0 06 ± 0 00**	0 07 ± 0 01**
METHANOLIC EXTRACT	39.37 ± 0.55**	145 69 ± 0,51*	163.13 ± 0.66*	1.02 ± 0.02**	0.25 ±0 00	19 75 ± 0 54	0 11 ± 0 00**	1 83 ± 0 02**	2.80 ± 0 04**	0.29 ± 0.01**	0 02 ± 0 00**	0 05 ± 0 00**
AQUEOUS EXTRACT	65.84 ± 0.64	128.15 ± 0.39*	95 90 ± 0.20**	0.96 ± 0.01**	0.30 ± 0 00	21.58 ± 0.35	0 10 ± 0.00**	2 53 ± 0 03**	3.98 ± 0 08	0.53 ± 0 00**	0 04 ± 0.00**	0 07 ± 0 01**
TOTAL AQUEOUS EXTRACT	50 43 ± 1.33**	130.95 ± 2.42*	118.83 ± 2.98**	1.00 ± 0.01**	0.24 ± 0.01	15.17 ± 0 38*	0 16 ± 0 00**	4.70 ± 0.04**	6.05 ± 0.10	0.50 ± 0.01**	0 05 ± 0 00**	0 12 ± 0 02*
ROOTS												
POWDER	45 55 ± 1.44**	131.85 ± 2.03*	163.10 ± 1.21*	0.95 ± 0.03**	0.35 ± 0.01	14.75 ± 0.38*	0 19 ± 0.01*	5.83 ± 0.04**	3 60 ± 0.03*	0.62 ± 0.02*	0 16 ± 0 01*	0.12 ± 0.01*
METHANOLIC EXRTRACT	20.75± 0.32**	35.31 ± 1.42**	103.63 ± 0.81**	0.95 ± 0.01**	0.28 ± 0.00	16.92 ± 030	0 19 ± 0 01*	5.18 ± 0 10**	4 15 0 03	0.59 ± 0.02*	0.13 ± 0 01*	0 11 ± 0 00*
AQUEOUS EXTRACT	15.84 ± 0.36**	32.74 ± 1.22**	102.70 ± 1.16**	1.01 ± 0.01**	0.33 ± 0.01	21.08 ± 0.40	0 16 ± 0.01**	4.48 ± 0.04**	5.25 ± 0.06	0.47 ± 0.01**	0.11 ± 0.01**	0 07 ± 0.01**
TOTAL AQUEOUS EXTRACT	47.14 ± 0.84**	95.44 ± 2.88**	79.53 ± 1.01**	1.19 ± 0.02*	0.25 ± 0.01	20.58 ± 0.47	0.17 ± 0.01**	5 24 ± 0.04**	4 03 ± 0.11	0.60 ± 0.01*	0 13 ± 0.01*	0.12 ± 0 01*
Fcalculated	143.67	192.19	236.95	10.26	83 33	94 40	36 67	578.00	139.67	48.21	468 75	20 00
5% ALLOWANCE	6.41	16.52	11.56	0.18	0.03	1.77	0.02	0 25	0 49	0 08	0 03	0 05
Fcritical = 2.30(P < 0.01); NOT SIGNIFICANT REDUCTION =*; SIGNIFICANT REDUCTION=**												

TABLE:27 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON NORMAL HEPATIC FUNCTIONS

GROUP	SERUM BIOCHEMICAL PARAMETERS , MEAN ± SEM					URINARY BIOCHEMICAL PARAMETERS , MEAN ± SEM						
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	TBil (mg/dl)	DBil (mg/dl)	URINE VOLUME (ml)	ASCORBIC ACID (g/dl)	CHOLESTE-ROL (mg/dl)	GLUCOSE (mg/dl)	TBil (mg/dl)	DBil (mg/dl)	TOTAL PROTEIN (g/dl)
CONTROL	56.96 ± 3.24	137,53 ± 12.28	169.05 ± 4.66	1.23 ± 0.03	0.20 ± 0 01	14.83 ± 0 46	0 19 ± 0 00	6.17 ± 0.04	3 47 ± 0.16	0 63 ± 0 02	0 15 ± 0 00	0 12 ± 0 02
SIDA ACUTA (AERIAL PARTS)												
POWDER	45 35 ± 1 09*	102 62 ± 3 08**	113 70 ± 2.14**	1 08 ± 0 03*	0 37 ± 0 01	14 25 ± 0 38*	0 18 ± 0 01*	4 42 ± 0 05 **	4 08 ± 0 04	0 49 ± 0 01**	0 07 ± 0 00**	0 11 ± 0 00 *
METHANOLIC EXTRACT	45 23 ±2 13*	101 31 ± 5 15**	129 80 ± 5.87**	1 42 ± 0 02*	0 22 ± 0 01*	19 13 ± 0 27	0 18 ± 0 00*	4 50 ± 0 03 **	4 72 ± 0 05	0 45 ± 0 01**	0 07 ± 0 00**	0 10 ± 0 00 *
AQUEOUS EXTRACT	54 71 ± 7 45*	82 00 ± 3 85 **	185.40 ± 7.12*	1.31 ± 0 04*	0 18 ± 0 01*	14 50 ± 0 22*	0 19 ± 0 01*	4 57 ± 0 04 **	4 30 ± 0 04	0.49 ± 0 00**	0 06 ± 0 00**	0 10 ± 0 00 *
SIDA ACUTA (ROOTS)												
POWDER	41 25 ± 0 84**	123 38 ± 1.66*	121.27 ± 2.17**	1 03 ± 0.01**	0 42 ± 0 01	21 08 ± 0 03	0 11 ± 0 01**	3 65 ± 0 03 **	5 60 ± 0 03	0 46 ± 0 02 **	0 09 ± 0 01**	0 12 ± 0 01 *
METHANOLIC EXTRACT	40 83 ± 2 56**	134.18 ± 6 13 *	154 75 ± 16 53*	1 28 ± 0 03*	0 20 ± 0 01*	20 33 ± 0 28	0 10 ± 0 00 **	3 54 ± 0 02 **	6 28 ± 0 03	0 46 ± 0 01 **	0 09 ± 0 00**	0 14 ± 0 00*
AQUEOUS EXTRACT	38 82 ± 4 01**	134 00 ± 6.15 *	155 50 ± 4.58 *	1 30 ± 0 07*	0 23 ± 0 01*	18 75 ± 0 31	0 09 ± 0 00 **	4 28 ± 0 05 **	5 73 ± 0 02	0 39 ± 0 01 **	0 10 ± 0 00 **	0 14 ± 0 00 *
SIDA ACUTA (WHOLE PLANT)												
TOTAL AQUEOUS EXTRACT	32 24 ± 0 58**	69 54 ± 1.65 **	115.73 ± 1.43**	1.54 ± 0.01	0 21 ± 0 00 *	16 67 ± 0 22	0 10 ± 0 01 **	4 09 ± 0.02 **	4 99 ± 0 03	0.42 ± 0 01 **	0 10 ± 0 02**	0 12 ± 0 01*
SIDA CORDIFOLIA (WHOLE PLANT)												
POWDER	43 73 ± 1 03*	149 64 ± 2 67 *	65 83 ± 1.26 **	1 54 ± 0 02	0 58 ± 0 01	20 33 ± 0 44	0 16 ± 0 01 *	4 08 ± 0 04 **	3 08 ± 0.04 *	0 50 ± 0 01 **	0 11 ± 0 01 **	0 10 ± 0 01 *
METHANOLIC EXTRACT	41 12 ± 2 11**	154 67 ± 2 70 *	69 95 ± 2 88 **	1 19 ± 0 04*	0 44 ± 0 02	19 75 ± 0 38	0 18 ± 0 01 *	4 98 ± 0 04 **	4,01 ± 0 05	0 55 ± 0 02 **	0 11 ± 0 01 **	0 12 ± 0 01 *
AQUEOUS EXTRACT	16 75 ± 0 55*	43 73 ± 1 70**	127.90 ± 2 66**	1 00 ± 0.02**	0.37 ± 0 02	21 25 ± 0 38	0 16 ± 0 01**	4 25 ± 0 02 **	3 03 ± 0.04 **	0 52 ± 0 01 **	0 11 ± 0 01 **	0 13 ± 0 01 *
TOTAL AQUEOUS EXTRACT	28.69 ± 0 46**	88.00± 4.42**	116.43 ± 2.90**	1.31 ± 0.03*	0 24 ± 0 01*	20.25 ± 0 31	0.13 ± 0.00**	4.28 ± 0.11**	2 90 ± 0 06 **	0.47 ± 0.00 **	0.07 ± 0 00 **	0 14 ± 0.01 *
SIDA RHOMBIFOLIA (AERIAL PARTS)												
POWDER	40 50 ± 0 93**	117 98 ± 3 06*	84 70 ± 2.36 **	1 20 ± 0 02*	0 55 ± 0 01	22 33 ± 0 44	0 16 ± 0 00 **	3 14 ± 0 02 **	3 05 ± 0 03 **	0 54 ± 0.01 **	0 11 ± 0 01 **	0 04 ± 0 01 **
METHANOLIC EXTRACT	14.78 ± 1 03*	109 79 ± 18 25*	107 17 ± 8.98**	1 38 ± 0.10*	0 25 ± 0.01*	24 13 ± 0 27	0 14 ± 0 00 **	2 20 ± 0 02 **	4 33 ± 0 07	0.47 ± 0 00 **	0 08 ± 0 00 **	0 02 ± 0 00 **
AQUEOUS EXTRACT	38 22 ± 2 96 **	120.62 ± 9.90*	122 45 ± 6 92**	1 23 ± 0.04*	0 22 ± 0 01*	18 88 ± 0 27	0.13 ± 0 00 **	3 16 ± 0 04 **	2 97 ± 0 07 **	0.48 ± 0 01 **	0 06 ± 0 00 **	0 03 ± 0 00 **
SIDA RHOMBIFOLIA (ROOTS)												
POWDER	33.77 ± 0 81**	126 46 ± 0 69	100.63 ± 1.30**	1.11 ± 0.03*	0.49 ± 0 03	16 33 ± 0 33*	0 20 ± 0 01*	5.62 ± 0 04 **	5 06 ± 0.04	0.62 ± 0.01*	0 23 ± 0 01	0 16 ± 0 00
METHANOLIC EXTRACT	25.47 ± 1.61**	74.92 ± 3.37**	120.33 ± 7.28**	1.08 ± 0.04*	0.16 ± 0.01*	15.25 ± 0.21*	0.23 ± 0.01	5.60 ± 0.02**	4.95 ± 0.09	0.77 ± 0.02	0.14 ± 0 00*	0 20 ± 0.00
AQUEOUS EXTRACT	76.71 ± 4 36	122 38 ± 5.63*	69 00 ± 4.83**	1 40 ± 0.04*	0 18 ± 0 01*	20.75 ± 0 36	0 19 ± 0 00*	3 49 ± 0 05**	3 55 ± 0 07*	0 54 ± 0 0**	0 07 ± 0 00**	0 10 ± 0 00*
SIDA RHOMBIFOLIA (WHOLE PLANT)												
TOTAL AQUEOUS EXTRACT	39 69 ± 1.59**	68.51 ± 1 17**	131.13 ± 3.47**	1.18 ± 0 02*	0.22 ± 0.01*	21 17 ± 0 01	0.19 ± 0 01*	5.58 ± 0.03**	5 03 ± 0.04	0.63± 0.01*	0 14 ± 0 0*	0 17± 0 01
Fcalculated	27 42	21 78	26.25	15.49	100 00	73 18	85 45	508 67	152 44	52 63	23 81	65 00
5% Allowance	13.33	32 31	29.30	0.20	0 07	1 66	0 02	0 22	0 42	0 06	0 04	0 03

Fcritical = 2.19(P<0.01), NOT SIGNIFICANT REDUCTION= *, SIGNIFICANT REDUCTION= **

leaves of M. pterygosperma, whereas all the other biochemical parameters are within the limits like those of control, indicating their non-toxic nature at the selected doses.

3.3.4 Assessment of Hepatoprotective Activity

Liver disorders which are so prevalent, have hardly any satisfactory remedy. An actual curative agent has not yet been found out and the treatment available is only symptomatic with the risk of relapses and side effects. Drugs claimed to possess hepatoprotective and antihepatotoxic effect can be evaluated by studying their ability to bring back the biochemical parameters involving hepatic functions to normal levels in an artificial chemical or drug induced toxicity in different experimental animal models. The chemical (CCl_4) induced hepatotoxicity in albino rats is the preliminary model for studying hepatoprotective or antihepatotoxic activity. Therefore, in the present studies, the selected plant drugs were evaluated for their hepatoprotective effects against chemical (CCl_4) and drug (paracetamol and rifampicin) induced hepatotoxicities in albino rats. In the present investigations, the evaluation of hepatoprotective activity of drug samples was first determined on the basis of reduction in the elevated levels of serum biochemical parameters due to intoxication which is followed by the histopathological studies of the livers of

the groups of rats treated with test samples having maximum activity as a supportive measure of activity.

i. Effect of Selected Plant Drugs on Carbon Tetrachloride Induced Hepatotoxicity

Carbon tetrachloride, a widely used hepatotoxin is known to cause liver damage due to free radical formation during its metabolism by hepatic microsomes which in turn causes peroxidation of cellular membranes leading to necrosis of hepatocytes.[187] The efficacy of any hepatoprotective drug mainly depend on its capacibility of either reducing the harmful effects or in maintaining the normal hepatic physiological mechanisms which have been disturbed by a hepatotoxin. In present studies, effects of selected plant drugs were monitored by estimating various biochemical moieties like serum transminase such as serum glutamate pyruvate transminase (SGPT), serum glutamate oxaloacetate transminase (SGOT), serum alkaline phosphatase (ALKP) serum bilirubin like total bilirubin (TBil) and direct bilirubin (DBil) levels, which gives an idea regarding the functional state of the liver.[188]

Carbon tetrachloride intoxication in normal rats elevated the levels of serum biochemical parameters i.e. SGPT (56.96 to 725.51 U/ml), SGOT (137.53 to 1160.77 U/ml), ALKP (169.05 to 456.70 U/l), TBil (1.23 to 3.55 mg/dl), and DBil (0.20 ro 1.50 mg/dl) significantly ($P < 0.01$), indicating

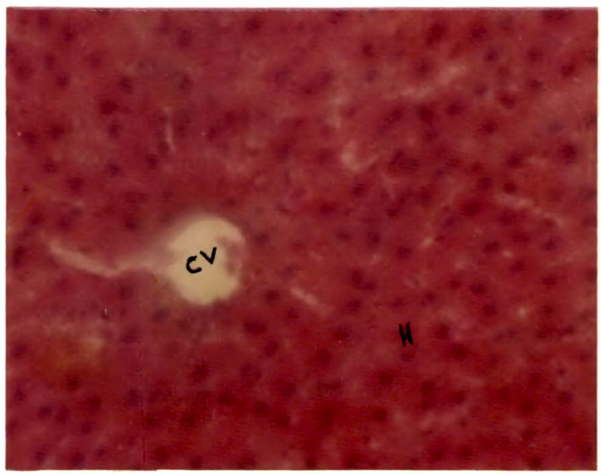


Fig.25 Photomicrograph of Normal Rat Liver Section
CV=Central Vein H=Hepatocytes

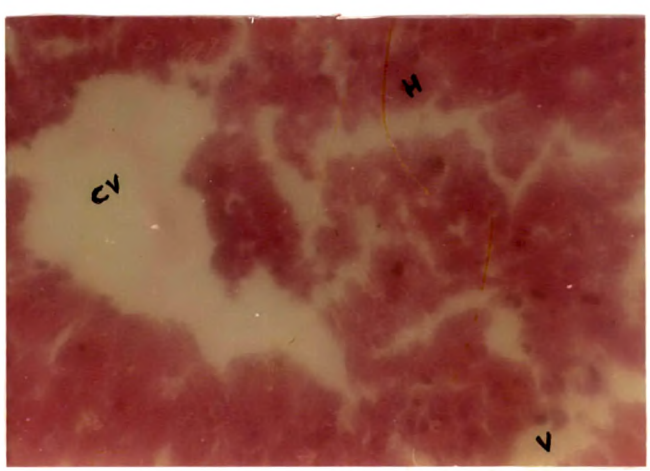


Fig.26 Photomicrograph of CCl_4 Intoxicated Rat Liver Section
CV=Central Vein H=Hepatocytes V=Vacuoles

acute hepatocellular damage and biliary obstruction. Administration of silymarin to CCl_4 intoxicated rats almost normalised the elevated levels of serum biochemical parameters (SGPT - 98.73%, SGOT - 98.49%, ALKP - 106.40%, TBil - 122.41%, and DBil - 96.92%) as represented in Table 28-32.

Histopathological examination of liver sections of the control group showed normal cellular architecture with distinct hepatic cells, sinusoidal spaces and central vein (Fig.25). The liver sections of CCl_4 intoxicated group showed complete disarrangement of normal hepatic cells with intense centrilobular necrosis and vacuolisation. Fatty degeneration was also observed in areas other than the centrilobular ones with mononuclear infiltration (Fig.26).

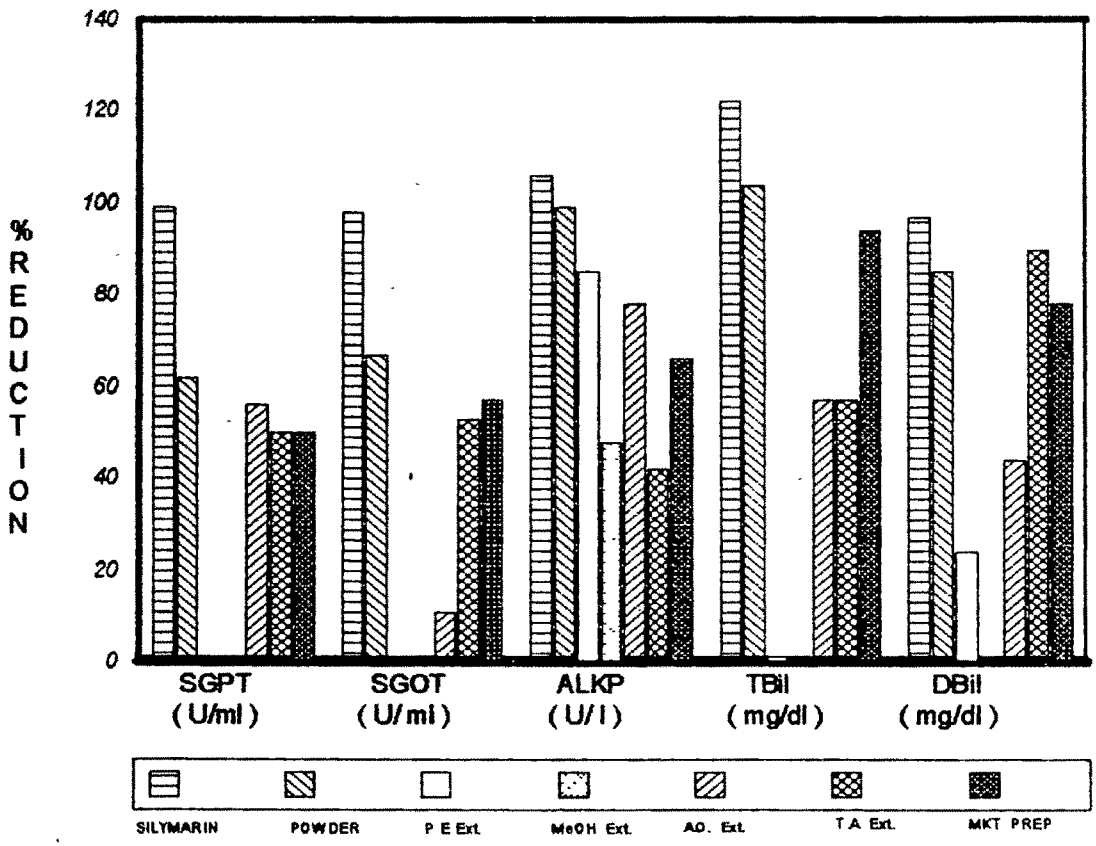
(a) Effect of rhizomes of C. orchioides: Effect of powdered drug, extracts and marketed preparation of rhizomes of C. orchioides on CCl_4 intoxicated rats revealed a significant reduction ($P<0.01$) in the levels of SGPT (61.66%), SGOT (66.83%), ALKP (98.86%), TBil (103.88%), and DBil (85.38%) in rats treated with the powdered drug when compared to those of CCl_4 intoxicated group (Table 28, Fig.27). The group treated with petroleum ether extract did not show any significant reduction ($P<0.01$) in serum biochemical parameters except in ALKP (85.24%), and DBil (23.85%) levels. The rats treated with methanolic extract showed insiginficant reduction in the

TABLE. 28 : EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON CCl_4 INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	56.96 ± 3.24	137.53 ± 12.28	169.05 ± 4.66	1.23 ± 0.03	0.20 ± 0.01
CCl_4	725.51 ± 38.03	1160.77± 52.08	456.70 ±13.15	3.55 ±0.11	1.50 ± 0.03
SILYMARIN	65.45 ± 1.54* (98.73)	152.95 ±2.47* (98.49)	150.63 ±1.54* (106.40)	0.71 ±0.02* (122.41)	0.24 ± 0.01* (96.92)
POWDER	313.29 ± 2.41* (61.66)	476.97 ±4.92* (66.83)	172.33 ±2.14** (98.86)	1.14 ±0.02** (103.88)	0.39 ± 0.02** (85.38)
PET. ETHER EXTRACT	1540.59 ±35.55 (-)	1217.69 ±55.09 (-)	211.50±18.73** (85.24)	3.53 ±0.10 (0.86)	1.19 ± 0.02* (23.85)
METHANOLIC EXTRACT	1905.10 ±74.32 (-)	1738.00 ±52.32 (-)	319.33 ±11.47* (47.76)	3.60 ±0.16 (-)	2.00 ± 0.12 (-)
AQUEOUS EXTRACT	351.27 ± 19.55* (55.98)	1051.15 ±43.46 (10.71)	233.00 ±14.63** (77.77)	2.23 ±0.24* (56.90)	0.93 ± 0.02* (43.85)
TOTAL AQUEOUS EXTRACT	389.80 ± 9.12* (50.21)	622.13 ±9.89* (52.64)	336.64 ±3.29 (41.74)	2.22 ±0.12* (57.33)	0.33 ± 0.01** (90.00)
MARKETED PREPARATION	388.47 ±4.39* (50.41)	579.31 ± 3.62* (56.83)	266.90± 1.90** (65.98)	1.37 ± 0.01** (93.97)	0.48 ± 0.01* (78.46)
$F_{calculated}$	*438.39*	*241.47*	*16.71*	*42.00*	*207.63*
5%Allowance	*149.38*	*165.04*	*123.18*	*0.92*	*0.21*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : CCl_4 : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 27 EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



levels of all the biochemical parameters except that of ALKP (47.76%) when compared to that of CCl_4 treated group. In groups treated with aqueous and total aqueous extracts and marketed preparation, significant reduction ($P < 0.01$) in biochemical parameters was observed when compared to those of CCl_4 treated group. When all the test groups were compared, the group treated with the powdered rhizomes showed maximum hepatoprotective activity in terms of reduction in the elevated levels of serum biochemical parameters due to CCl_4 intoxication. The rats treated with the powdered rhizomes also showed reduction, comparable to those of silymarin in elevated levels of ALKP, TBil & DBil.

Histopathological examination of liver sections of the rats treated with powdered rhizomes of C. orchioides, which could protect the CCl_4 intoxication, as evidenced by absenece of necrosis, low infiltration in inflammatory cells, less vacuole formation and a marked regenerative process indicating the presence of normal hepatic cords confirmed its activity (Fig.28).

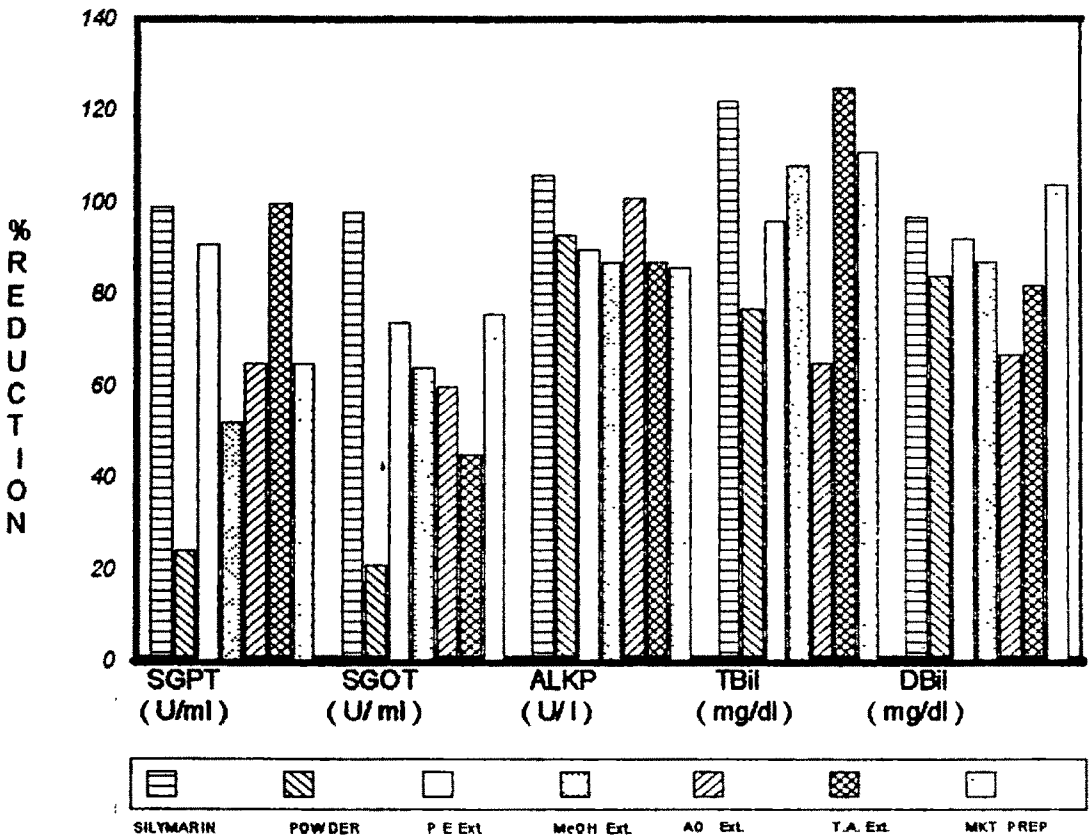
(b) Effect of whole plant of F. indica: The rats treated with the powdered drug, extracts and marketed preparation of the whole plant of F. indica showed a significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters compared to those treated with CCl_4. (Table 29, Fig. 29). These observations showed maximum significant

TABLE. 29 : EFFECT OF FUMARIA INDICA WHOLE PLANT ON CCl_4 INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	56.96 ± 3.24	137.53 ± 12.28	169.05 ± 4.66	1.23 ± 0.03	0.20 ± 0.01
CCl_4	725.51 ± 38.03	1160.77± 52.08	456.70 ±13.15	3.55 ±0.11	1.50 ± 0.03
SILYMARIN	65.45 ± 1.54* (98.73)	152.95 ±2.47* (98.49)	150.63 ±1.54* (106.40)	0.71 ±0.01* (122.41)	0.24 ± 0.01* (96.92)
POWDER	567.84 ± 9.46* (23.58)	941.24 ±11.73* (21.45)	187.83 ±4.08** (93.47)	1.75 ±0.03* (77.16)	0.41 ±0.01* (83.85)
PET. ETHER EXTRACT	119.35 ±11.57** (90.67)	405.22 ±24.69* (73.84)	198.25 ±21.89** (89.85)	1.32 ±0.14* (96.12)	0.30 ±0.01** (92.31)
METHANOLIC EXTRACT	377.41 ±43.41* (52.07)	503.85 ±46.44* (64.20)	206.85 ±9.95* (86.86)	1.04 ±0.04** (108.19)	0.37 ±0.01* (86.92)
AQUEOUS EXTRACT	291.88 ±24.41* (64.86)	551.77 ±33.99* (59.52)	165.45 ±9.96** (101.25)	2.04 ±0.14* (65.09)	0.63 ±0.01* (66.92)
TOTAL AQUEOUS EXTRACT	56.68 ±1.87** (100.04)	705.08 ±3.83* (44.53)	206.70 ±3.46* (86.91)	0.64 ±0.02** (125.43)	0.43 ±0.01* (82.31)
MARKETED PREPARATION	290.90 ±6.02* (65.01)	385.08 ±4.71* (75.81)	210.15 ±4.04* (85.71)	0.98 ±0.02** (110.78)	0.15 ±0.01*** (103.85)
$F_{calculated}$	*124.00*	*149.92*	*83.58*	*121.75*	*637.50*
5%Allowance	*103.51*	*133.37*	*48.44*	*0.39*	*0.08*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : CCl_4 : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 29 EFFECT OF FUMARIA INDICA WHOLE PLANT ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



Photomicrographs of Liver Sections of Rats Treated With:

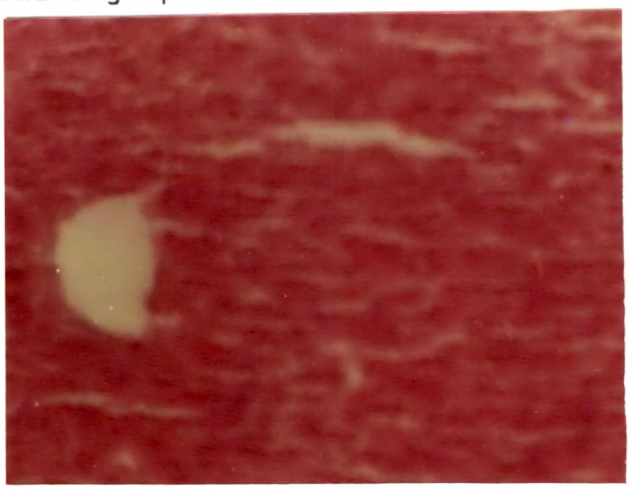


Fig.28 Powdered Rhizomes of C. orchioides and CCl_4

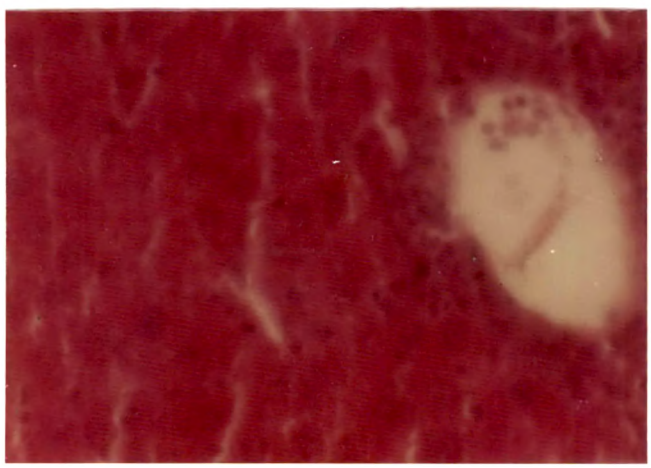


Fig.30 Pet. Ether Extract of Whole Plant of F. indica and CCl_4

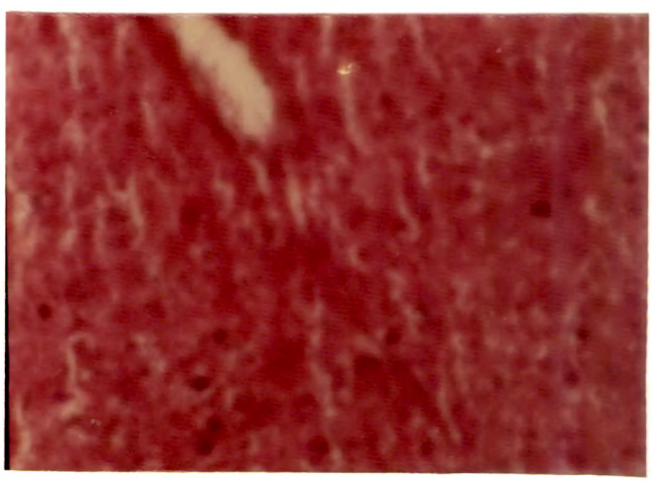


Fig.32 Powdered Roots of I. racemosa and CCl_4

reduction ($P < 0.01$) in the elevated levels of various determinations (SGPT - 90.67%, SGOT - 73.84%, ALKP - 89.85%, TBil - 96.12%, and DBil - 92.31%) in the group treated with the petroleum ether extract. This reduction in the elevated levels of serum biochemical parameters was followed by the total aqueous extract, marketed preparation, aqueous extract, methanolic extract and powdered drug when arranged in descending order in terms of activity. This indicates that the petroleum ether extract of the whole plant of F. indica protects the CCl_4 intoxicated liver to a greater extent than the other test samples. The group of rats treated with petroleum ether extract also showed reduction in the elevated levels of SGPT, ALKP and DBil comparable to those of silymarin treated group ($P < 0.01$).

Histopathological examination of liver sections of rats intoxicated with CCl_4 and treated with petroleum ether extract showed marked regenerative activity without any necrosis and steatosis, confirming its hepatoprotective activity against CCl_4 intoxication (Fig.30).

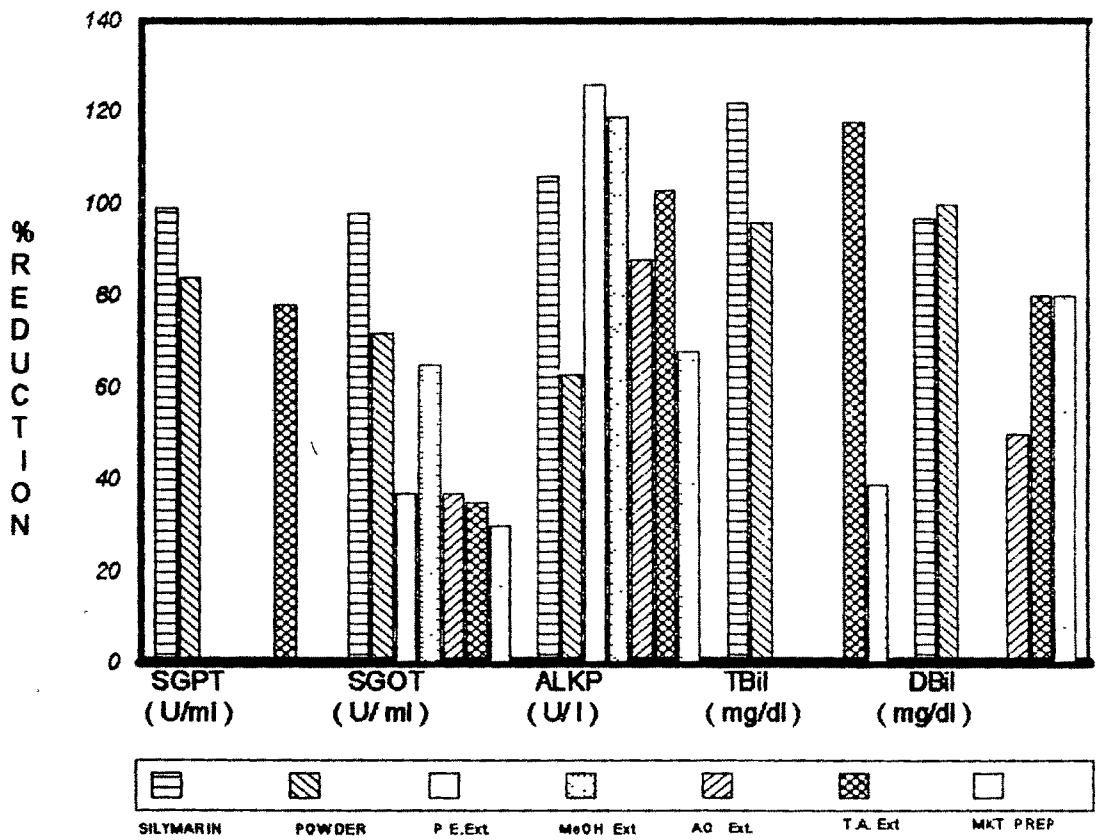
(c) Effect of roots of I. racemosa: The effect of powdered drug, extracts and marketed preparation of the roots of I. racemosa on CCl_4 induced hepatotoxicity showed a significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters in rats treated with the powdered drugn and total aqueous extract when compared to those of

TABLE. 30: EFFECT OF INULA RACEMOSA ROOTS ON CCl_4 INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	56.96 ± 3.24	137.53 ± 12.28	169.05 ± 4.66	1.23 ± 0.03	0.20 ± 0.01
CCl_4	725.51 ± 38.03	1160.77± 52.08	456.70 ±13.15	3.55 ±0.11	1.50 ± 0.03
SILYMARIN	65.45 ± 1.54* (98.73)	152.95 ±2.47* (98.49)	150.63 ±1.54* (106.40)	0.71 ±0.01* (122.41)	0.24 ± 0.01* (96.92)
POWDER	163.26 ±2.78* (84.10)	422.08 ± 9.40* (72.19)	274.30 ± 5.78* (63.41)	1.33 ± 0.02* (95.69)	0.20 ± 0.01** (100.00)
PET. ETHER EXTRACT	782.90 ± 4.50 (-)	778.18 ± 3.45* (37.39)	93.97 ±3.15** (126.10)	3.82 ± 0.04 (-)	2.37 ± 0.02 (-)
METHANOLIC EXTRACT	891.59 ± 6.50 (-)	495.46 ± 2.91* (65.02)	114.17 ± 3.30** (119.08)	3.99 ± 0.06 (-)	1.99 ± 0.03 (-)
AQUEOUS EXTRACT	822.99 ± 3.79 (-)	785.96 ± 4.10* (36.63)	203.45 ± 4.24* (88.04)	3.98 ± 0.03 (-)	0.85 ± 0.10* (50.00)
TOTAL AQUEOUS EXTRACT	204.65 ± 3.03* (77.91)	800.08 ± 3.85* (35.25)	160.35 ± 2.91** (103.02)	0.81 ± 0.01** (118.10)	0.46 ± 0.01* (80.00)
MARKETED PREPARATION	775.88 ± 5.46 (-)	852.69 ± 3.06* (30.11)	262.42 ± 2.83* (67.54)	2.64 ± 0.03* (39.22)	0.46 ± 0.01* (80.00)
$F_{calculated}$	*746.61*	*349.19*	*386.47*	*872.86*	*504.88*
5%Allowance	*63.58*	*87.81*	*27.00*	*0.23*	*0.18*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : CCl_4 : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 31 EFFECT OF INULA RACEMOSA ROOTS ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



CCl_4 intoxicated group. (Table 30, Fig.31) The rats treated with petroleum ether, methanolic and aqueous extracts showed significant reduction ($P < 0.01$) only in the elevated levels of SGOT and ALKP. In addition to these, the group treated with the aqueous extract, also showed a significant reduction ($P < 0.01$) in DBil levels. The rats treated with the marketed preparation indicated significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters except that of SGPT. While comparing the activity of different test samples, it was observed that the powdered drug showed maximum hepatoprotective activity in terms of reduction in the elevated levels of serum biochemical parameters (SGPT - 84.10%, SGOT-72.19%, ALKP- 63.41%, TBil - 95.69%, DBil - 100.00%) followed by the total aqueous extract and marketed preparation.

The effect of powdered roots of I. racemosa on CCl_4 intoxication was also confirmed by histopathological studies on liver sections of rats treated with this test sample. These sections when compared to that of intoxicated ones showed protection as evidenced by the absence of necrosis, vacuolisation, steatosis and by the restoration of disarranged liver cell architecture to almost normal level (Fig.32).

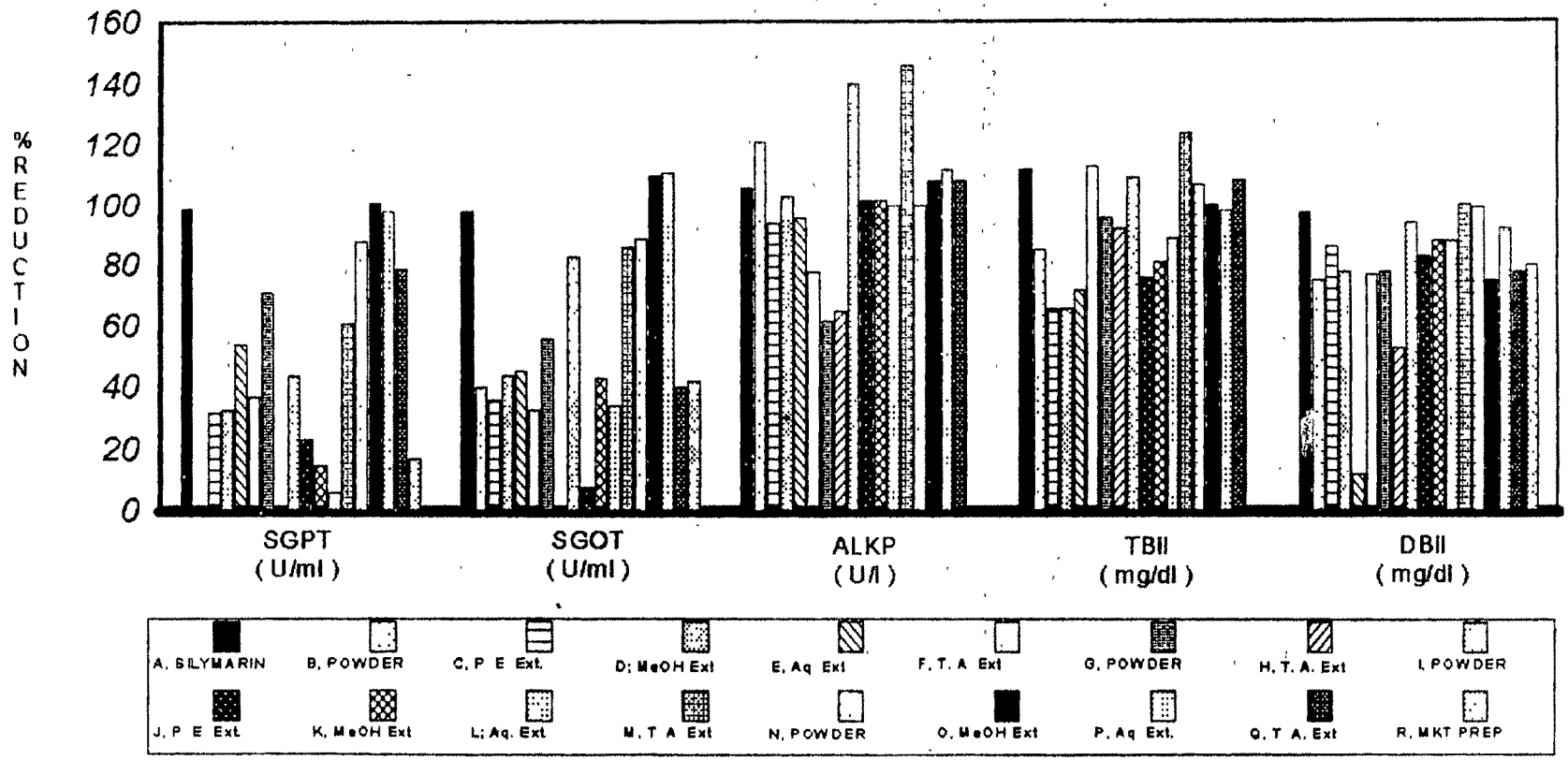
(d) Effect of different organs of M. pterygosperma: The effect of powdered organs, their extracts and marketed

TABLE:31 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	56.96±3.24	137.53±12.28	169.05±4.66	1.23±0.03	0.20±0.01
CARBON TETRACHLORIDE	725.57±38.03	1160.77±52.08	456.70±13.15	3.55±0.11	1.50±0.03
SILYMARIN	65.45±1.54* (98.73)	152.95±2.47* (98.49)	150.63±1.54* (106.40)	0.71±0.01* (122.41)	0.24±0.01* (96.92)
FRUITS					
POWDER	909.71±5.19 (-)	755.26±4.49* (39.63)	108.42±3.59*** (121.08)	1.57±0.04* (85.34)	0.53±0.02* (74.62)
PET. ETHER Ext.	514.18±6.28 (31.61)	796.60±6.76* (35.59)	184.99±3.29* (94.46)	2.01±0.03* (66.38)	0.38±0.02* (86.15)
METHANOLIC EXTRACT	503.75±4.62 (33.17)	711.98±6.73* (43.86)	159.76±3.12** (103.23)	2.01±0.03* (66.38)	0.49±0.02* (77.69)
AQUEOUS EXTRACT	363.56±6.73 (54.14)	700.72±3.07* (44.96)	131.36±2.44* (95.72)	1.87±0.02* (72.41)	1.34±0.02* (12.31)
TOTAL AQUEOUS Ext.	477.88±2.24 (37.04)	823.15±4.37* (33.00)	233.35±1.25* (77.65)	0.92±0.02* (113.36)	0.50±0.01* (76.92)
LEAVES					
POWDER	252.86±4.82** (70.70)	586.87±3.71* (56.09)	279.30±4.97* (61.67)	1.30±0.01* (96.98)	0.49±0.03* (77.69)
TOTAL AQUEOUS Ext.	2459.45±15.78 (-)	2731.49±15.22 (-)	269.97±3.31* (64.92)	1.42±0.03* (91.81)	0.81±0.02* (53.08)
STEM BARK					
POWDER	431.41±9.27 (43.99)	306.74±6.61* (83.46)	55.27±2.43*** (139.56)	1.03±0.02* (108.62)	0.28±0.01** (93.85)
PET.ETHER Ext.	574.22±3.04 (22.63)	1081.16±6.12* (7.78)	163.33±3.30** (101.99)	1.79±0.01* (75.86)	0.42±0.02* (83.08)
METHANOLIC EXTRACT	622.35±6.80 (15.43)	716.38±5.54* (43.43)	163.76±2.79** (101.84)	1.67±0.02* (81.03)	0.36±0.01* (87.69)
AQUEOUS EXTRACT	683.99±5.16 (6.21)	807.85±7.97* (34.49)	167.73±1.58** (100.46)	1.48±0.02* (89.22)	0.36±0.01* (87.69)
TOTAL AQUEOUS Ext.	317.70±3.07** (61.00)	276.59±4.97* (86.41)	37.40±1.16*** (145.77)	0.68±0.01** (123.71)	0.20±0.02** (100.00)
ROOTS					
POWDER	138.12±2.04** (87.86)	247.85±3.55* (89.22)	168.55±5.84** (100.17)	1.06±0.02* (107.33)	0.21±0.01** (99.23)
METHANOLIC EXTRACT	49.67±1.70** (101.09)	37.22±0.99*** (109.80)	146.73±2.08** (107.76)	1.23±0.02* (100.00)	0.53±0.01* (74.62)
AQUEOUS EXTRACT	67.26±1.71** (98.46)	27.78±1.21*** (110.73)	135.97±2.14** (111.50)	1.27±0.01* (98.28)	0.31±0.01** (91.54)
TOTAL AQUEOUS Ext.	195.82±2.00** (79.23)	748.54±5.24* (40.29)	145.08±1.81** (108.33)	1.04±0.03* (108.19)	0.48±0.01* (78.46)
MARKETED PREPARATION	612.82±3.04 (16.86)	727.85±3.92* (42.31)	467.53±2.62 (-)	3.63±0.04 (-)	0.46±0.02* (80.00)
Fcalculated	63.78	1969.80	665.56	544 93	423.53
5% Allowance	369.52	65 98	20.98	0.17	0.08

Fcritical = 2.13 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO CCl 4 = * , SILYMARIN = *** ; NOT SIGNIFICANT COMPARED TO SILYMARIN = **.

Fig. 33 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



A, B, C, D, E, F = FRUITS; G, H = LEAVES; I, J, K, L, M = STEMBARK; N, O, P, Q = ROOTS

preparation containing stem bark of M. pterygosperma on CCl_4 induced hepatotoxicity revealed significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters in different groups of rats when treated with the powdered roots aqueous and total aqueous extracts of roots; total aqueous extract of stem bark and powdered leaves compared to those of CCl_4 intoxicated group. (Table 31, Fig.33). The rats treated with the aqueous extract of roots showed maximum reduction in the elevated levels of serum biochemical parameters (SGPT - 98.46%, SGOT - 110.73%, ALKP - 111.50%, TBil - 98.28%, DBil - 91.54%) followed by methanolic extract, powdered roots and total aqueous extract of roots; total aqueous extract and powdered drug of stem bark; powdered leaves; total aqueous, methanolic, petroleum ether and aqueous extracts of fruits in descending order of activity. The rats treated with the powdered fruits showed significant reduction ($P < 0.01$) only in the elevated levels of SGOT, ALKP, TBil and DBil, the total aqueous extract of leaves in ALKP, TBil and DBil; and the marketed preparation in SGOT and DBil levels when compared to those of CCl_4 intoxicated group. The rats treated with the marketed preparation showed least hepatoprotective activity in terms of reduction in the elevated levels of serum biochemical parameters compared to that of other test groups. The rats treated with the aqueous extract of roots also showed comparable reduction in SGPT, ALKP and DBil levels and better significant reduction ($P < 0.01$) in SGOT levels when compared to those of silymarin

Photomicrographs of Liver Sections of Rats Treated With:

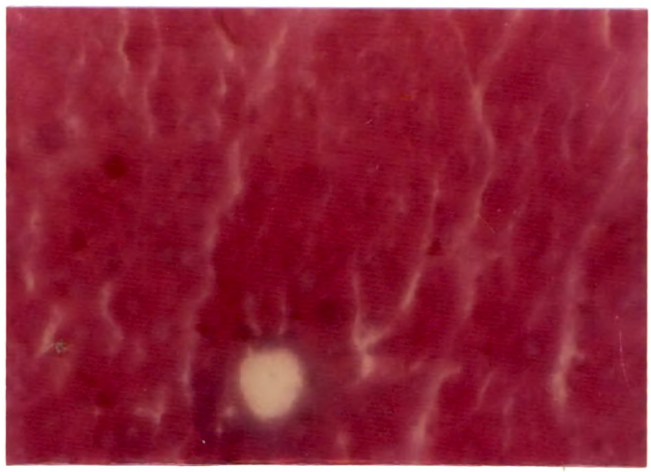


Fig.34 Aqueous Extract of Roots of M.pterygosperma and CCl_4

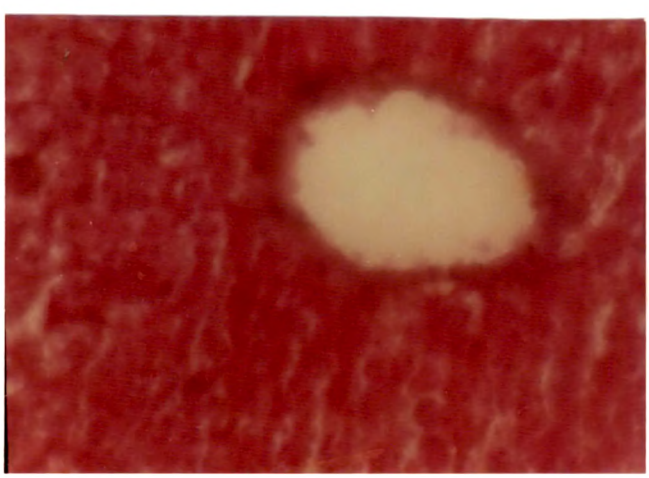


Fig.36 Powdered Roots of S. rhombifolia and CCl_4

treated group.

Maximum hepatoprotective activity, in terms of reduction in the elevated levels of serum biochemical parameters, shown by the aqueous extract of roots of M. pterygosperma was further supported by the histopathological examination of the liver sections of the rats treated with this extract against CCl_4 intoxication. The activity was evidenced by the absence of necrosis and vacuolisation with a marked regenerative activity showing almost normal liver cell architecture (Fig.34).

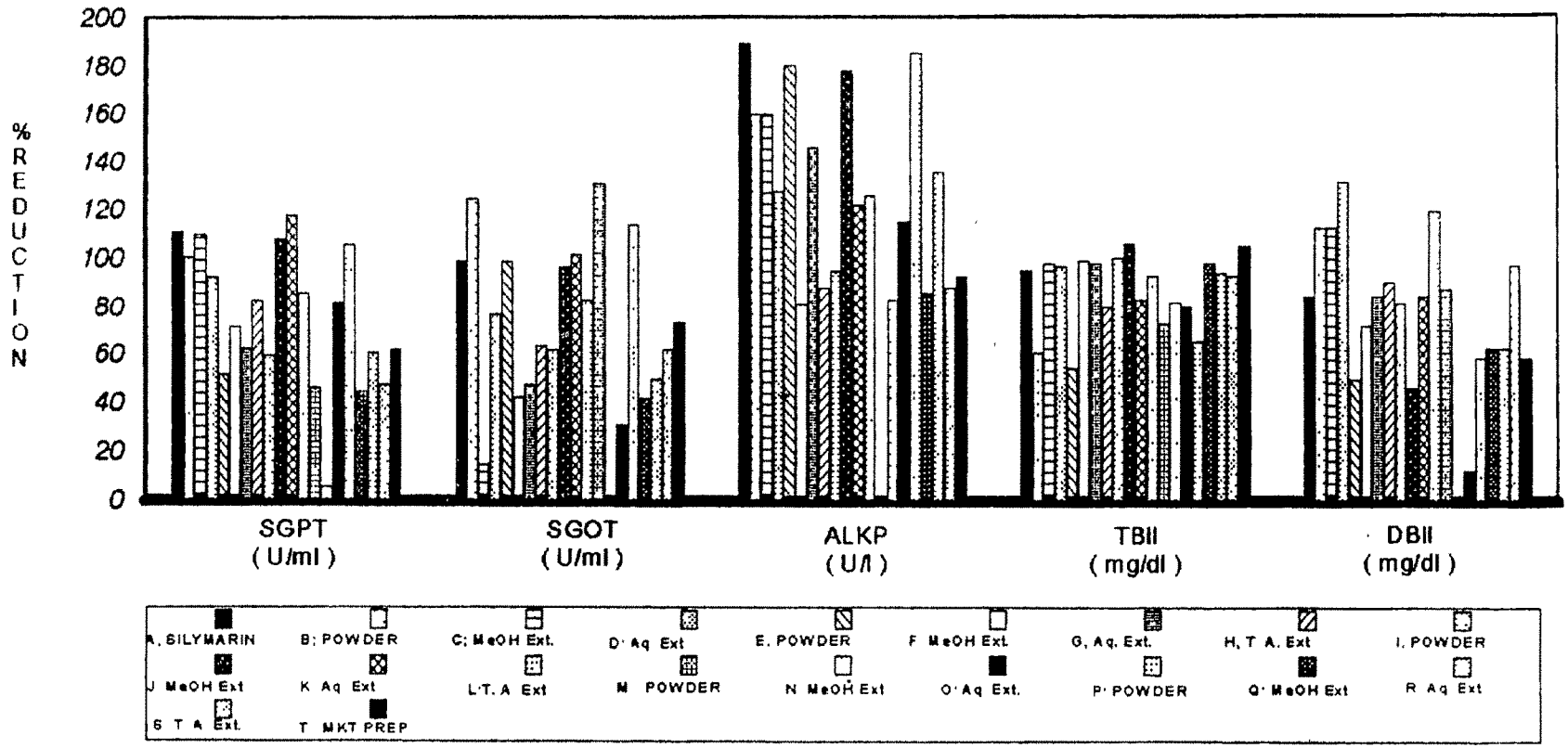
(e) Effect of different organs of various species of Sida: The effect of powdered drugs, extracts and marketed preparation of different organs of various species of Sida showed maximum significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters (SGPT 103.45%, SGOT 102.36%, ALKP 44.24%, TBil 107.76%, DBil 93.08%) in rats treated with the powdered roots of S. rhombifolia followed by the groups treated with methanolic extract of whole plant of S. cordifolia; powdered aerial parts of S. rhombifolia and whole plant of S. cordifolia; marketed preparation; powdered roots of S. acuta; aqueous extract of whole plant of S. cordifolia; aqueous extract and powdered drug of aerial parts of S. acuta when placed in descending order of activity. (Table 32, Fig.35) In groups treated with the methanolic and aqueous extracts of roots of

TABLE:32 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	56.96±3.24	137.53±12.28	169.06±4.66	1.23±0.03	0.20±0.01
CARBON TETRACHLORIDE	725.51±38.03	1160.77±52.08	456.70±13.15	3.55±0.11	1.50±0.03
SILYMARIN	65.45±1.54* (98.73)	152.95±2.47* (98.49)	150.63±1.54* (106.40)	0.71±0.01* (122.41)	0.24±0.01* (96.92)
SIDA ACUTA(AERIAL PARTS)					
POWDER	713.63±10.76 (1.78)	1052.05±13.78 (10.63)	274.92±6.50* (63.19)	1.40±0.07* (92.67)	0.16±0.02*** (103.08)
METHANOLIC EXTRACT	1398.24±35.48 (-)	1506.15±22.27 (-)	379.50±8.11* (26.84)	3.30±0.07 (10.78)	1.16±0.01* (26.15)
AQUEOUS EXTRACT	258.85±12.08* (69.80)	586.15±36.68* (56.16)	144.67±6.35** (108.48)	2.37±0.08* (50.86)	0.71±0.01* (60.77)
SIDA ACUTA(ROOTS)					
POWDER	331.96±7.68* (58.87)	430.90±5.22* (71.33)	281.23±6.11* (61.00)	1.11±0.02* (105.17)	0.11±0.00*** (106.92)
METHANOLIC EXTRACT	770.76±23.15 (-)	1128.72±36.06 (3.13)	515.33±8.59 (-)	5.03±0.12 (-)	1.63±0.02* (-)
AQUEOUS EXTRACT	1733.97±44.05 (-)	1464.74±37.88 (-)	542.33±13.86 (-)	4.83±0.08 (-)	1.73±0.01 (-)
SIDA ACUTA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	566.08±8.03* (23.85)	1236.03±10.85 (-)	200.08±1.98* (89 21)	1.80±0.03* (75.43)	0.72±0.01 (60.00)
SIDA CORDIFOLIA(WHOLE PLANT)					
POWDER	386.41±1.95* (50.72)	525.85±2.72* (62.05)	169.55±3.32** (99.83)	1.06±0.02* (107.33)	0.18±0.01** (101.54)
METHANOLIC EXTRACT	273.10±3.55* (67.67)	315.69±3.11* (82.59)	228.93±5.57* (78 91)	0.96±0.04** (111.64)	0.18±0.02** (101.54)
AQUEOUS EXTRACT	239.35±1.91* (72.72)	528.15±3.31* (61.83)	300 70±2.82* (54.04)	1.26±0.01* (98.71)	0.32±0.01* (90.77)
TOTAL AQUEOUS Ext.	679.00±30 19 (6.96)	907.44±30.57* (24.76)	429.67±7.68 (9.36)	3.05±0.12* (21.55)	0.95±0.02* (42..31)
SIDA RHOMBIFOLIA(AERIAL PARTS)					
POWDER	35.71±1.60** (103.13)	138.41±1.52** (99.91)	424.17±6.97 (11.31)	0.79±0.03** (118.97)	0.23±0.02** (97.69)
METHANOLIC EXTRACT	556.47±38.02* (25.28)	773.40±40 88* (37.86)	261.17±12.39* (67.97)	2.02±0.09* (65.95)	0.75±0.01* (57.69)
AQUEOUS EXTRACT	814.51±34.20 (-)	1222.05±39.26 (-)	477.83±9 91 (-)	2.77±0.08* (33.62)	1.25±0.02* (19.23)
SIDA RHOMBIFOLIA(ROOTS)					
POWDER	33.88±1.48** (103.45)	113.39±3.65** (102.36)	329.45±4.90* (44.24)	1.05±0.03** (107.76)	0.29±0.03** (93.08)
METHANOLIC EXTRACT	590.00±38.60* (20.27)	951.54±25.34* (20.45)	376.00±9.61* (28.05)	2.10±0.11* (62.50)	0.85±0.01* (50.00)
AQUEOUS EXTRACT	1214.41±28.69 (-)	1256.79±37.68 (-)	370.92±20.08* (29.82)	3.15±0.09* (17.24)	1.31±0.01* (14.62)
SIDA RHOMBIFOLIA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	620.49±4 95 (15.71)	1171 28±25 29 (-)	195.58±2 17* (90.78)	1.53±0.02* (87.07)	0 71±0.02* (60 77)
MARKETED PREPARATION	212.86±1 02* (76.68)	289.00±0 78* (85 20)	275.20±2.79* (63 10)	1.20±0.01* (101.29)	0 29±0.01** (93.08)
Fcalculated	385.05	328.66	207 37	323.49	1050.00
5% Allowance	113.67	128 56	42.37	0.35	0.08

Fcritical = 2.04 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO CCl 4 = * , SILYMARIN = *** , NOT SIGNIFICANT COMPARED TO SILYMARIN = **.

Fig. 35 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



SIDA ACUTA
B,C,D = AERIAL PARTS
E,F,G = ROOTS
H = WHOLE PLANT

SIDA CORDIFOLIA
I,J,K,L = WHOLE PLANT

SIDA RHOMBIFOLIA
M,N,O = AERIAL PARTS
P,Q,R = ROOTS
S = WHOLE PLANT

S. acuta, insiginficant reduction in the elevated levels of serum biochemical parameters was observed indicating their ineffectiveness against CCl_4 intoxication. The rats treated with the methanolic extract of aerial parts of S. acuta, aqueous extract of the roots and total aqueous extract of the whole plant of S. rhombifolia showed significant reduction ($P < 0.01$) only in the elevated levels of ALKP, TBil and DBil when compared to those of CCl_4 intoxicated group. The powdered drug and methanolic extract of the whole plant of S. cordifolia treated rats showed better hepatoprotective activity against CCl_4 intoxication compared to that of marketed preparation. The rats treated with the powdered roots of S. rhombifolia showed comparable reduction ($P < 0.01$) in the elevated levels of serum transaminases, ALKP and DBil compared to those of silymarin treated group.

Histopathological examination of liver sections of the rats treated with powdered roots of S. rhombifolia, which showed maximum reduction in the elevated levels of serum biochemical parameters among all the test samples, indicated the absence of necrosis and vacuolisation (Fig.36). The entire liver structure is restored to normal indicating that it offers a significant protection against CCl_4 induced hepatotoxicity.

Out of all the extracts and marketed preparations and powders of these plant durgs, the aqueous extract of the

roots of M. pterygosperma showed maximum hepatoprotective activity against CCl_4 intoxication in terms of reduction in the elevated levels of serum biochemical parameters followed by petroleum ether extract of whole plant of F. indica, powdered roots of S. rhombifolia and I. racemosa and powdered rhizomes of C. orchioides. The powdered drugs as well as the extracts showed better activity compared to that of marketed preparations against CCl_4 intoxication.

The hepatoprotective activity of these drugs might be due to their inhibitory effects on microsomal enzymes or on lipid peroxidation or due to their stimulatory effects on hepatic regeneration.

ii. Effect of Selected Plant Drugs on Paracetamol Induced Hepatotoxicity

Paracetamol, an analgesic and antipyretic agent is safe in recommended doses but produces hepatic necrosis when ingested in very large doses. It is metabolised in the liver primarily to glucuronide and sulphate conjugates. Paracetamol toxicity is due to the formation of toxic metabolites when a part of it is metabolised by cytochrome P_{450}. Induction of cytochrome P_{450} or depletion of hepatic glutathione is a prerequisite for paracetamol induced hepatotoxicity. Therefore, it is likely that protection against paracetamol is due to either inhibition of cytochrome P_{450} or promotion of its glucuronidation thereby causing quicker elimination of

paracetamol from the body fluids. In the present study the selected plant drugs were subjected to study the hepatoprotective activity against paracetamol induced acute hepatotoxicity.

Paracetamol, when administered in overdose, resulted in liver damage in albino rats as evidenced by significant elevation (P 0.01) in serum biochemical parameters, i.e. SGPT (58.98 to 265.28 U/ml), SGOT (137.53 to 356.00 U/ml), ALKP (182.67 to 313.49 U/l), TBil (0.88 to 3.42 mg/dl) and DBil (0.25 to 0.57 mg/dl). Administration of silymarin to paracetamol intoxicated rats almost normalised the elevated levels of serum biochemical parameters as evident from the control and silymarin treated groups (Table 33-37).

Paracetamol overdose is reported to produce hepatic necrosis in rats and mice.[189] The histopathological changes seen in human liver after paracetamol overdose are similar to those which can be induced in experimental animals.[190] Necrosis of hepatic cells are seen in the centrilobular areas in less severely affected cases, whereas wide areas of necrosis are seen in fulminant hepatic failure.[191] Histopathological examination of the liver sections of the rats treated with paracetamol indicated gross necrosis of the centrilobular hepatocytes characterised by fatty infiltration and vacuole formation indicating hepatic damage and peliosis (Fig. 37). The liver sections of the rats treated with

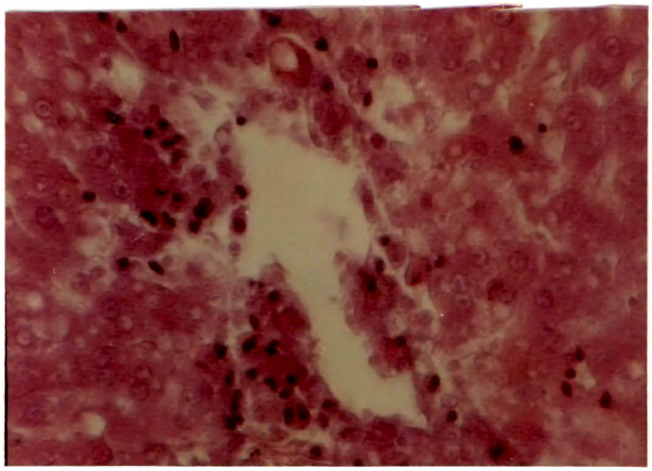


Fig.37 Photomicrograph of Paracetamol Intoxicated Rat Liver Section

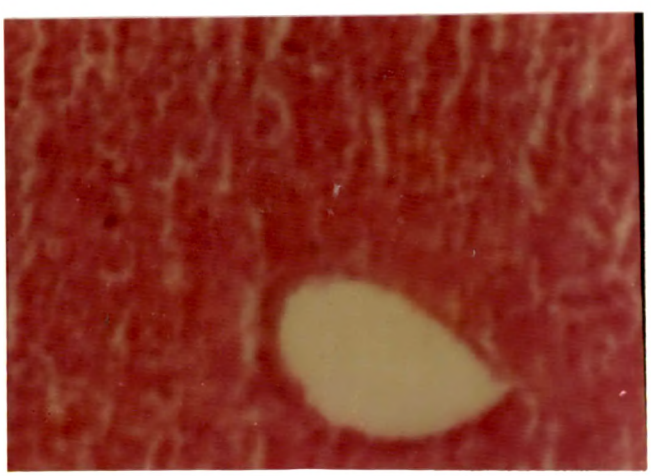


Fig.39 Photomicrograph of Liver Section of Rat Treated with Methanolic Extract of Rhizomes of C. orchioides and Paracetamol

paracetamol as well as the test samples were compared for the improvement caused by the test samples indicating their hepatoprotective activity on paracetamol intoxicated liver.

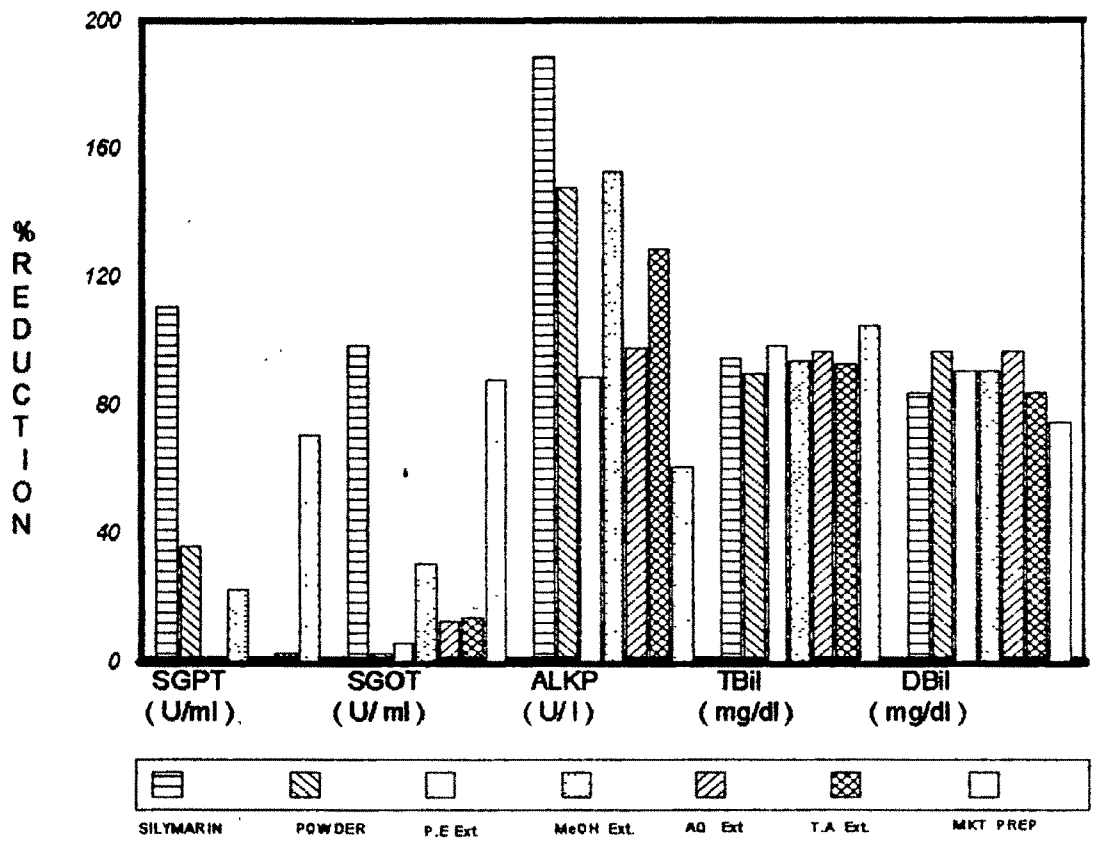
(a) Effect of rhizomes of C. orchioides: Effect of the powdered drug, extracts and marketed preparation of the rhizomes of C. orchioides against paracetamol intoxication in rats indicated that the group of rats treated with marketed preparation showed maximum reduction in the elevated levels of serum biochemical parameters (SGPT 70.91%, SGOT 87.70%, ALKP 60.74%, TBil 105.12%, DBil 75.00%) when compared to those of the groups treated with other test samples (Table 33, Fig.38). This was followed by the group of rats treated with methanolic extract, powdered rhizomes, total aqueous, aqueous and petroleum ether extracts when placed in descending order of activity in terms of reduction in the elevated levels of serum biochemical parameters. The group of rats treated with the methanolic extract showed better activity in comparison to the groups of rats treated with the powdered drug and the extracts. The group of rats treated with the powdered rhizomes and extracts showed significant reduction ($P<0.01$) only in the elevated levels of ALKP, TBil and DBil when compared to those of paracetamol intoxicated group. The groups treated with methanolic, total aqueous and petroleum ether extracts showed comparable reductions in the elevated levels of ALKP, TBil and DBil to those of silymarin treated group.

TABLE. 33: EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	58.98 ± 0.63	137.53 ± 1.27	182.67 ± 0.79	0.88 ± 0.02	0.25 ± 0.01
PARACETAMOL	265.28 ± 3.14	356.00 ± 5.17	313.49 ± 7.40	3.42 ± 0.17	0.57 ± 0.03
SILYMARIN	36.47 ± 1.16* (110.91)	139.06 ± 1.42* (99.30)	66.20 ± 0.57* (189.03)	1.00 ± 0.01* (95.28)	0.30 ± 0.01* (84.38)
POWDER	190.61 ± 3.82* (36.19)	350.33 ± 5.85 (2.60)	120.05 ± 1.13* (147.87)	1.13 ± 0.02** (90.16)	0.26 ± 0.01** (96.88)
PET. ETHER EXTRACT	411.92 ± 1.94 (-)	341.85 ± 0.89 (6.48)	196.80 ± 2.38*	0.90 ± 0.02** (99.21)	0.28 ± 0.01** (90.63)
METHANOLIC EXTRACT	216.82 ± 1.05 (23.49)	289.28 ± 1.42 (30.54)	113.67 ± 3.24** (152.74)	1.03 ± 0.02** (94.09)	0.28 ± 0.00** (90.63)
AQUEOUS EXTRACT	292.31 ± 3.01 (-)	327.74 ± 3.21 (12.94)	185.67 ± 3.49* (97.71)	0.95 ± 0.02** (97.24)	0.26 ± 0.01** (96.88)
TOTAL AQUEOUS EXTRACT	259.96 ± 2.06 (2.58)	326.46 ± 3.43 (13.52)	144.20 ± 2.33** (129.41)	1.05 ± 0.04** (93.31)	0.30 ± 0.00** (84.38)
MARKETED PREPARATION	119.00 ± 1.77* (70.91)	164.41 ± 1.94* (87.70)	234.03 ± 5.40 (60.74)	0.75 ± 0.02** (105.12)	0.33 ± 0.01** (75.00)
$F_{calculated}$	*33.84*	*12.18*	*4.65*	*186.36*	*65.56*
5%Allowance	*63.95*	*127.93*	*112.88*	*0.29*	*0.06*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : PARACETAMOL : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 38 EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON PARACETAMOL INDUCED HEPATOTOXICITY



The reduction in the elevated levels of serum biochemical parameters as obtained in case of group of rats treated with marketed preparation when compared to powdered drug and extracts were significantly ($P < 0.01$) high which might be due to the incorporation of some other component drugs of the polyherbal formulation. It was therefore, thought worthwhile only to compare between the activities of the powdered drug and different extracts of the rhizomes of C. orchioides. In the treatment of paracetamol intoxication, the methanolic extract being the most active among the test samples in terms of reduction in the elevated levels of serum biochemical parameters (SGPT 23.49%, SGOT 30.54%, ALKP 152.74%, TBil 94.09%, DBil 90.63%) was again subjected to histopathological examination. The paracetamol intoxicated rat liver sections were compared with those of the methanolic extract treated ones, which showed regenerative activity and slight sinusoidal dilatation confirming the hepatoprotective activity of the methanolic extract of the rhizomes of C. orchioides (Fig.39).

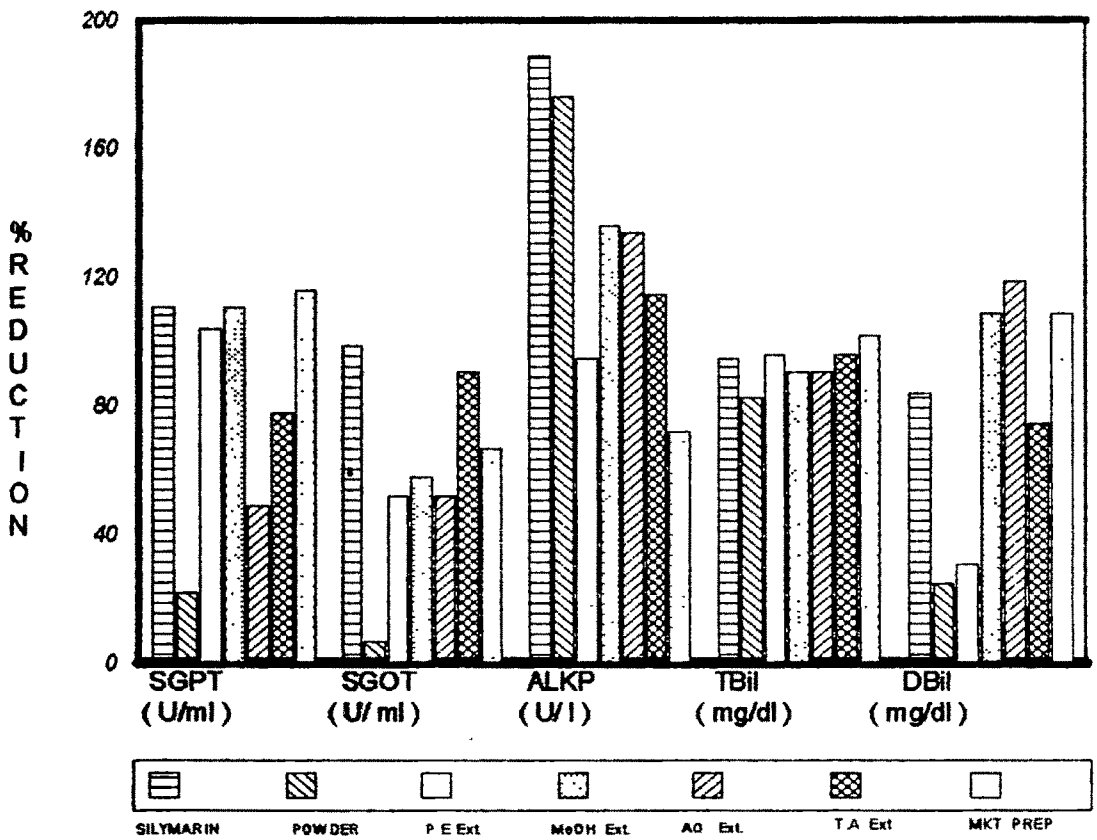
(b) Effect of whole plant of F. indica: Effect of the powdered drug, extracts and marketed preparation of the whole plant of F. indica against paracetamol induced hepatotoxicity indicated maximum, significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters (SGPT 77.95%, SGOT 91.28%, ALKP 155.04%, TBil 95.67%, DBil 75.00%) in rats

TABLE. 34 : EFFECT OF FUMARIA INDICA WHOLE PLANT ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	58.98 ± 0.63	137.53 ± 1.27	182.67 ± 0.79	0.88 ± 0.02	0.25 ± 0.01
PARACETAMOL	265.28 ± 3.14	356.00 ± 5.17	313.49 ± 7.40	3.42 ± 0.17	0.57 ± 0.03
SILYMARIN	36.47 ± 1.16* (110.91)	139.06 ± 1.42* (99.30)	66.20 ± 0.57* (189.03)	1.00 ± 0.01* (95.28)	0.30 ± 0.01* (84.38)
POWDER	219.94 ± 9.44 (21.98)	339.82 ± 8.77 (7.41)	83.15 ± 3.13** (176.07)	1.31 ± 0.03* (83.07)	0.49 ± 0.01* (25.00)
PET. ETHER EXTRACT	50.24 ± 0.51** (104.24)	241.69 ± 2.06 (52.32)	189.05 ± 2.25* (95.12)	0.99 ± 0.01** (95.67)	0.47 ± 0.01* (31.25)
METHANOLIC EXTRACT	35.53 ± 0.56** (111.37)	230.08 ± 1.11 (57.64)	135.40 ± 1.11** (136.13)	1.10 ± 0.02** (91.34)	0.22 ± 0.01*** (109.38)
AQUEOUS EXTRACT	163.47 ± 1.06* (49.35)	241.62 ± 3.53 (52.36)	138.55 ± 1.83** (133.73)	1.12 ± 0.02** (90.55)	0.19 ± 0.01*** (118.75)
TOTAL AQUEOUS EXTRACT	104.47 ± 1.76** (77.95)	156.59 ± 3.13** (91.28)	110.67 ± 2.31** (155.04)	0.99 ± 0.02** (95.67)	0.33 ± 0.01** (75.00)
MARKETED PREPARATION	26.70 ± 0.79** (115.65)	210.31 ± 2.99** (66.69)	219.67 ± 2.74 (71.72)	0.84 ± 0.01** (101.57)	0.22 ± 0.01*** (109.38)
$F_{calculated}$	*11.40*	*5.82*	*4.62*	*183.86*	*104.55*
5%Allowance	*96.11*	*128.44*	*112.52*	*0.29*	*0.06*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : PARACETAMOL : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 40 EFFECT OF FUMARIA INDICA WHOLE PLANT ON PARACETAMOL INDUCED HEPATOTOXICITY



Photomicrographs of Liver Sections of Rats Treated With:

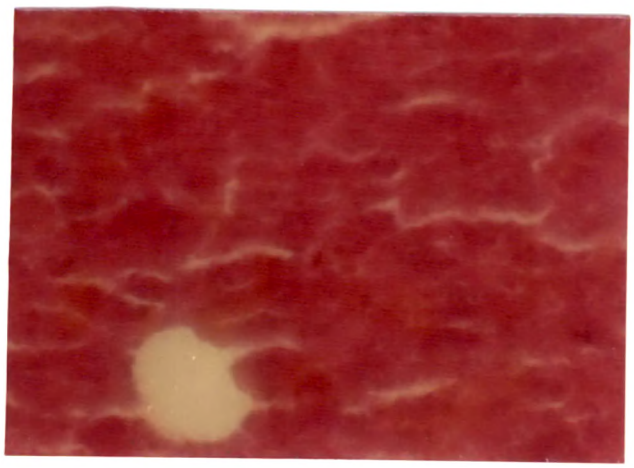


Fig.41 Total Aqueous Extract of F. indica Whole Plant and Paracetamol

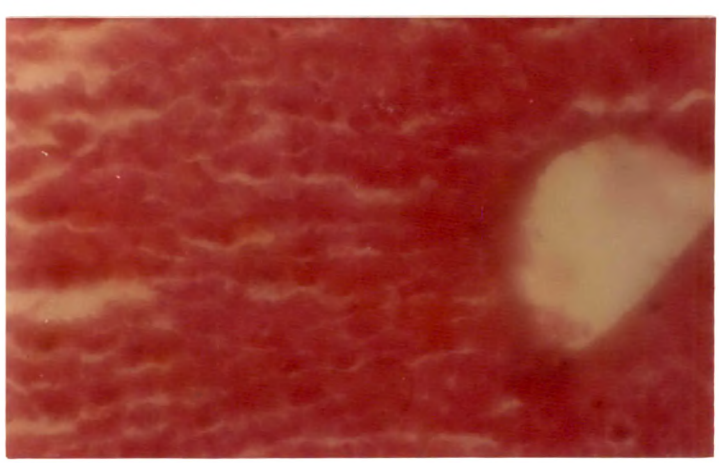


Fig.43 Total Aqueous Extract of I. racemosa Roots and Paracetamol

treated with total aqueous extract when compared to those of paracetamol intoxicated group (Table 34, Fig.40). The activity in terms of reduction in serum biochemical parameters was followed by methanolic extract, marketed preparation, aqueous and petroleum ether extracts and powdered drug when placed in descending order. The total aqueous extract showed comparable activity with that of silymarin. Histopathological examination of the liver sections of the group of rats treated with total aqueous extract also supported the hepatoprotective activity shown in terms of reduction in the elevated levels of serum biochemical parameters by exhibiting complete regeneration of liver cell architecture to normal level compared to those of rats intoxicated with paracetamol. (Fig.41).

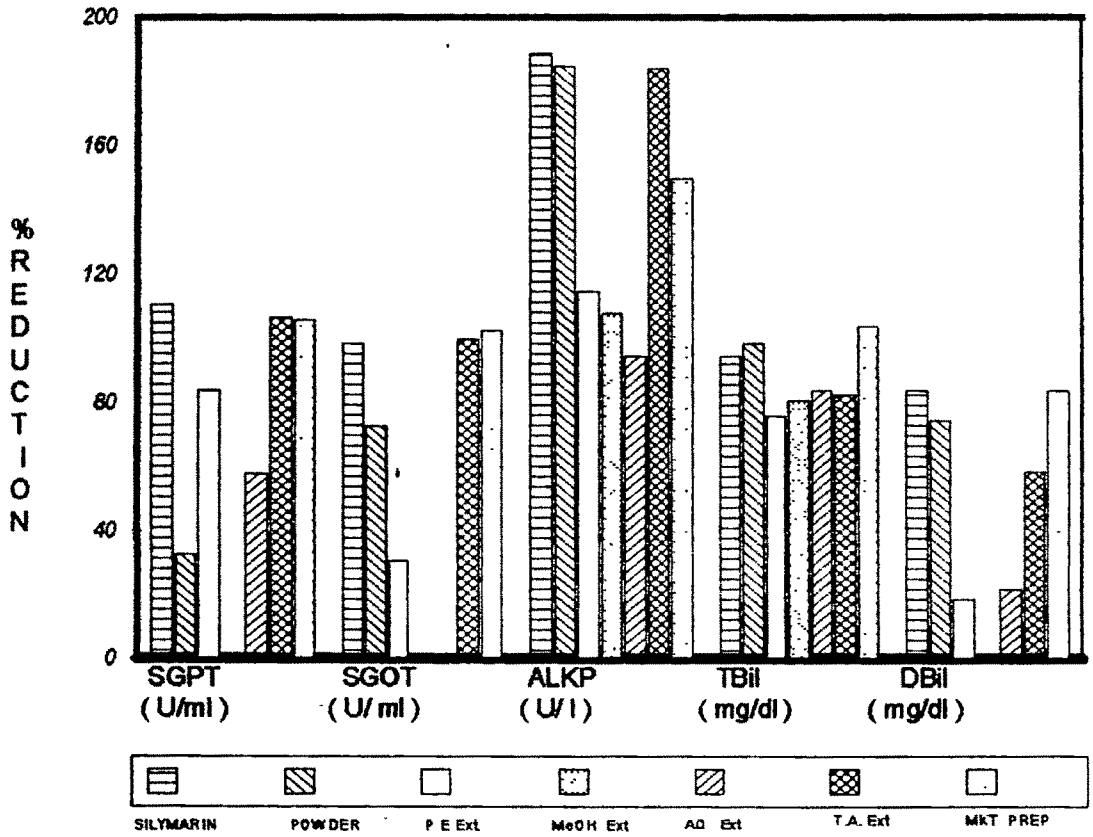
(c) Effect of roots of I. racemosa: Effect of powdered drug, extracts and marketed preparation of the roots of I. racemosa against paracetamol intoxication revealed the following information. (Table 35, Fig. 42). The group of rats treated with marketed preparation showed the most significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters (SGPT 106.17%, SGOT 103.26%, ALKP 150.45%, TBil 104.33%, DBil 84.38%) when compared to the groups of rats treated with other test samples. This reduction in elevated levels of serum biochemical parameters was followed by the group treated with total aqueous extract, powdered drug, petroleum, ether aqueous and methanolic

TABLE. 35 : EFFECT OF INULA RACEMOSA ROOTS ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	58.98 ± 0.63	137.53 ± 1.27	182.67 ± 0.79	0.88 ± 0.02	0.25 ± 0.01
PARACETAMOL	265.28 ± 3.14	356.00 ± 5.17	313.49 ± 7.40	3.42 ± 0.17	0.57 ± 0.03
SILYMARIN	36.47 ± 1.16* (110.91)	139.06 ± 1.42* (99.30)	66.20 ± 0.57* (189.03)	1.00 ± 0.01* (95.28)	0.30 ± 0.01* (84.38)
POWDER	197.02 ± 6.06 (33.09)	195.44 ± 3.26** (73.49)	72.00 ± 2.72** (184.60)	0.91 ± 0.01** (98.82)	0.33 ± 0.02** (75.00)
PET. ETHER EXTRACT	92.39 ± 2.13** (83.81)	288.41 ± 1.81 (30.94)	163.35 ± 2.10** (114.77)	1.50 ± 0.02* (75.59)	0.51 ± 0.01 (18.75)
METHANOLIC EXTRACT	298.55 ± 4.87 (-)	364.21 ± 2.17 (-)	172.17 ± 1.08** (108.03)	1.36 ± 0.00* (81.10)	0.58 ± 0.01 (-)
AQUEOUS EXTRACT	146.24 ± 2.66* (57.70)	367.49 ± 2.40 (-)	189.53 ± 4.17* (94.76)	1.28 ± 0.02* (84.25)	0.50 ± 0.01 (21.88)
TOTAL AQUEOUS EXTRACT	44.86 ± 1.65** (106.84)	138.17 ± 2.05** (99.71)	72.55 ± 1.35** (184.18)	1.32 ± 0.01* (82.68)	0.38 ± 0.01* (59.38)
MARKETED PREPARATION	46.25 ± 0.48** (106.17)	130.40 ± 2.37** (103.26)	116.67 ± 1.91** (150.45)	0.77 ± 0.00** (104.33)	0.30 ± 0.01** (84.38)
$F_{calculated}$	*19.12*	*13.66*	*4.71*	*186.96*	*61.88*
5%Allowance	*95.85*	*127.65*	*112.56*	*0.28*	*0.08*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : PARACETAMOL : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 42 EFFECT OF INULA RACEMOSA ROOTS ON PARACETAMOL INDUCED HEPATOTOXICITY



extracts when placed in descending order of activity. The group treated with the total aqueous extract showed a marked, significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters (SGPT 106.84%, SGOT 99.77%, ALKP 184.18%, TBil 82.68%, DBil 59.38%) when compared to those of the groups treated with powdered drug and extracts. The group of rats treated with marketed preparation showed comparable activity with that of silymarin. As the total aqueous extract was found to show maximum activity in comparison to other test samples, it was subjected to histopathology. The liver sections of rats treated with total aqueous extract against paracetamol intoxication indicated the absence of necrosis and a marked regnerative activity almost like that of control group (Fig.43)

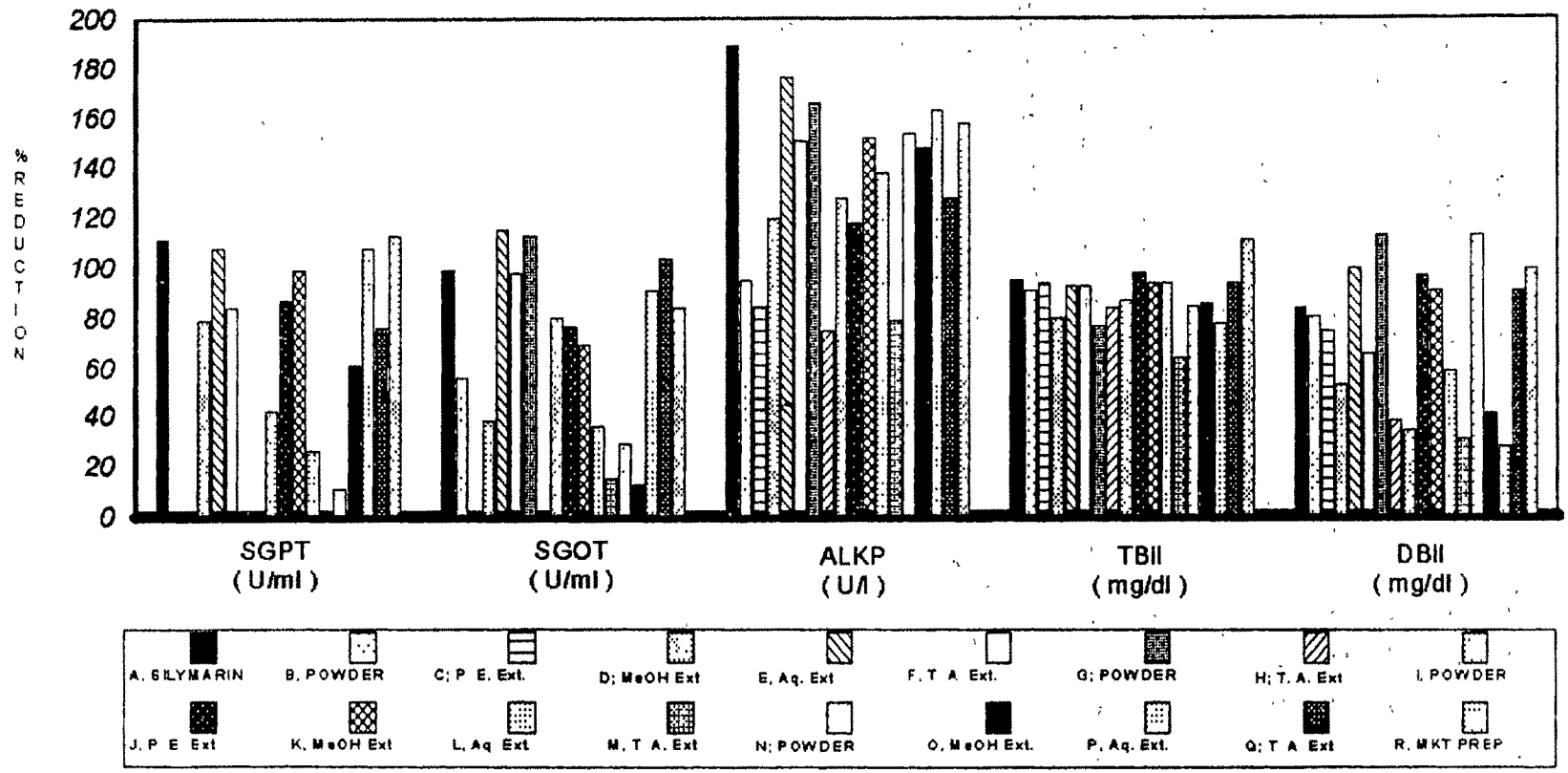
(d) Effect of different organs of M. pterygosperma: Effect of powdered drugs, extracts and marketed preparation of different organs of M. pterygosperma on paracetamol induced liver toxicity in rats is shown in Table 36, Fig. 44). The group treated with aqueous extract of fruits showed most significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters (SGPT 108.16%, SGOT 115.30%, ALKP 175.71%, TBil 93.31%, DBil 100.00%) when compared to the groups treated with other test samples against paracetamol intoxication. The activity was followed by marketed preparation, methanolic extract of stem bark, total aqueous extracts of fruits and roots, petroleum ether extract of stem

TABLE:36 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	58.98±0.63	137.53±1.27	182.67±0.79	0.88±0.02	0.25±0.01
PARACETAMOL	265.28±3.14	356.00±5.17	313.49±7.40	3.42±0.17	0.57±0.03
SILYMARIN	36.47±1.16* (110.91)	139.06±1.42* (99.30)	66.20±0.57* (189.03)	1.00±0.01* (95.28)	0.30±0.01* (84.38)
FRUITS					
POWDER	329.94±10.00 (-)	232.97±5.65* (56.31)	189.30±2.41* (94.93)	1.11±0.04** (90.94)	0.31±0.01** (81.25)
PET. ETHER Ext.	445.25±1.48 (-)	446.97±1.82 (-)	201.97±2.85* (85.25)	1.03±0.02** (94.09)	0.33±0.01** (75.00)
METHANOLIC EXTRACT	102.90±1.65** (78.71)	273.90±1.70 (37.58)	157.00±4.10* (119.62)	1.39±0.02* (79.92)	0.40±0.01* (53.13)
AQUEOUS EXTRACT	42.14±0.72** (108.16)	104.10±1.45** (115.30)	83.63±1.97** (175.71)	1.05±0.03** (93.31)	0.25±0.01** (100.00)
TOTAL AQUEOUS Ext.	91.73±1.22** (84.13)	142.36±2.28** (97.79)	116.23±3.11** (150.79)	1.07±0.03** (92.52)	0.36±0.01* (65.63)
LEAVES					
POWDER	284.65±3.97 (-)	109.69±2.68** (112.74)	96.45±3.91** (165.91)	1.46±0.02* (77.17)	0.21±0.01*** (112.50)
TOTAL AQUEOUS Ext.	284.47±3.12 (-)	408.51±2.20 (-)	215.10±2.79* (75.21)	1.28±0.01* (84.25)	0.45±0.01* (37.50)
STEM BARK					
POWDER	178.96±6.86* (41.84)	180.23±2.87** (80.45)	146.10±3.07* (127.95)	1.22±0.05** (86.61)	0.46±0.03* (34.38)
PET.ETHER Ext.	85.90±1.60** (86.95)	188.00±2.19** (76.90)	159.37±2.84* (117.81)	0.94±0.04** (97.64)	0.26±0.01** (96.88)
METHANOLIC EXTRACT	61.44±1.33** (98.81)	204.67±3.42** (69.27)	114.57±3.00** (152.06)	1.02±0.03** (94.49)	0.28±0.01** (90.63)
AQUEOUS EXTRACT	210.94±2.06 (26.34)	277.74±3.26 (35.82)	133.53±2.25** (137.56)	1.04±0.02** (93.70)	0.38±0.01* (59.38)
TOTAL AQUEOUS Ext.	317.80±2.28 (-)	323.90±3.39 (14.69)	209.60±2.37* (79.41)	1.79±0.02* (64.17)	0.47±0.01* (31.25)
ROOTS					
POWDER	241.64±6.64 (11.46)	291.62±3.62 (29.47)	111.60±3.95** (154.33)	1.26±0.03* (85.04)	0.21±0.01*** (112.50)
METHANOLIC EXTRACT	140.35±1.03* (60.56)	327.74±2.85 (12.94)	119.83±1.14** (148.04)	1.23±0.01* (86.22)	0.44±0.01* (40.63)
AQUEOUS EXTRACT	42.31±0.38** (108.08)	157.23±1.92** (90.98)	100.53±1.61** (162.79)	1.43±0.02* (78.35)	0.48±0.01* (28.13)
TOTAL AQUEOUS Ext.	108.00±3.06* (76.24)	129.03±1.86** (103.89)	146.43±3.05* (127.70)	1.02±0.02** (94.49)	0.28±0.01** (90.63)
MARKETED PREPARATION	31.71±1.39** (113.22)	171.62±2.04** (84.40)	10630±1.76** (158.38)	0.61±0.01*** (110.63)	0.25±0.00** (100.00)
Fcalculated	76.00	30.06	7.33	156.23	73.33
5% Allowance	68.37	89.62	79.20	0.23	0 06

Fcritical = 2.13 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO PARACETAMOL = * ; SILYMARIN = *** ; NOT SIGNIFICANT COMPARED TO SILYMARIN = **.

Fig. 44 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON PARACETAMOL INDUCED HEPATOTOXICITY



B, C, D, E, F = FRUITS; G, H = LEAVES, I, J, K, L, M = STEMBARK; N, O, P, Q = ROOTS

bark, aqueous extract of roots, powdered roots and stem bark, methanolic extract of fruits, aqueous extract of stem bark, methanolic extract of roots when placed in descending order in terms of reduction in the elevated levels of serum biochemical parameters. The groups of rats treated with petroleum ether extract of fruits and total aqueous extract of leaves indicated significant reduction ($P < 0.01$) only in the elevated levels of ALKP, TBil and DBil while the groups of rats treated with powdered fruits and leaves, and total aqueous extract of stem bark showed significant reduction ($P < 0.01$) in SGOT levels in addition to the above parameters when compared to group of rats intoxicated with paracetamol. Out of all the groups, the group treated with total aqueous extract of stem bark showed minimum activity in terms of reduction in the elevated levels of serum biochemical parameters. The aqueous extract of fruits, marketed preparation, methanolic extract of stem bark showed comparable reduction in the elevated levels of serum biochemical parameters with that of silymarin.

The maximum activity was shown by the aqueous extract of fruits, which was further confirmed by its histopathological studies. These studies indicated marked regenerative activity showing almost normal liver cell architecture, thereby suggesting that the aqueous extract of fruits protects the liver completely against paracetamol intoxication (Fig.45).

Photomicrographs of Liver Sections of Rats Treated With:

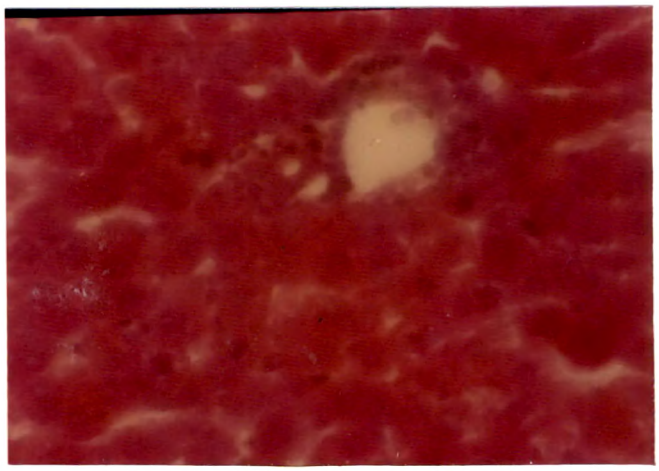


Fig.45 Aqueous Extract of Fruits of M. pterygosperma and Paracetamol

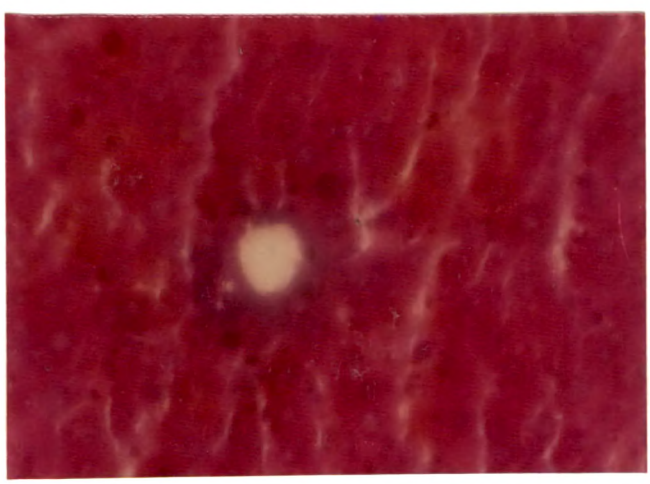


Fig.47 Powdered Aerial Parts of S. acuta and Paracetamol

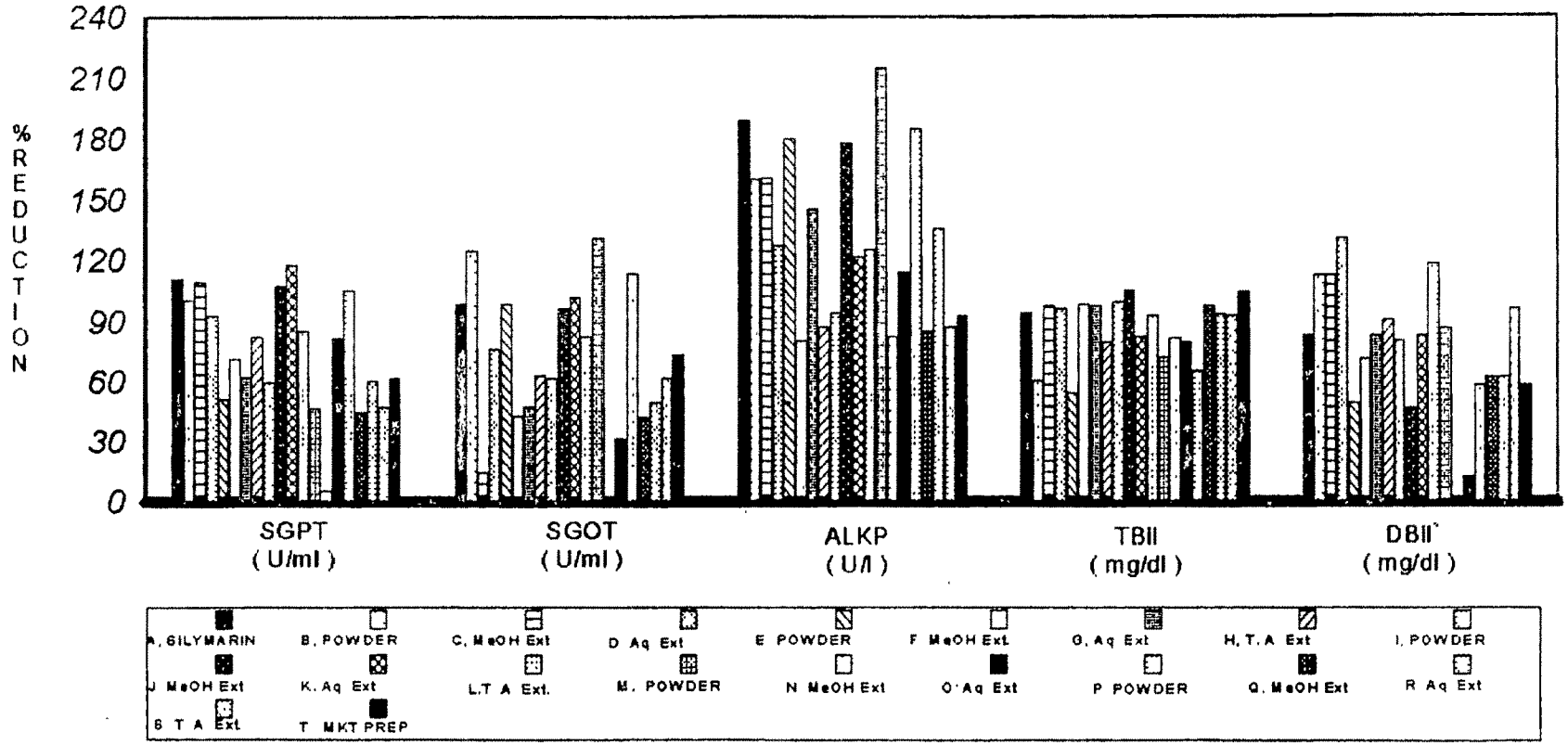
(e) Effect of different organs of various species of Sida: Effect of powdered drugs, extracts and marketed preparation of different organs of various species of Sida on Paracetamol intoxicated rats revealed the following (Table 37, Fig 46). The group of rats treated with powdered aerial parts of S. acuta against paracetamol intoxication showed most significant activity ($P < 0.01$) in terms of reduction in the elevted levels of serum biochemical parameters (SGPT 100.68%, SGOT 125.47%, ALKP 159.91%, TBil 61.42%, DBil 112.50%) in comparison to the other test samples. The methanolic extract of aerial parts of S. rhombifolia showed minimum activity. The activity in terms of reduction in the elevated levels of serum biochemical parameters may be placed in the descending order followed by the powdered aerial parts of S. acuta and S. rhombifolia, methanolic extract of whole plant of S. cordifolia, powdered roots of S. rhombifolia, aqueous extract of aerial parts of S. acuta, aqueous and total aqueous extracts of whole plant of S. cordifolia, methanolic extract of aerial parts of S. acuta, aqueous extract of roots of S. acuta, powdered roots of S. acuta, total aqueous extract of whole plant of S. acuta, aqueous extract of roots of S. rhombifolia, powdered aerial parts of S. cordifolia, marketed preparation, total aqueous extract of whole plant of S. rhombifolia, methanolic extract of roots of S. acuta and S. rhombifolia, aqueous and methanolic extracts of aerial parts of S. rhombifolia. The activity of powdered aerial parts of S. acuta was highest among the other test samples and was

TABLE:37 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	58.98±0.63	137.53±1.27	182.67±0.79	0.88±0.22	0.25±0.01
PARACETAMOL	265.28±3.14	356.00±5.17	313.49±7.40	3.42±0.17	0.57±0.03
SILYMARIN	36.47±1.16* (110.91)	139.06±1.42 (99.30)	66.20±0.57* (189.83)	1.00±0.01* (95.28)	0.30±0.01* (84.38)
SIDA ACUTA(AERIAL PARTS)					
POWDER	57.57±2.41** (100.91)	81.89±3.66** (125.47)	104.30±4.51** (159.91)	1.86±0.02** (61.42)	0.21±0.01*** (112.50)
METHANOLIC EXTRACT	37.41±0.97** (110.46)	322.62±0.63 (15.28)	103.37±2.73** (160.62)	0.94±0.01** (97.64)	0.21±0.00*** (112.50)
AQUEOUS EXTRACT	73.33±2.31** (93.04)	184.15±2.04 (78.66)	145.80±2.63* (128.18)	0.95±0.01** (97.24)	0.15±0.00*** (131.25
SIDA ACUTA(ROOTS)					
POWDER	157.59±4.26* (52.20)	140.23±2.54** (98.76)	77.60±3.03** (180.32)	2.03±0.04* (54.72)	0.41±0.01* (50.00)
METHANOLIC EXTRACT	116.82±2.67* (71.96)	262.36±0.88 (42.86)	206.93±2.73* (81.46)	0.91±0.01** (98.82)	0.34±0.01** (71.88)
AQUEOUS EXTRACT	134.47±1.63* (63.41)	250.62±1.90 (48.14)	121.90±2.37** (146.45)	0.92±0.01** (98.43)	0.30±0.00** (84.38)
SIDA ACUTA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	94.47±1.27** (82.80)	216.72±1.72 (63.75)	198.77±1.97* (87.69)	1.40±0.01* (79.53)	0.28±0.01** (90.63)
SIDA CORDIFOLIA(WHOLE PLANT)					
POWDER	141.33±4.30* (60.08)	221.59±1.87 (61.52)	189.67±2.62* (94.65)	0.88±0.02** (100.00)	0.31±0.00** (81.25)
METHANOLIC EXTRACT	42.53±1.16** (107.07)	143.90±2.07** (97.08)	80.30±1.26** (178.25)	0.74±0.01*** (105.51)	0.42±0.01* (46.88)
AQUEOUS EXTRACT	21.58±1.29** (118.13)	132.62±1.62** (102.25)	154.03±2.98* (121.89)	1.31±0.01* (83.07)	0.30±0.02** (93.38)
TOTAL AQUEOUS Ext.	88.04±0.71** (85.91)	173.90±1.90** (83.35)	148.40±1.26* (126.20)	1.06±0.03** (92.91)	0.19±0.01*** (118.75)
SIDA RHOMBIFOLIA(AERIAL PARTS)					
POWDER	167.43±2.99* (47.43)	69.06±1.77** (131.34)	32.45±1.23** (214.83)	1.56±0.02* (73.23)	0.29±0.01** (87.50)
METHANOLIC EXTRACT	252.12±2.82 (6.38)	462.36±3.51 (-)	204.37±1.30* (83.41)	1.33±0.03* (82.28)	0.59±0.01 (-)
AQUEOUS EXTRACT	96.24±1.21** (81.94)	288.00±2.60 (31.13)	163.472.31* (114.68)	1.38±0.03* (80.31)	0.53±0.01 (12.50)
SIDA RHOMBIFOLIA(ROOTS)					
POWDER	46.65±2.08** (105.98)	106.49±3.77** (114.21)	71.55±2.26** (184.94)	1.75±0.03* (65.75)	0.38±0.01* (59.38)
METHANOLIC EXTRACT	171.73±2.18* (45.35)	263.64±2.59 (42.28)	201.20±2.41* (85.84)	0.94±0.02** (97.64)	0.37±0.02* (62.50)
AQUEOUS EXTRACT	139.37±2.12* (61.03)	245.69±1.84 (50.49)	136.17±1.79** (135.55)	1.04±0.01** (93.70)	0.37±0.01* (62.50)
SIDA RHOMBIFOLIA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	167.22±1.37* (47.53)	220.82±6.35 (61.88)	198.33±2.75* (88.03)	1.07±0.03** (92.52)	0.26±0.01** (96.88)
MARKETED PREPARATION	138.24±2.44* (61.58)	194.67±2.49 (73.85)	192.13±4.42* (92.77)	0.76±0.01*** (104.72)	0.38±0.01* (59.38)
Fcalculated	20.58	6 42	12.30	194.55	90 11
5% Allowance	63.91	174.47	75.46	0.21	0.06

Fcritical = 2.04 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO PARACETAMOL = * ; SILYMARIN = *** ; NOT SIGNIFICANT COMPARED TO SILYMARIN = **.

Fig. 46 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON PARACETAMOL INDUCED HEPATOTOXICITY



SIDA ACUTA
B,C,D = AERIAL PARTS
E,F,G = ROOTS
H = WHOLE PLANT

SIDA CORDIFOLIA
I,J,K,L = WHOLE PLANT

SIDA RHOMBIFOLIA
M,N,O = AERIAL PARTS
P,Q,R = ROOTS
S = WHOLE PLANT

comparable to that of silymarin. This was also supported by the histopatholoical examination of its liver sections, which showed almost normalised liver cell architecture without necrosis indicating the hepatoprotective activity of powdered aerial parts against paracetamol intoxication (Fig.47).

The comparative account of overall effects of different powders and extracts of various organs of the selected plant drugs against paracetamol intoxication revealed that aqueous extract of fruits of M. pterygosperma showed maximum significant activity ($P < 0.01$). This was followed by powdered aerial parts of S. acuta, total aqueous extracts of roots of I. racemosa, whole plant of F. indica and methanolic extract of rhizomes of C. orchioides when placed in the descending order in terms of activity.

Thus, the hepatoprotective activity of the selected plant drugs such as C. orchioides, F. indica, I. racemosa, M. pterygosperma, S. acuta, S. cordifolia and S. rhombifolia against paracetamol hepatotoxicity might be due to either inhibition of cytochrome P_{450}[192] or promotion of its glucuronidation or stimulation of heaptic regeneration or activation of the functions of reticuloendothelial systems or inhibition of protein biosynthesis.

iii. Effect of Selected Plant Drugs on Rifampicin Induced Hepatotoxicity

Rifampicin, a broad spectrum antibiotic is widely used in the treatment of tuberculosis particularly in combination with INH or any other similar drugs. It was reported that rifampicin is hepatotoxic[193] and it does not accumulate even in hepatic insufficiency.[194] This suggests that rifampicin should be used cautiously in hepatic dysfunction. Hence in the present studies, rifampicin induced hepatotoxicity in rats has been used as a model to evaluate the hepatoprotective activity of the selected plant drugs.

Rifampicin is widely distributed in the body, even into the cerebrospinal fluid and about 98% of the drug in plasma is protein bound. About 85% of the drug is eliminated by biotransformation in the liver. Rifampicin is metabolised by hepatocytes into an active metabolite called 25-desacetyl rifampin. It reduces drug metabolising enzymes and actively and specifically binds to RNA polymerases and thereby inhibits the synthesis of all forms of RNA. Thus, by inhibiting nucleic acid and protein synthesis it induces fatty liver and finally cirrhosis.[195]

The rats intoxicated with rifampicin elevated significantly ($P<0.01$) the serum biochemical parameters i.e. SGPT (76.24 to 195.53 U/ml), SGOT (85.69 to 265.46 U/ml) ALKP

(76.17 to 141.05 U/l),TBil (1.01 to 2.81 mg/dl) and DBil (0.19 to 1.21 mg/dl) levels, when compared to those of control group. The administration of silymarin to rifampicin intoxicated rats almost normalised the elevated levels of serum biochemical parameters (Table 38-42). The elevated levels of serum biochemical parameters due to rifampicin intoxication indicates toxic effects of rifampicin in albino rats. This was further confirmed by the histopathological examination of liver sections of the rats intoxicated with rifampicin indicating sinusoidal dilatation with fatty infiltration (Fig. 48).

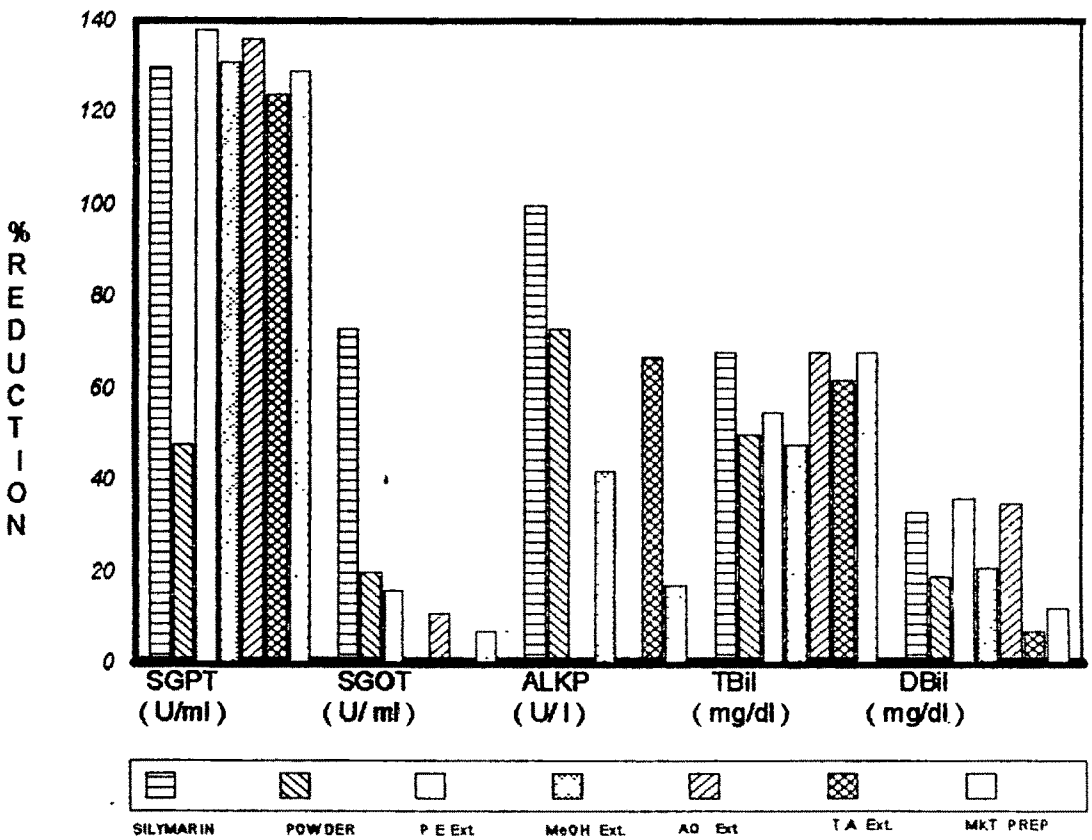
(a) Effect of rhizomes of C. orchioides: The effect of powdered drug, extracts, and marketed preparation of the rhizomes of C. orchioides against rifampicin induced hepatotoxicity in rats revealed the following (Table 38, Fig.49). The powdered drug showed maximum activity in terms of reduction in the elevated levels of all the serum biochemical parameters (SGPT 47.68%, SGOT 19.76%, ALKP 72.52%, TBil 60.00%, DBil 18.63%). The activity was followed by marketed preparation which also exhibited reduction in the levels of all the above parameters. The aqueous extract, petroleum ether extract, methanolic extract and total aqueous extract showed reduction in the levels of all other biochemical parameters except that of ALKP and SGOT respectively. The histopathological examination of liver sections of rats intoxicated with rifampicin and treated with

TABLE. 38 : EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	76.24 ± 1.61	85.69 ± 2.16	76.17 ± 1.66	1.01 ± 0.03	0.19 ± 0.01
RIFAMPICIN	195.53 ± 3.50	265.46 ± 2.27	141.05 ± 2.91	2.81 ± 0.05	1.21 ± 0.03
SILYMARIN	41.00 ± 0.66* (129.54)	135.07 ± 1.30* (72.53)	76.03 ± 2.26* (100.22)	1.59 ± 0.02* (67.78)	0.87 ± 0.04* (33.33)
POWDER	138.65 ± 1.02* (47.68)	229.94 ± 2.38 (19.76)	94.00 ± 1.79* (72.52)	1.91 ± 0.03* (50.00)	1.02 ± 0.02* (18.63)
PET. ETHER EXTRACT	30.52 ± 0.86*** (138.33)	236.46 ± 3.80 (16.13)	168.80 ± 1.70 (-)	1.82 ± 0.02* (55.00)	0.84 ± 0.02** (36.27)
METHANOLIC EXTRACT	38.98 ± 0.55** (131.23)	277.23 ± 0.79 (-)	113.73 ± 3.35* (42.11)	1.95 ± 0.01* (47.78)	1.00 ± 0.02* (20.59)
AQUEOUS EXTRACT	33.14 ± 1.16*** (136.13)	244.92 ± 5.30 (11.43)	162.20 ± 1.69 (-)	1.58 ± 0.02** (68.33)	0.85 ± 0.01** (35.29)
TOTAL AQUEOUS EXTRACT	47.92 ± 1.31** (123.74)	289.54 ± 2.61 (-)	97.80 ± 2.81* (66.66)	1.69 ± 0.01** (62.22)	1.14 ± 0.01 (6.86)
MARKETED PREPARATION	42.20 ± 1.08** (128.54)	253.13 ± 2.55 (6.86)	130.10 ± 3.02 (16.88)	1.58 ± 0.02** (68.33)	1.09 ± 0.02* (11.76)
$F_{calculated}$	*1378.95*	*570.00*	*204.42*	*311.36*	*148.61*
5%Allowance	*7.43*	*92.06*	*11.69*	*0.13*	*0.12*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : RIFAMPICIN : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 4.9 EFFECT OF CURCULIGO ORCHIOIDES RHIZOMES ON RIFAMPICIN INDUCED HEPATOTOXICITY



the powdered rhizomes of C. orchioides showed a marked sinusoidal dilatation, indicating that the powdered drug did not protect the liver completely.

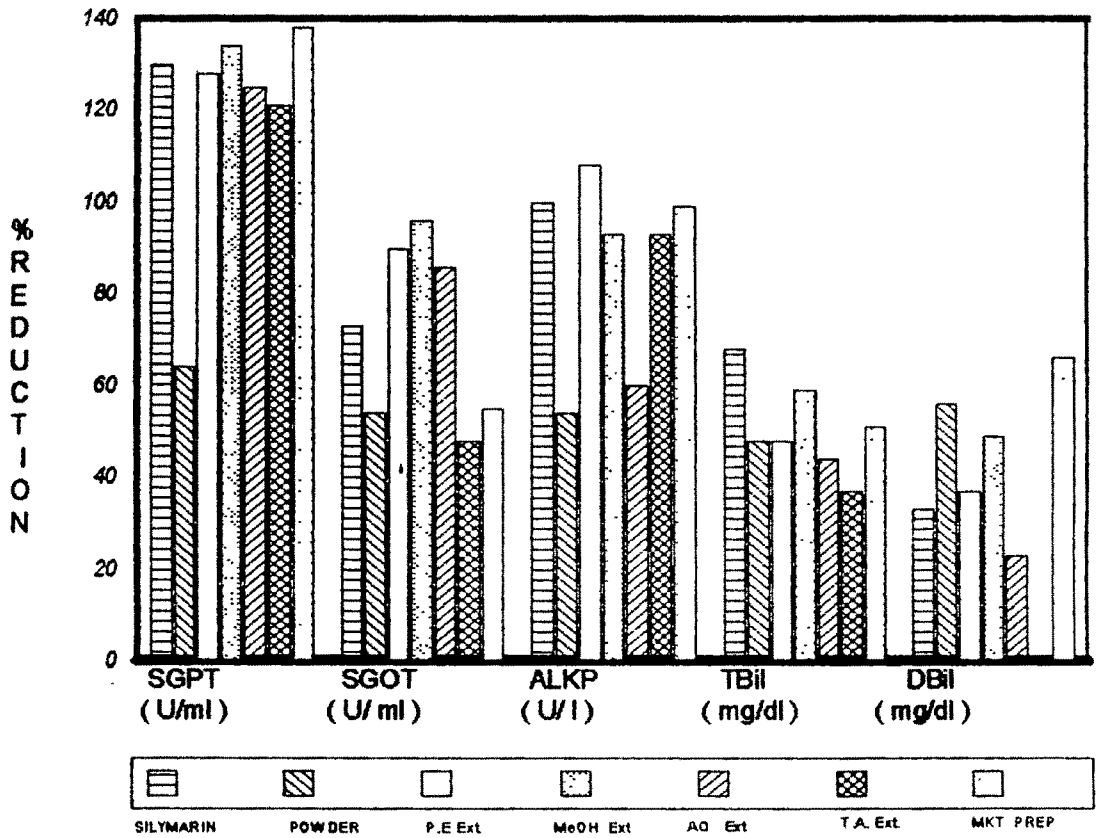
(b) Effect of whole plant of F. indica: The effect of powdered drug, extracts and marketed preparation of whole plant of F. indica against rifampicin induced hepatotoxicity in rats revealed the following (Table 39, Fig.50). The methanolic extract showed maximum significant ($P<0.01$) activity in terms of reduction in the elevated levels of serum biochemical parameters (SGPT 134.44%, SGOT 95.86%, ALKP 92.76%, TBil 59.44%, DBil 49.02%), followed by petroleum ether extract, marketed preparation, aqueous extract, powdered drug and total aqueous extract when placed in the descending order of activity. The total aqueous extract showed significant reduction ($P<0.01$) in all the other serum biochemical parameters except that of ALKP. The methanolic extract showed similar activity in terms of reduction in SGPT and ALKP levels and significantly better activity ($P<0.01$) in terms of reduction in SGOT and DBil levels when compared to that of silymarin. Histopathological examination of the liver sections of the rats treated with methanolic extract of whole plant of F. indica against rifampicin intoxication showed almost normal cell architecture with little sinusoisal dilatation (Fig.51). This confirmed the hepatoprotective activity of the methanolic extract.

TABLE. 39 : EFFECT OF FUMARIA INDICA WHOLE PLANT ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	76.24 ± 1.61	85.69 ± 2.16	76.17 ± 1.66	1.01 ± 0.03	0.19 ± 0.01
RIFAMPICIN	195.53 ± 3.50	265.46 ± 2.27	141.05 ± 2.91	2.81 ± 0.05	1.21 ± 0.03
SILYMARIN	41.00 ± 0.66* (129.54)	135.07 ± 1.30* (72.53)	76.03 ± 2.26* (100.22)	1.59 ± 0.02* (67.78)	0.87 ± 0.04* (33.33)
POWDER	118.76 ± 3.46* (64.35)	168.15 ± 2.71* (54.13)	105.95 ± 3.02* (54.10)	1.95.± 0.03* (47.78)	0.65 ± 0.02*** (55.57)
PET. ETHER EXTRACT	42.55 ± 1.28** (128.24)	103.64 ± 1.27*** (90.02)	70.97.± 0.81** (108.01)	1.95.± 0.01* (47.78)	0.83 ± 0.01** (37.25)
METHANOLIC EXTRACT	35.16 ± 1.55** (134.44)	93.13 ± 0.74*** (95.86)	80.87.± 0.80** (92.76)	1.74.± 0.02* (59.44)	0.71 ± 0.02*** (49.02)
AQUEOUS EXTRACT	46.43 ± 0.73** (124.99)	110.05 ± 1.72*** (86.45)	102.43.± 0.82* (59.53)	2.01.± 0.01* (44.44)	0.98 ± 0.01* (22.55)
TOTAL AQUEOUS EXTRACT	51.61 ± 1.47* (120.65)	178.77 ± 0.90* (48.27)	81.00.± 1.28** (92.56)	2.14.± 0.01* (37.22)	1.23 ± 0.01 (-)
MARKETED PREPARATION	31.23 ± 1.59*** (137.73)	168.44 ± 1.73* (54.97)	76.77 ±1.54** (99.08)	1.89 ± 0.02* (51.11)	0.54 ± 0.02*** (65.69)
$F_{calculated}$	*721.03*	*1055.86*	*147.03*	*341.25*	*240.74*
5%Allowance	*9.65*	*8.41*	*8.95*	*0.12*	*0.10*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : RIFAMPICIN : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 50 EFFECT OF FUMARIA INDICA WHOLE PLANT ON RIFAMPICIN INDUCED HEPATOTOXICITY



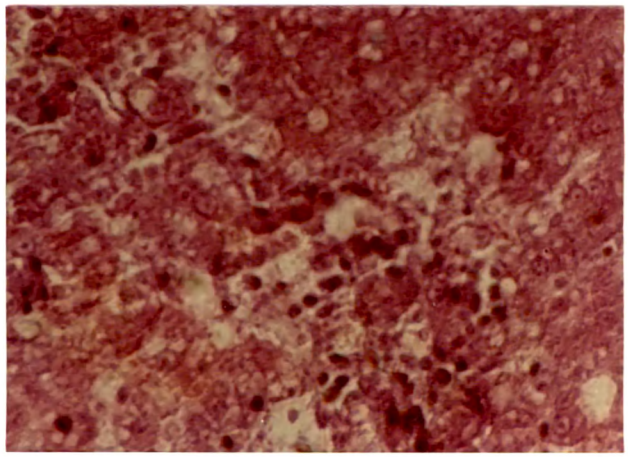


Fig.48 Photomicrograph of Rifampicin Intoxicated Rat Liver Section

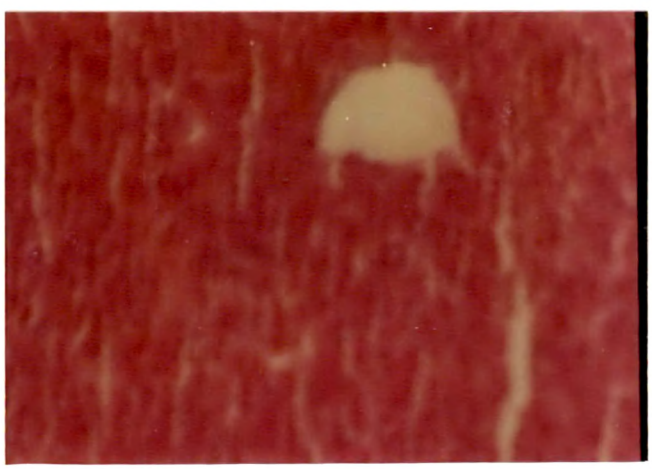


Fig.51 Photomicrograph of Liver Section of Rat Treated with Methanolic Extract of Whole Plant of *F. indica* and Rifampicin

(c) Effect of roots of I. racemosa: The effect of powdered drug, extracts and marketed preparation of the roots of I. racemosa against rifampicin intoxication indicated the following (Table 40, Fig. 52) The methanolic extract showed maximum, significant activity ($P<0.01$) in terms of reduction in the elevated lelves of serum biochemical parameters (SGPT 143.32%, SGOT 99.86%, ALKP 93.13%, TBil 52.22%, DBil 14.71%) followed by marketed preparation, total aqueous extract, powdered drug, petroleum ether extract and aqueous extract when arranged in the descending order of activity. The powdered drug, petroleum ether and aqueous extracts showed reduction in the elevated levels of all other serum biochemical parameters except that of SGOT and DBil. The methanolic extract showed comparable activity with that of silymarin. Histopathological examination of the liver sections of rats treated with methanolic extract of roots of I. racemosa against rifampicin induced hepatotoxicity indicated almost normal cellular architecture (Fig.53). These observations supported the hepatoprotective activity of the methanolic extract against rifampicin intoxication.

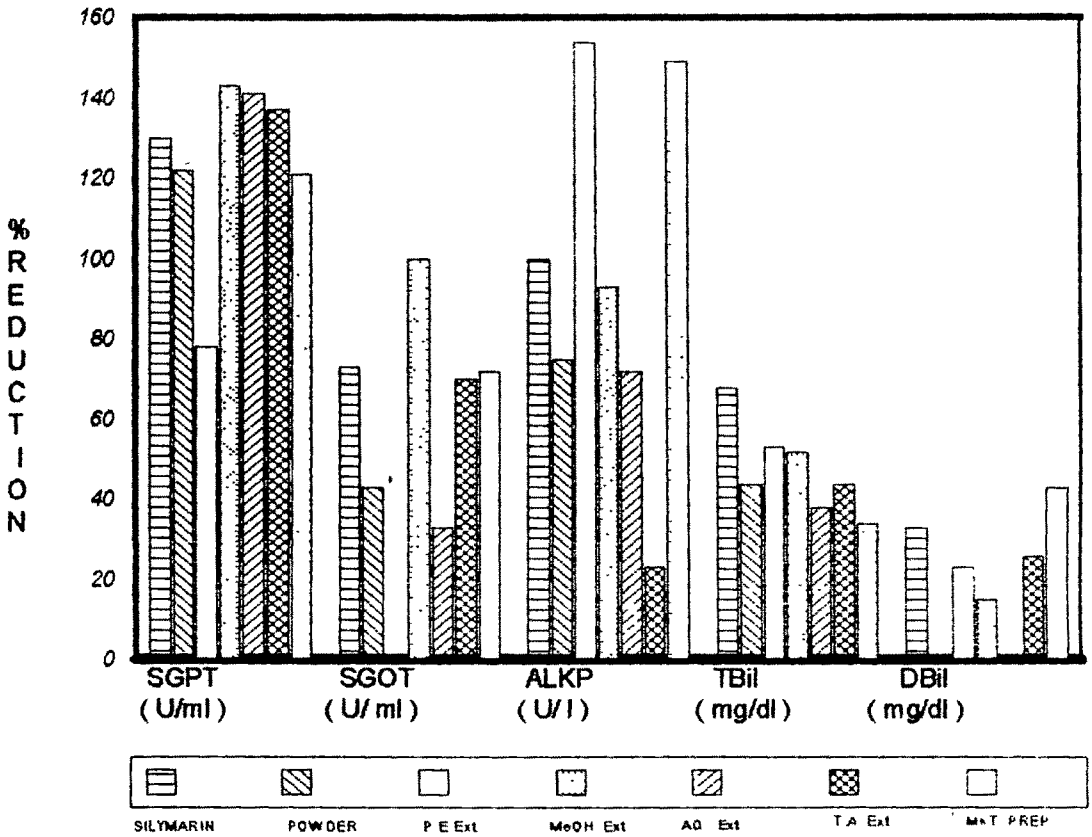
(d) Effect of different organs of M. pterygosperma: The effect of powdered drugs, extracts and marketed preparation of different organs of M. pterygosperma against rifampicin intoxication in rats revealed the following (Table 41, Fig 54). The powdered roots showed maximum, significant activity ($P < 0.01$) in terms of reduction in the elevated levels of

TABLE. 40: EFFECT OF INULA RACEMOSA ROOTS ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS MEAN ± SEM (% REDUCTION)				
	SGPT (u/ml)	SGOT (u/ml)	ALKP (u/l)	TBIL (mg/dl)	DBIL (mg/dl)
CONTROL	76.24 ± 1.61	85.69 ± 2.16	76.17 ± 1.66	1.01 ± 0.03	0.19 ± 0.01
RIFAMPICIN	195.53 ± 3.50	265.46 ± 2.27	141.05 ± 2.91	2.81 ± 0.05	1.21 ± 0.03
SILYMARIN	41.00 ± 0.66* (129.54)	135.07 ± 1.30 (72.53)	76.03 ± 2.26* (100.22)	1.59 ± 0.02* (67.78)	0.87 ± 0.04* (33.33)
POWDER	49.96 ± 2.54* (122.03)	189.03 ± 2.06 (42.52)	92.35 ± 2.49* (75.06)	2.01 ± 0.03* (44.44)	1.22 ± 0.03 (-)
PET. ETHER EXTRACT	102.71 ± 2.08* (77.81)	274.41 ± 2.85 (-)	41.20 ± 0.87*** (153.90)	1.85 ± 0.02* (53.33)	0.98 ± 0.02* (22.55)
METHANOLIC EXTRACT	24.56 ± 1.55*** (143.32)	85.95 ± 2.42** (99.86)	80.63 ± 0.81** (93.13)	1.87 ± 0.02* (52.22)	1.06 ± 0.02* (14.71)
AQUEOUS EXTRACT	26.82 ± 0.93*** (141.43)	206.27 ± 3.02 (32.93)	94.63 ± 2.88* (71.55)	2.13 ± 0.02* (37.78)	1.49 ± 0.02 (-)
TOTAL AQUEOUS EXTRACT	31.83 ± 0.75*** (137.23)	140.05 ± 1.48 (69.76)	125.87 ± 1.34* (23.40)	2.01 ± 0.02* (44.44)	0.94 ± 0.01* (26.47)
MARKETED PREPARATION	51.26 ± 0.60* (120.94)	136.72 ± 1.28 (71.61)	44.67 ± 1.10*** (148.55)	2.19 ± 0.01* (34.44)	0.77 ± 0.01*** (43.14)
$F_{calculated}$	*883.42*	*7.00*	*276.74*	*297.87*	*1975.00*
5%Allowance	*8.79*	*145.05*	*9.49*	*0.13*	*0.04*

*$F_{CRITICAL}$ = 2.95(P<0.01); SIGNIFICANT REDUCTION COMPARED TO : RIFAMPICIN : *; SILYMARIN : ***; NOT SIGNIFICANT COMPARED TO SILYMARIN : ***

Fig. 52 EFFECT OF INULA RACEMOSA ROOTS ON RIFAMPICIN INDUCED HEPATOTOXICITY



serum biochemical parameters (SGPT 135.02%, SGOT 73.18%, ALKP 120.04%, TBil 77.22%, DBil 36.27%) followed by powdered fruits, stem bark, and leaves, methanolic extract of fruits and roots, total aqueous extract of leaves, marketed preparation, total aqueous extract of stem bark and roots, methanolic, extract of stem bark total aqueous extract of fruits, aqueous extract of stem bark, petroleum ether extract of fruits and stem bark, aqueous extract of roots and fruits when placed in the descending order of activity. The aqueous extract of fruits showed minimum activity compared to that of other test samples, since it could reduce significantly ($P < 0.01$) only ALKP and TBil levels. The powdered roots and fruits showed comparable activity with that of silymarin. However, the powdered roots showed better reduction in the elevated levels of serum biochemical parameters than that of powdered fruits. Histopathological examination of liver sections of the group treated with powdered roots showed almost normalised hepatocellular architecture without any sinusoidal dilatation (Fig. 55). This indicates that the powdered roots protects the rifampicin intoxication completely.

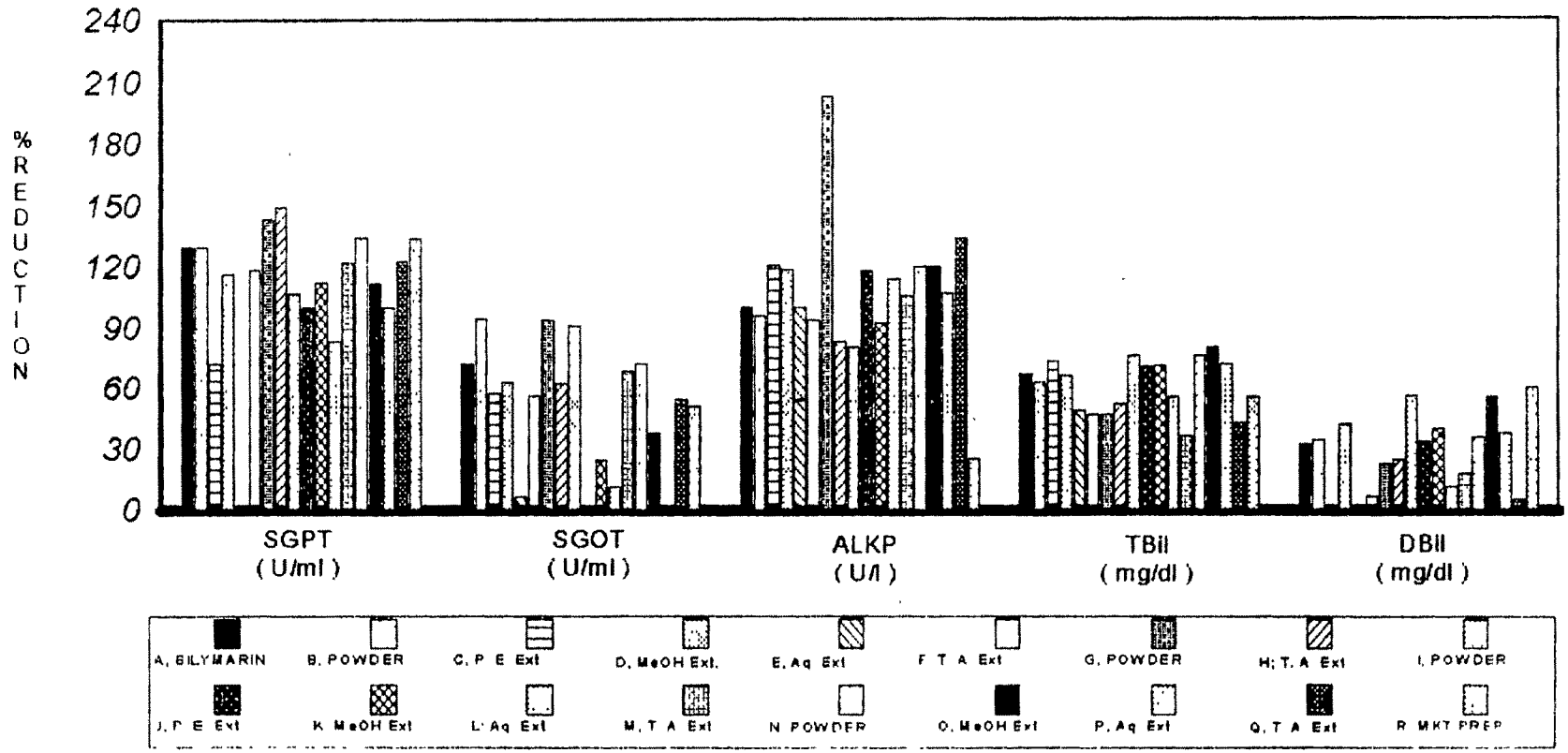
(e) Effect of different organs of various species of Sida: The effect of powdered drugs, extracts and marketed preparation of different organs of various species of Sida against rifampicin intoxication in rats revealed the following (Table 42, Fig. 56). The aqueous extract of aerial

TABLE:41 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	76.24±1.61	85.69±2.16	76.17±1.66	1.01±0.03	0.19±0.01
RIFAMPICIN	195.53±3.50	265.46±2.27	141.05±2.91	2.81±0.05	1.21±0.03
SILYMARIN	41.00 ± 0.66* (129.54)	135.07±1.30* (72.53)	76.03±2.26* (100.22)	1.59±0.02* (67.78)	0.87±0.04** (33.33)
FRUITS					
POWDER	39.94±0.49** (130.43)	94.77±3.40*** (94.95)	78.80±3.21** (95.95)	1.65±0.09*** (64.44)	0.85±0.02** (35.29)
PET. ETHER Ext.	108.71±1.25* (72.78)	160.56±1.60* (58.35)	62.60±0.85*** (120.92)	1.48±0.01** (73.89)	1.24±0.01 (-)
METHANOLIC EXTRACT	56.24±0.43* (116.77)	149.54±2.28* (64.48)	63.67±1.26*** (119.27)	1.61±0.01** (66.67)	0.78±0.02** (42.16)
AQUEOUS EXTRACT	237.22±1.30 (-)	252.87±2.98* (7.00)	76.07±1.04** (100.15)	1.92±0.02* (49.44)	1.21±0.01 (0.00)
TOTAL AQUEOUS Ext.	53.71±1.40* (118.89)	163.13±1.26* (56.92)	80.13±0.42** (93.90)	1.97±0.02* (46.67)	1.14±0.01 (6.86)
LEAVES					
POWDER	23.49±0.43*** (144.22)	95.69±2.14*** (94.44)	9.43±0.50*** (202.87)	1.97±0.05* (46.67)	0.98±0.03* (22.55)
TOTAL AQUEOUS Ext.	17.05±0.46*** (149.62)	151.59±0.79* (63.34)	86.43±2.02* (84.19)	1.85±0.02* (53.33)	0.95±0.01** (25.49)
STEM BARK					
POWDER	68.18±1.96* (106.76)	102.38±2.42*** (90.72)	88.65±3.53* (80.76)	1.43±0.05** (76.67)	0.63±0.01*** (56.86)
PET.ETHER Ext.	76.43±1.79* (99.84)	289.28±2.43 (-)	64.60±1.15*** (117.83)	1.54±0.02** (70.56)	0.86±0.02** (34.31)
METHANOLIC Ext.	60.55±1.57* (113.15)	221.33±1.36* (24.55)	80.43±1.01** (93.43)	1.52±0.01** (71.67)	0.80±0.01** (40.20)
AUEOUS EXTRACT	91.14±1.16* (84.16)	243.64±0.92* (12.14)	66.80±1.47*** (114.44)	1.80±0.02* (56.11)	1.09±0.01* (11.76)
TOTAL AQUEOUS Ext.	50.30±0.62* (121.75)	140.56±1.32** (69.48)	72.13±1.17** (106.23)	2.15±0.02* (36.67)	1.03±0.01* (17.65)
ROOTS					
POWDER	34.47±1.69** (135.02)	133.90±3.49** (73.18)	63.17±2.05** (120.04)	1.42±0.06*** (77.22)	0.84±0.03** (36.27)
METHANOLIC EXTRACT	61.53±0.48* (112.33)	196.62±4.18* (38.29)	63.07±0.81*** (120.19)	1.35±0.01*** (81.11)	0.64±0.01*** (55.88)
AQUEOUS EXTRACT	76.24±1.09* (100.00)	278.00±1.18 (-)	71.67±0.71** (106.94)	1.49±0.01** (73.33)	0.82±0.01** (38.24)
TOTAL AQUEOUS Ext.	49.35±1.69* (122.54)	165.95±1.22* (55.35)	53.93±1.21*** (134.28)	2.03±0.03* (43.33)	1.15±0.01 (5 88)
MARKETED PREPARATION	35.76±0.99** (133.93)	174.49±2.02* (50.60)	124.17±1.82* (26.02)	1.80±0.01* (56.11)	0.59±0 01*** (60.78)
Fcalculated	1450.52	817.61	211.75	125.74	181.82
5% Allowance	7.11	11.11	8.84	0.17	0.10

Fcritical = 2.13 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO RIFAMPICIN = *; SILYMARIN = ***; NOT SIGNIFICANT COMPARED TO SILYMARIN = **

Fig. 54 EFFECT OF DIFFERENT ORGANS OF MORINGA PTERYGOSPERMA ON RIFAMPICIN INDUCED HEPATOTOXICITY



B, C, D, E, F = FRUITS, G, H = LEAVES, I, J, K, L, M = STEMBARK, N ,O, P, Q = ROOTS

Photomicrographs of Liver Sections of Rats Treated With:

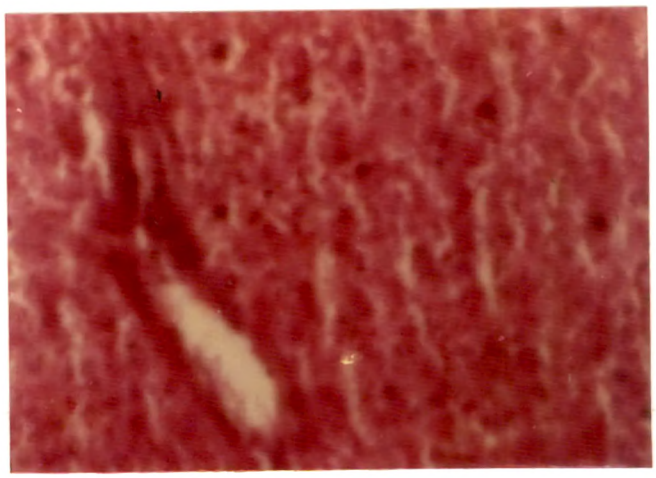


Fig.53 Methanolic Extract of *I. racemosa* Roots and Rifampicin

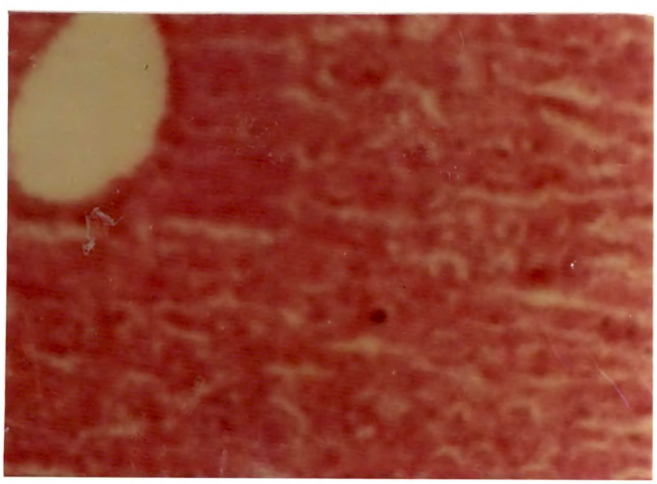


Fig.55 Powdered Roots of *M. pterygosperma* and Rifampicin

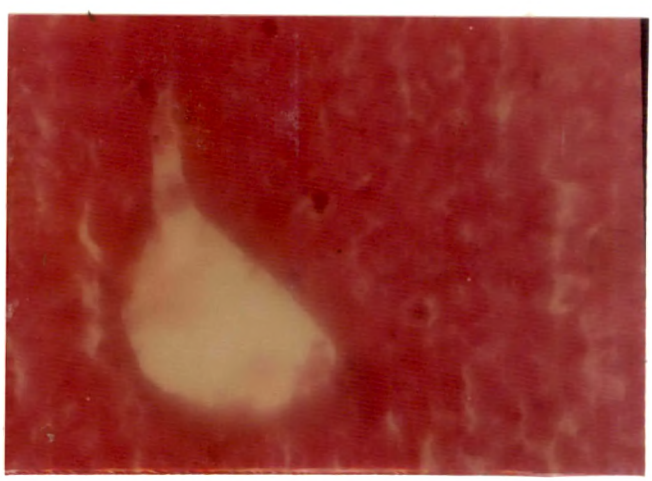


Fig.57 Aqueous Extract of Aerial Parts of *S. rhombifolia* and Rifampicin

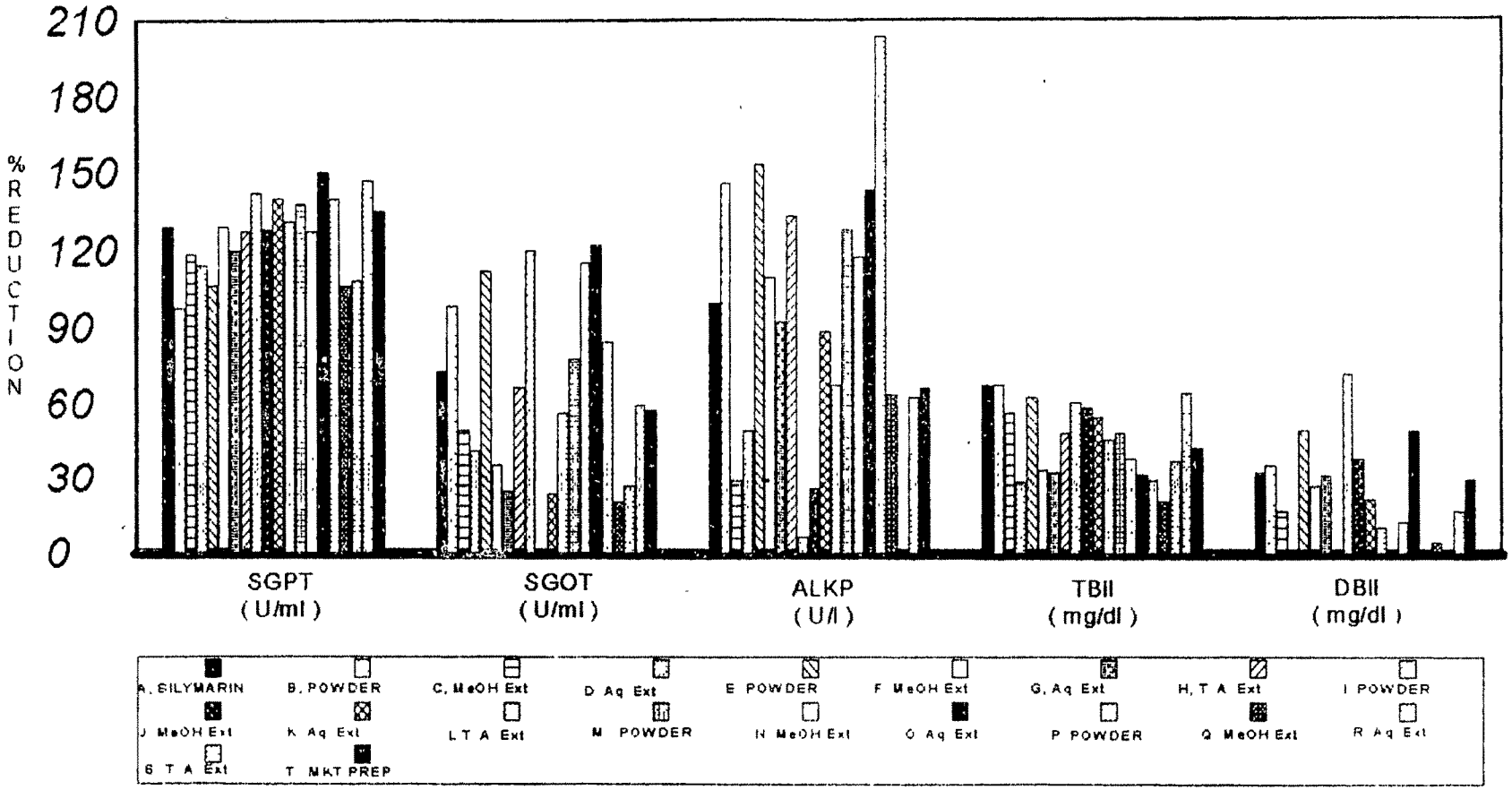
parts of S. rhombifolia showed maximum, significant activity ($P < 0.01$) in terms of reduction in the elevated levels of serum biochemical parameters (SGPT 151.36%, SGOT 122.55%, ALKP 143.88%, TBil 31.67%, DBil 50.00%) followed by powdered roots and aerial parts of S. acuta, methanolic extract of aerial parts of S. rhombifolia, powdered whole plant of S. cordifolia, total aqueous extract of whole plant of S. rhombifolia, marketed preparation, methanolic extract of roots of S. acuta aqueous, aqueous extracts of S. cordifolia, methanolic extract of aerial parts of S. acuta, methanolic extract of roots of S. rhombifolia, powdered roots and aerial parts of S. rhombifolia, methanol extract of whole plant of S. cordifolia total aqueous extract of whole plant of S. acuta, extracts of roots and aerial parts of S. acuta and aqueous extract of roots of S. rhombifolia when placed in descending order of activity. Out of these, the aqueous extract of roots of S. rhombifolia showed minimum activity with a significant reduction ($P<0.01$) in SGPT, SGOT and TBil levels. The aqueous extract of aerial parts of S. rhombifolia showed significantly better reduction ($P<0.01$) in all other serum biochemical parameters except that of TBil compared to those of silymarin. This was further supported by the histopathological examination of liver sections of the group treated with the aqueous extract of aerial parts of S. rhombifolia, which indicated the absence of sinusoidal dilatation and fatty infiltration with normal cellular architecture (Fig. 57). This indicates that the aqueous

TABLE:42 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	BIOCHEMICAL PARAMETERS, MEAN ± SEM				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	76.24±1.61	85.69±2.16	76.17±1.66	1.01±0.03	0.19±0.01
RIFAMPICIN	195.53±3.50	265.46±2.27	141.05±2.91	2.81±0.05	1.21±0.03
SILYMARIN	41.00 ± 0.66* (129.54)	135.07±1.30* (72.53)	76.03±2.26* (100.22)	1.59±0.02* (67.78)	0.87±0.04** (33.33)
SIDA ACUTA(AERIAL PARTS)					
POWDER	78.98±2.22* (97.70)	86.97±1.43*** (99.29)	45.77±1.47*** (146.86)	1.58±0.01** (68.33)	0.84±0.01** (36.27)
METHANOLIC EXTRACT	53.40±1.36* (119.15)	175.69± 0.89* (49.94)	121.43±0.85* (30.24)	1.78± 0.02* (57.22)	1.04± 0.01* (16.67)
AQUEPUS EXTRACT	58.88±0.99* (114.55)	189.79±1.28* (42.09)	108.50± 0.56* (50.17)	2.29± 0.01* (28.89)	1.26± 0.01 (-)
SIDA ACUTA(ROOTS)					
POWDER	68.39±1.49* (106.58)	62.62±1.84*** (112.83)	41.03±1.59*** (154.16)	1.68±0.02** (62.78)	0.70±0.01*** (50.00)
METHANOLIC EXTRACT	40.05±0.57** (130.34)	200.82±1.51* (35.96)	69.50±0.89** (110.28)	2.19±0.01* (34.44)	0.93±0.01** (27.45)
AQUEOUS EXTRACT	50.66±0.57* (121.44)	220.56±2.34* (24.98)	80.43±1.27** (93.43)	2.21±0.01* (33.33)	0.88±0.01** (32.35)
SIDA ACUTA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	43.39±0.86** (127.54)	145.18±1.32*** (66.91)	53.90±1.36*** (134.32)	1.92±0.02* (49.44)	1.21± 0.04 (0.00)
SIDA CORDIFOLIA(WHOLE PLANT)					
POWDER	24.01±1.54*** (143.05)	47.92±0.96*** (121.01)	136.50±1.77 (7.01)	1.72±0.02* (60.56)	0.48±0.01*** (71.57)
METHANOLIC EXTRACT	41.60±0.97** (129.04)	293.40±0.65 (-)	124.40±1 04* (25.66)	1.75±0.03* (58.89)	0.81± 0.01** (39 22)
AQUEOUS EXTRACT	27.65±1.45*** (140.73)	223.13±3.72* (23.57)	83.53±1.76** (88.66)	1.82± 0.02* (55.00)	0.99± 0.02* (21.57)
TOTAL AQUEOUS Ext.	38.26±1.75** (131.84)	163.64±1.37* (56.64)	96.80±2.09* (68.20)	1.98±0.03* (46.11)	1.10±0.03* (10.78)
SIDA RHOMBIFOLIA(AERIAL PARTS)					
POWDER	29.37±1.85*** (139.29)	124.41±2.14*** (78.46)	57.13±2.26*** (129.35)	1.92± 0.03* (49.44)	1.22± 0.03 (-)
METHANOLIC EXTRACT	42.91±1.57** (127.94)	57.78±1.45*** (115.53)	64.27±1.34*** (118.34)	2.10± 0.02* (39.44)	1.08± 0.03* (12.75)
QUEOUS EXTRACT	14.97±0.68*** (151.36)	45.16±0.49*** (122..55)	47.70±1.02*** (143.88)	2.24±0.01* (31.67)	0.70±0.03*** (50 00)
SIDA RHOMBIFOLIA(ROOTS)					
POWDER	27.24±0.79*** (141.08)	113.38±2.86*** (84.60)	8.80±0.21*** (203.84)	2.27± 0.03* (30.00)	1.37± 0.05 (-)
METHANOLIC EXTRACT	67.47± 1.11* (107.35)	2.27± 2.41* (20.98)	99.83± 2.65* (63.53)	2.43± 0.02* (21.11)	1.16± 0.01 (4.90)
AQUEOUS EXTRACT	65.32± 1.19* (109:15)	216.97± 1.54* (26.97)	152.07± 1.15 (-)	2.13± 0.01* (37.78)	1.32± 0.01 (-)
SIDA RHOMBIFOLIA(WHOLE PLANT)					
TOTAL AQUEOUS Ext.	18.48±0.54*** (148.42)	157.23±1.87* (60.20)	99.90± 2.13* (63.42)	1.64± 0.02** (65.00)	1.04± 0.03* (16.67)
MARKETED PREPARATION	32.90±0.76*** (136.33)	160.31± 1.37* (58.49)	97.37± 2 87* (67 32)	2.04± 0.03* (42.78)	0.90± 0.01** (30 39)
Fcalculated	659.83	1505.83	432.97	244.12	154.84
5% Allowance	7.17	9.17	8.69	0.12	0.11

Fcritical = 2.04 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO RIFAMPICIN = *; SILYMARIN = ***; NOT SIGNIFICANT COMPARED TO SILYMARIN = **

Fig. 56 EFFECT OF DIFFERENT ORGANS OF VARIOUS SPECIES OF SIDA ON RIFAMPICIN INDUCED HEPATOTOXICITY



SIDA ACUTA
B,C,D = AERIAL PARTS
E,F,G = ROOTS
H = WHOLE PLANT

SIDA CORDIFOLIA
I,J,K,L = WHOLE PLANT

SIDA RHOMBIFOLIA
M,N,O = AERIAL PARTS
P,Q,R = ROOTS
S = WHOLE PLANT

extract of aerial parts of S. rhombifolia protects the liver completely against rifampicin intoxication.

The comparative account of overall effects of different powdered drugs and extracts of various organs of the selected plant drugs against rifampicin intoxication revealed that the aqueous extract of aerial parts of S. rhombifolia showed maximum, significant activity followed by powdered roots of M. pterygosperma, methanolic extract of roots of I. racemosa, methanolic extract of whole plant of F. indica and powdered rhizomes of C. orchioides when arranged in the descending order of activity.

Thus the hepatoprotective activity of these selected plants might be due to inhibitory activity on the formation of active metabolite, 25-desacetyl rifampin or by activating the RNA polymerases, and thereby prevents fatty liver formation and cirrhosis.

The preliminary screening of different extracts obtained from selected plant drugs for biological activities provided a comparative account on the degree of bioactivity of various extracts, compiled in Table 43. These informations provide means of identification of the most active extracts of individual plant organs against carrageenan induced inflammation, along with CCl_4, paracetamol and rifampicin

TABLE 43: COMPARATIVE ACCOUNT OF THE EXTRACTS OF SELECTED PLANT DRUGS WITH MAXIMUM BIOLOGICAL ACTIVITIES.

PLANT DRUGS	BIOLOGICAL ACTIVITY			
	AIA	*HEPATOPROTECTIVE ACTIVITY*		
	CARRAGEENAN	*CCl_4*	*PARACETAMOL*	*RIFAMPICIN*
C. ORCHIOIDES (Rhizomes)	METHANOLIC Ext.	TOTAL AQUEOUS Ext.	METHANOLIC Ext.	PETROLUM ETHER Ext.
F. INDICA (Whole Plant)	METHANOLIC Ext.	PETROLUM ETHER Ext.	TOTAL AQUEOUS Ext.	METHANOLIC Ext.
I. RACEMOSA (Roots)	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.	METHANOLIC Ext.
M.PTERYGOSPERMA (Fruits)	AQUEOUS Ext.	AQUEOUS Ext.	AQUEOUS Ext.	METHANOLIC Ext.
M. PTERYGOSPERMA (Leaves)	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.
M. PTERYGOSPERMA (Roots)	METHANOLIC Ext.	AQUEOUS Ext.	TOTAL AQUEOUS Ext.	TOTAL AQUEOUS Ext.
M. PTERYGOSPERMA (Stembark)	METHANOLIC Ext.	TOTAL AQUEOUS Ext.	PETROLUM ETHER Ext.	METHANOLIC Ext.
S. ACUTA (Aerial parts, Roots, Whole plant)	AQUEOUS Ext. (Roots)	AQUEOUS Ext. (Aerial Parts)	AQUEOUS Ext. (Aerial Parts)	METHANOLIC Ext. (Roots)
S. CORDIFOLIA (Whole plant)	TOTAL AQUEOUS Ext.	METHANOLIC Ext.	TOTAL AQUEOUS Ext.	AQUEOUS Ext.
S. RHOMBIFOLIA (Aerial parts, Roots, Whole plant)	METHANOLIC Ext.(Aerial Parts)	METHANOLIC Ext.(Aerial Parts)	AQUEOUS Ext. (Roots)	AQUEOUS Ext. (Aerial Parts)

induced liver damage. These most active extracts as identified from the above studies were, therefore, selected after discarding the remaining less active ones for isolation of possible active compounds responsible for biological activity.

3.4 ISOLATION OF CHEMICAL COMPOUNDS FROM THE BIOACTIVE EXTRACTS

The preliminary phytochemical screening and thin layer chromatographic studies revealed the presence of various constituents in the selective bioactive extracts. These extracts were then subjected extensively to various chromatographic studies like thin layer, paper and column chromatography using different adsorbents, like silica gel, alumina and cellulose, solvent systems and developing reagents. Since these studies did not provide satisfactory resolutions, other isolation procedure like fractional extraction method was followed. Out of all these extracts tried for isolation of compounds, petroleum ether extracts of the rhizomes of C. orchioides and whole plant of F. indica, methanolic extract of whole plant of F. indica, total aqueous extracts of whole plant of S. cordifolia and stem bark of M. pterygosperma, petroleum ether extract of the roots of I. racemosa afforded compounds in pure form.

3.4.1 Isolation and Characterisation of the Compounds

The compounds isolated from the fractional extraction in different solvents were purified by recrystallisation and thr purity was confirmed by obtaining singular spot on TLC. The physico-chemical tests and spectral analysis were also then performed on the individual purified compounds for their characterisation.

i. Compounds from the Rhizomes of C. orchioides

Two compounds designated as C-1 and C-2 were isolated from the petroleum ether extract of the rhizomes of C. orchioides.

(a) Compound C-1: The compound C-1 was isolated from the residue left over after saponification of the petroleum ether extract by fractional solvent extraction. The acetone insoluble fraction of the benzene soluble fraction yielded the compound C-1 and was purified by recrystallisation in chloroform.

Description: The compound C-1 appeared as cream coloured amorphous powder with λ max ($CHCl_3$) 203 and 306 nm and decomposed at 145°-150°C. Freely soluble freely in benzene, chloroform and insoluble in acetone, methanol and water.

Elemental Analysis Data: C-73.78%, H - 10.84%, O- 15.38%

Emperical Formula: $C_6H_{10}O$

Mass Spectral Data: The mass spectrum showed a molecular ion

peak at M/E 474 M^+, with a base peak at M/E 43 (C_3H_7). The prominent peaks at 57 (C_3H_5O,CH_3CO) 111,128, 139, 153, 167, 181, 195, 209 (CH_2), 223 (C_3H_5), 264 (C_3H_6) 306 (OH), 323 (C_2H_2), 349(C_3H_7), 392(C_2H_4), 420(C_2H_4), 442(CH_2), 462(C_2H_4)

Molecular Formula: $C_{30}H_{50}O_4$

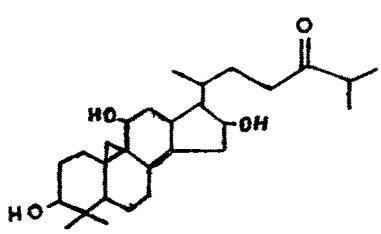
Calculated Elemental content: C-75.95%, H-10.55%, O-13.50%

IR Spectral Data(KBr): The I.R. spectrum showed maxima at 3500 (OH stretch), 2850-2900 (CH stretch), 1600 (C-C multiple bond stretch), 1460 (CH_2 symmetrical stretch), C-OH stretch), 1090(CO stretch of ketones) 700 (CH deformations) Cm^{-1}.

^1H NMR Spectral Data ($CDCl_3$): 8.40 (OH), 1.25 (CO), 0.99, 0.88, 8.85, 0.82, 0.80, 0.07 (several methyl groups) ppm.

^{13}C NMR Spectral Data: 1.019 (methyl group probably at the end of a long chain) 22.689 (methylene group), 29.31 (multiple methylene groups) 77.00 (CH group) ppm.

From the above data and literature, the compound C-1 from the rhizomes of C. orchioides is proposed to have the following probable structure.



3,11,16-Trihydroxycycloartan-24-one

(Curculigenin A) : C-1

(b) Compound C-2: The compound C-2 was isolated from the

methanol soluble fraction of the residue left over after saponification of the petroleum ether extract of the rhizomes of C. orchioides.

Description: The compound occurs as colourless amorphous powder with λmax (MeOH) 254 nm and eecomposed at 165°-170°C. It is freely soluble methanol, sparingly soluble in chloroform and benzene and insoluble in acetone.

Elemental Analysis Data: C-83.09%, H-12.77%, O-4.14%

Emperical Formula: $C_{14}H_{13}O_1$

Mass Spectral Data: The mass spectrum showed the molecular ion peak at M/E 452, M^+ with a base peak at M/E 43 (C_3H_7), 410(C_3H_6), 327 (C_5H_7O), 297(C_6H_{10}), 282 (CH_3), 264(OH), 109(C_8H_{13})

Molecular Formula: $C_{31}H_{52}O_2$

Calculated Elemental content: C-81.58%, H-11.40%, O-7.02%.

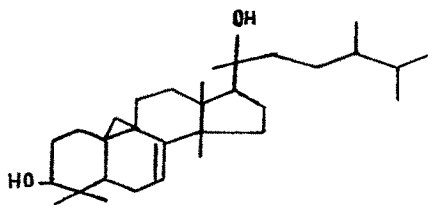
IR Spectral Data (KBr): The IR spectrum showed maxima at 3750-3500 (-OH stretch), 2950(CH_2 stretch), 2850 (C-H stretch, vinyl), 1660 (C-C multiple bond stretch, alkene nonconjugated), 1460 (C-H bending of CH_2)cm^{-1}.

^1H NMR Spectral Data ($CDCl_3$): 0.01, 0.03, 0.05, 0.06, 0.19, 0.85, 0.88, 1.16, 1.18, 1.25, 1.88 ppm ($-CH_3$) 7.26 (C=C) ppm.

^{13}C NMR Spectral Data : 14.43 ($-CH_3$), 24.276 and 33.043 ($-CH_2$), a cluster of peaks at 49.0 ($-CH_2$ or -CH) 75.233 (-C=C-) ppm.

From the above strctural data and literature the

compound C-2 is proposed to have the following probable structure.



24-Methyl cycloart-7-ene-3,20-diol

Curculigol : C-2

ii. Compounds from F. indica

Two compounds designated as F-1 and F-2 were isolated from the methanolic and petroleum ether extracts of whole plant of F. indica respectively.

(a) Compound F-1: The residue from the methanolic extract after fractional extraction afforded a colourless crystalline compound F-1 and was recrystallised from distilled water after treatment with activated charcoal.

Description: The compound F-1 occurs as colourless needle shaped, prismatic and leaflet type crystals. Sparingly soluble in methanol and freely soluble in water. λ max (H_2O) 226 nm and decomposed at 100-105°C.

Elemental Analysis Data: C-46.16%, H-4.65%, O-49.19%.

Emperical Formula: CHO

Mass Spectral Data: The mass spectrum showed the molecular ion peak M^+ at M/E 130 with a base peak at M/E 44 (CH_2-C-H),

M/E 55 (CH_2=CH-C-H), 105 (C_2H)

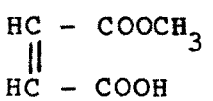
Molecular Formula: $C_5H_6O_4$.

Calculated Elemental content: C-46.15%, H-4.62%, O-49.23%.

IR Spectral Data: 3500 (OH Stretch), 2850 (CH stretch), 1760 (carboxylic acid acyclic ester), 1020 and 1180 (C-O stretch) cm^{-1}.

^1H NMR spectral Data (D_2O): 10.00 (Carboxylate ion), 3.97 (methylene group) ppm.

From the above spectral data and literature the compound F-1 is proposed to have the following probable structure



Monomethyl Fumarate

(b) Compound F-2: The methanol insoluble fraction of the petroleum ether extract yielded a compound F-2, which was recrystallised from acetone. It occurs as colourless, amorphous powder with λ max (Acetone) 322 nm, m.p. 70-80°C. Freely soluble in acetone, sparingly soluble in chloroform and insoluble in methanol.

Elemental Anaysis Data: C-80.34%, H-15.84%, O3.82%.

Mass Spectral Data: M/E 410 M^+, with a base peak at 97 (C_7H_{13}), 43(C_3H_7), 57. 111. 125, 189, 181(CH_2), 337(OH), 439(CH_3).

Molecular Formula: $C_{28}H_{58}O$

Calculated Elemental Content: C-81.87%, H-14.23%, O-3.90%.

IR Spectral Data (KBr): 3450-3500 (OH stretch), 2920-2850 (C-H stretch of alkanes), 1520 (C-H bending of alkane methyl groups) 1020-1180 (O-H bending and C-O stretching of primary alcohols), 1340, 1260 (OH bending), 670-1020 (CH bending) cm^{-1}.

^{1}H NMR Spectral Data ($CDCl_3$): 7.26 (OH) 0.06 (CH_3) ppm.

From the above spectral data and literature the compound F-2 is proposed to have the following probable structure:

$H_3C(CH_2)_{26}CH_2OH$

n-octacosanol

iii. Compound from the roots of I. racemosa

(a) Compound I-1: The methanolic fraction of petroleum ether extract from the roots of I. racemosa, on standing yielded colourless thick needle shaped crystalline compound designated as I-1 which was recrystallised from methanol.

Description: The compound I-1 occurs as colourless, blunt needle shaped crystals with λmax (MeOH) 235 nm and melted at 78°-80°C. Freely soluble in chloroform and sparingly soluble in methanol.

Elemental Analysis Data: C-78.90%, H-9.0%, O-12.10%.

Emperical Formula: $C_8H_{10}O$

Mass Spectral Data: M/E 232 M^+, base peak M/E 91 (C_7H_7), 105 (CH_2), 131 ($C_4H_6O_2$), 217 (CH_3)

Molecular Formula: $C_{15}H_{20}O_2$

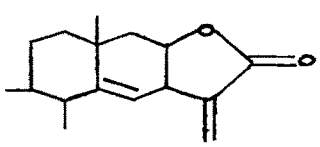
Calculated Elemental content: C-77.60%, H-8.60%, O-13.70%.

IR Spectral Data: 3100 (C-H stretch), 1760 (CO stretch in acyclic or strain free ring, lactone of five membered ring), 1670-1650 (C=C stretch), 930-940 (C-O-C stretch, cyclic anhydride), 500(CO of aldhyde and ketone stretch)cm^{-1}

^{1}H NMR Spectral Data ($CDCl_3$): 2.96 (proton attached to lactone ring) ppm.

^{13}C NMR spectral data: 120 (conjugated double bonds), 18 and 24 (methyl carbons), 34, 36, 42, 49 (Methylene groups as part of carboxylic rings or carbon chains) ppm.

From the above spectral data and literature the compound I-1 is proposed to have the following probable structure.



Alantolactone

5,4 (13)-Eudesmadien-12,8-olide

iv. Compounds from M. pterygosperma

Three compounds designated as M-1, M-2 and M-3 were isolated from the total aqueous extract of stem bark of M. pterygosperma.

(a) Compound M-1: The benzene fraction of the residue of the petroleum ether extract obtained from the total aqueous

extract of stem bark, after saponification, yielded colourless, amorphous powder designated as compound M-1 with λmax (MeOH) 388 nm and decomposed at 179-185°C. Sparingly soluble in water, freely soluble in chloroform, benzene and alcohol.

Elemental analysis Data: C-60.15%, H-5.0%, O-34.85%

Emperical Formula : CHO

Mass Spectral Data: M/E 152 M^+, base peak at M/E 43(C_3H_3O), 71(C_3H_2), 98(OH), 100 (OCH_3), 123(C_6H_5COO).

Molecular Formula: $C_8H_8O_3$

Calculated Elemental content: C-63.15%, H-5.30%, O-31.55%.

IR Spectral Data (KBr): 2850 (Aryl C=O stretch), 1640 (C-C multiple bond stretch, C=C).

1560 (CO stretch of C-OH), 1470 (CH_2 symmetrical stretch) 1020 (C-O-C symmetric stretch) 700 (C-H deformations, Aromatic)cm^{-1}.

^1H NMR Spectral Data: ($CDCl_3$): 0.07, 0.86, 0.20, 0.88, 0.97 ($-CH_3$), 7.26 (Aromatic nucleus) ppm.

^{13}C NMR Spectral Data: 14.38, 23.68 ($-CH_3$), 27.76, 28.15, 30 to 33, 39.21, 49 (CH_2 or CH), 130.80 (Aromatic nucleus).

From the above available data, the structure of the compound M-1 could not elucidated for the want of confirmatory chemical tests and spectral details.

(b) Compound M-2: The marc left over after successive solvent fractionation of the total aqueous extract on acidic hydrolysis followed by extraction with diethyl ether yielded the compound M-2. It occurs as colourless, spherical crystals with λmax (MeOH) 206 nm and sublimed at 195-200°C. Freely soluble in methanol, acetone and water, sparingly soluble in chloroform.

Elemental Analysis Data: C-40.6%, H-3.8%, O-56.6%

Emperical Formula: CHO

Mass Spectral Data: M/E 116 M^+, base peak at M/E 45 (COOH), 60(CH_2COOH), 71(HC=CH-COOH)

Molecular formula: $C_4H_4O_4$

Calculated Elemental Content: C-41.89%, H-3.47%, O-55.14%

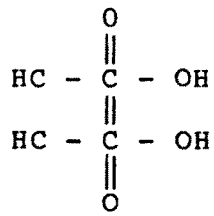
IR Spectral Data (KBr): 3100 (CH stretch), 1420 (CO stretch of COOH), 1700 (COOH stretch), 1660

C=C, C=O stretch)cm^{-1}.

^1H NMR Spectral Data ($CDCl_3$): 6.8 (protons of OH), 7.2 (protons of COOH) ppm.

^{13}C NMR Spectral Data: 48.431, 49.002, 49.284, 49.565 (CG_2 or CH), 135.15 (C=C), 168.041 (COOH with unsaturation) ppm.

From the above spectral data and literature the compound M-2 is proposed to have the following probable structure.



Fumaric acid

(Butenedioic acid)

(c) Compound M-3: The methanolic fraction of the residue after saponification of the petroleum ether extract, obtained from the total aqueous extract of stem bark, yielded brown amorphous powder designated as M-3. λ max (MeOH) 237, 311 nm and decomposed at 220-225°C. Freely soluble in methanol, acetone and insoluble in benzene and chloroform.

Elemental Analaysis Data: C-59.38%, H-4.49%, O-36.13%

Emperical Formula: C_2H_2O

Mass Spectral Data: M/E 180 M^+, base peak at M/E 45 (COOH), 71 (C=C), 149 (C_6H_5), 167 (OH).

Molecular Formula: $C_9H_8O_4$

Calculated Elemental content: C-60.0%, H-4.48%, O-35.52%

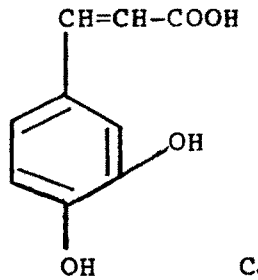
IR Spectral Data (KBr): 3800, 3550, 3480 (OH stretch), 2950 (CH stretch), 1720 (unsaturated COOH stretch), 1460 (CH bend, CO stretch, C-C aromatic multiple bond stretch) 1120 (phenolic OH) cm^{-1}.

^1H NMR Spectral Data: (MeOH): 6.90 (Aromatic nucleus, unsaturation, OH protons, COOH protons) ppm

^{13}C NMR Spectral Data: 49(CH_2 or CH, -OH protons) ppm.

From the above spectral data and literature the compound

M-3 is proposed to have the following probable structure.



Caffeic acid

(3,4-dihydroxy cinnamic acid)

v. Compounds from S. cordifolia

One compound designated as S-1 was isolated from the total aqueous extract of the whole plant of S. cordifolia.

(a) Compound S-1: The diethyl ether fraction of acid hydrolysed total aqueous extract yielded colourless flakes or spherical crystalline compound, S-1 with max(MeOH)-212 nm and decomposed at 195-200°C. Freely soluble in methanol, acetone and water and insoluble in chloroform and benzene.

Elemental Analysis Data: C-42.0%, H-4.0%, O-54.0%

Emperical Formula: CHO

Mass Spectral Data: M/E 116 M^+, base peak at 45 (COOH), 50 (CH_2COOH), 71(C=C-COOH)

Molecular Formula: $C_4H_4O_4$

Calculated Elemental Content: C-41.38%, H-3.45%, O-55.17%.

IR Spectral Data(KBr): 3775 (OH stretch), 3100 (CH stretch), 1685 (CO stretch of COOH), 1420 (COOH).

^1H NMR Spectral Data (MeOH):. 6.75 (OH proton, COOH protons) ppm.

^{13}C NMR Spectral Data: 48.44, 49.00, 49.29, 49.54 (CH_2 or CH), 135.14(conjugated double bonds), 168.03(unsaturated acid).

From the above spectral data and literature, the compound S-1 is proposed to have the following probable structure.

HC - COOH
‖
HC - COOH Fumaric acid
(Butenedioic acid)
(1,2-ethylene dicarboxylic acid)

3.4.2 Biological Studies on the Isolated Compounds from the Selected Plant Drugs

The compounds isolated from the bioactive extracts were subjected to biological studies in both in vitro and in vivo models to evaluate their hepatoprotective activities. In case of in vitro hepatoprotective testing, these were studied against galactosamine and thioacetamide induced liver cytotoxicities, while in case of in vivo testing, these were studied against CCl_4, paracetamol and rifampicin induced hepatotoxicities. The effects on normal liver functions were also recorded prior to proceeding for hepatoprotective and anti-inflammatory activities.

TABLE:44 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON VIABILITY OF NORMAL RAT HEPATOCYTES				
GROUP	VIABILITY , MEAN ± SEM (% PROTECTION)			
	% VIABLE CELLS			OXYGEN UPTAKE (ul/hr/mg Protein)
CONTROL	98.05 ± 0.56			4.13 ± 0.13
ISOLATED COMPOUNDS	CONCENTRATION (ug /ml)			
	10	100	1000	1000
C-1	91.08±0.11	94.12±0.12	95.48±0.11	4.10±0.10*
C-2	93.25±0.11	94.08±0.18	92.51±0.11	4.01±0.11*
F-1	91.30±0.14	90.10±0.11	87.94±0.20	3.88±0.07*
F-2	94.15±0.08	95.02±0.19	92.02±0.16	3.98±0.16*
I-1	93.28±0.11	92.11±0.12	95.99±0.07	4.26± 0.20*
M-1	95.13±0.17	96.05±0.11	97.19±0.19	4.36±0.05*
M-2	96.27±0.23	97.01±0.21	98.02±0.12*	4.29±0.06*
M-3	92.14±0.14	91.20±0.14	90.15± 0.11	4.24±0.14*
S-1	97.39±0.04*	98.05±0.09*	99.10±0.10	4.69±0.07*
Fcalculated	279.54(A)			2.57 (B)
5% Allowance	0.84			0.61
Fcritical = 1.74 (A); 2.80 (B) (P < 0.01); NOT SIGNIFICANT COPARED TO CONTROL=*				

i. Effect of the Isolated Compounds on Normal Rat Hepatocytes

All these isolated compounds were studied for their effects on normal rat hepatocytes isolated by the collagenase perfusion technique of Seglen modified by Visen et al. The percentage viability of hepatocytes was studied by determining the percentage number of viable cells using trypan blue exclusion method and oxygen uptake using Gilson's oxygraph and the results are recorded (Table 44). The studies revealed that the values obtained of all the compounds were almost comparable with those of control (viable cells 98.05%, oxygen uptake - 4.13 ul/hr/mg protein) values indicating that the isolated compound are not cytotoxic in nature.

ii. In vitro Hepatoprotective Activity Testing

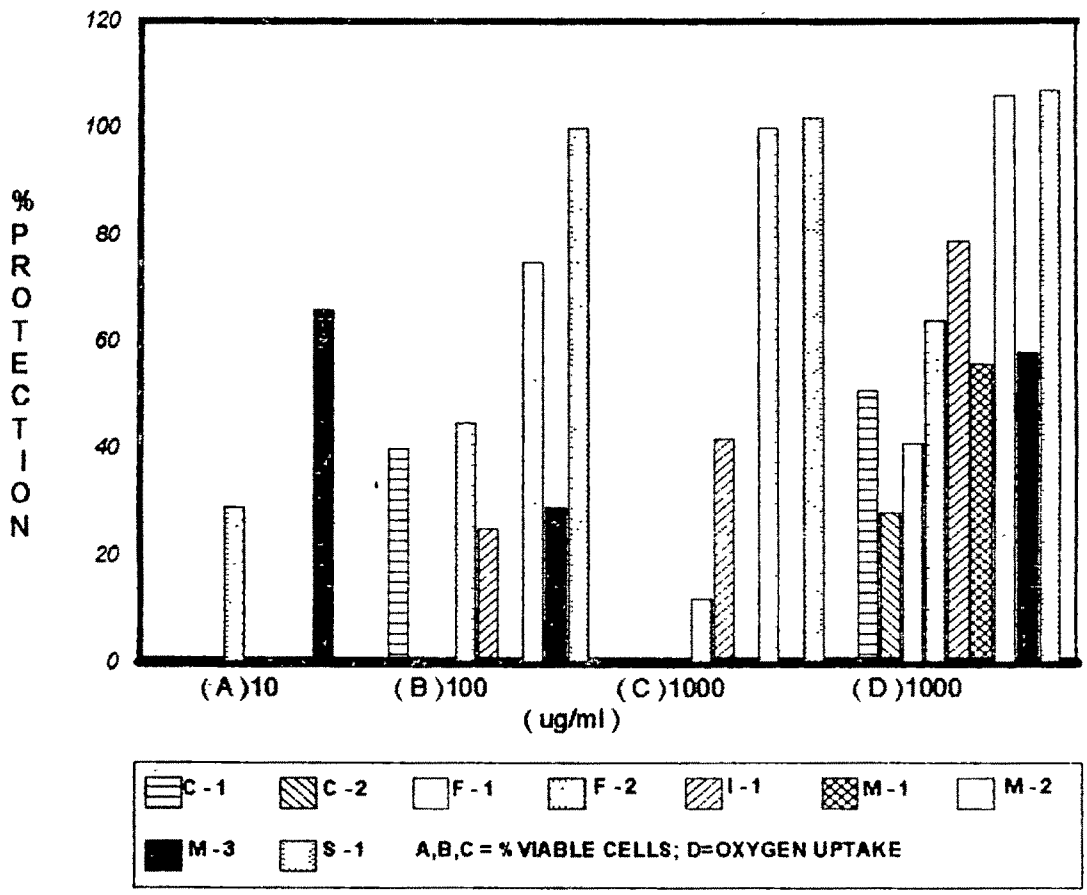
In vitro hepatoprotectivity of the isolated compounds from the selected plant drugs were studied against galactosamine and thioacetamide induced cytotoxicities.

(a) Effect of isolated compounds on galactosamine induced hepatic cytotoxicity: Incubation of isolated rat hepatocytes with galactosamine significanly (P 0.01) reduced the viability (% viable cells from 98.05 to 50.01 and oxygen up take from 4.13 to 1.98 ul/hr/mg protein) indicating its cytotoxicity (Table 45, Fig.58). Almost 100% protection was observed by pretreatment with compound M-2 at the dose of 1000 ug/ml. The compound M-3 showed 65% protection at the

TABLE:45 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON VIABILITY OF GALACTOSAMINE INDUCED HEPATIC CYTOTOXICITY

GROUP	VIABILITY , MEAN ± SEM (% PROTECTION)			
	% VIABLE CELLS			OXYGEN UPTAKE (ul/hr/mg Protein)
CONTROL	98.05 ± 0.56			4.13 ± 0.13
GALACTOSAMINE	50.01 ± 0.11			1.98 ± 0.02
ISOLATED COMPOUNDS	CONCENTRATION (ug /ml)			
	10	100	1000	1000
C-1	48,65±0.94 (-)	69.05±1.03* (39,63)	41.51±0.55 (-)	3.07±0.02* (50.70)
C-2	48.57±1.03 (-)	32.35±0.08 (-)	20.10±0.76 (-)	2.58±0.04* (27.91)
F-1	12.50±0.54 (-)	13.29±1.43 (-)	32.50±0.32 (-)	2.86±0.01* (40.93)
F-2	68.39±0.58* (28.89)	71.43±0.54* (44.59)	55.56±0.07* (11.55)	3.36±0.08* (64.19)
I-1	47.83±0.83 (-)	61.98±1.43* (24.92)	70.37±1.12* (42.38)	3.68±0.04 * (79.07)
M-1	23.53±0.46 (-)	37.50±1.03 (-)	47.54±0.95 (-)	3.18±0.04* (55.81)
M-2	25.10±0.48 (-)	86.11±1.39* (75.15)	98.1 ±1.01* (100.10)	4.26±0.04* (106.05)
M-3	81.63±0.95* (65.80)	64.15±0.54* (29.43)	50.01±1.35 (0.00)	3.23±0.10* (58.14)
S-1	32.50±0.94 (-)	98.10 ± 1.03* (100.10)	99.10±1.12* (102.19)	4.28±0.05* (106.98)
Fcalculated	851.74 (A)			136.61 (B)
5% Allowance	4.32			0.30
Fcritical = 1.73(A); 2.67(B) (P<0.01); SIGNIFICANT PROTECTION COMPARED TO GALACTOSAMINE=*				

Fig. 58 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON VIABILITY OF GALACTOSAMINE INDUCED HEPATIC CYTOTOXICITY



dose of 10 ug/ml. However, the higher doses did not show any activity. Compounds C-1, F-2 and S-1 exhibited protection at the dose of 100 ug/ml which was not dose dependent. The compounds C-2, F-2 and M-1 were, however, found inactive in all the three dose range against galactosamine induced toxicity. The oxygen uptake values at the dose of 100 ug/ml were singificantly ($P < 0.01$) corresponding to the active compounds, supporting their protective action.

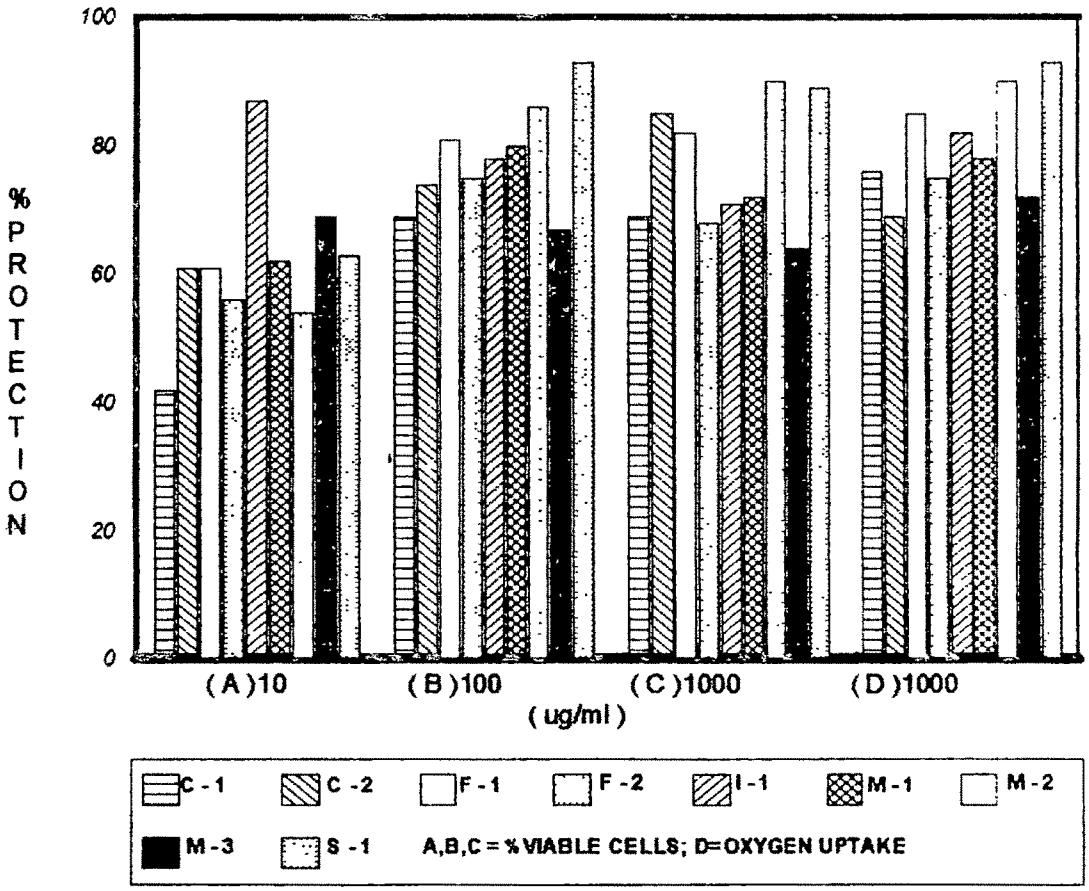
Galactosamine induces hepatotoxicity either by lowering the levels of uracil nucleotides (UTP, UDP glucose and UDP galactose) that results in inhibition of RNA synthesis or by stimulating hepatic regeneration, or by activating the functions of reticuloendothelial system or by inhibiting protein synthesis. Thus the protective effect of these compounds might be due to their effects on any one of these mechanisms.

(b) Effect of isolated compounds on thioacetamide induced hepatic cytotoxicity: Thioacetamide treatment resulted in the reduction of percentage viability of the isolated rat hepatocytes (% viable cells from 98.05 to 24.73, and oxygen uptake from 4.13 to 0.98 ul/hr/mg/protein) indicating cytotoxicity. (Table 46, Fig 59). All the compounds offered significant protection ($P < 0.01$) against thioacetamide induced cytotoxicity. Out of these compounds, the compounds S-1 showed maximum protection while the compound M-3 showed

TABLE:46 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON VIABILITY OF THIOACETAMIDE INDUCED HEPATIC CYTOTOXICITY

GROUP	VIABILITY, MEAN ± SEM (% PROTECTION)			
	% VIABLE CELLS			OXYGEN UPTAKE (ul / hr / mg Protein)
CONTROL	98.05 ± 0.56			4.13 ± 0.13
Thioaceta-mide	24.73 ± 1.14			0.98 ± 0.01
Isolated Compounds	CONCENTRATION (ug /ml)			
	10	100	1000	1000
C- 1	55.56 ± 1.07 (42.05)	75.53 ± 1.02 (69.29)	75.56 ± 1.02 (69.33)	3.37 ± 0.04 (75.87)
C-2	69.17± 0.97 (60.61)	78.89 ± 1.20 (73.87)	86.81 ± 1.06 (84.67)	3.15 ± 0.11 (68.89)
F-1	69.33 ± 1.10 (60.83)	84.31 ± 0.07 (81.26)	84.81 ± 0.56 (81.94)	3.66 ± 0.06 (85.08)
F-2	65.66 ± 1.02 (55.82)	79.37 ± 0.59 (74.56)	74.76 ± 1.31 (68.24)	3.34 ± 0.05 (74.92)
I-1	88.31 ± 1.12 (86.72)	82.05 ± 0.60 (78.18)	76.69 ± 1.16 (70.87)	3..56 ± 0.04 (81.90)
M-1	70.00 ± 0.63 (61.74)	78.95 ± 1.43 (79.95)	77.55 ± 1.05 (72.04)	3.44 ± 0.14 (78.10)
M-2	64.47 ± 0.64 (54.20)	88.04 ± 0.49 (86.35)	90.40 ± 1.05 (89.57)	3.82 ± 0.07 (90.16)
M-3	75.49 ± 0.52 (69.23)	73.86 ± 1.02 (67.01)	71.88 ± 1.20 (64.31)	3.25 ± 0.13 (72.06)
S-1	70.59 ± 1.31 (62.55)	92.96 ± 0 54 (93 08)	90.01 ± 1 15 (89.03)	3.91 ± 0.07 (93.02)
Fcalculated	198 41(A)			113.32(B)
5% Allowance	4.71			0.38
Fcritical = 1.73 (A) ; 2.67 (B) (P < 0.01), ALL SHOWED SIGNIFICANT PROTECTION COMPARED TO THIOACETAMIDE				

Fig. 59 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON VIABILITY OF THIOACETAMIDE INDUCED HEPATIC CYTOTOXICITY



minimum protection. The compound M-2 showed similar activity compared to that of the compound S-1. The activity was followed by the compounds F-1, M-1, I-1, F-2, C-2, C-1, and M-3 when placed in descending order. This was further confirmed by their oxygen uptake values. The compounds showed better protection against thioacetamide than galactosamine induced cytotoxicity.

Thioacetamide has been widely used to produce varying grades of liver damage in rats. It has been reported to induce liver damage by inhibiting the respiratory metabolism of the liver due to the uncontrolled entry of calcium ion into the hepatocytes resulting in inhibition of oxidative phosphorylation. It also causes some metabolic disturbances like increase in the RNA and the protein content of the nuclear fraction of hepatocytes. These compounds therefore might be showing activity by preventing the uncontrolled entry of calcium ions into the liver cells or by rise in the RNA and protein content of the nuclear fraction of hepatocytes and thereby protects hepatocytes against thioacetamide induced toxicity.

iii. In vivo Hepatoprotective Activity of the Isolated Compounds:

Out of all the isolated compounds only the compounds F-1, I-1 and S-1 were tested for in vivo biological activities since their yields were sufficient and also because of

encouraging results obtained from *in vitro* hepatoprotective activity studies.

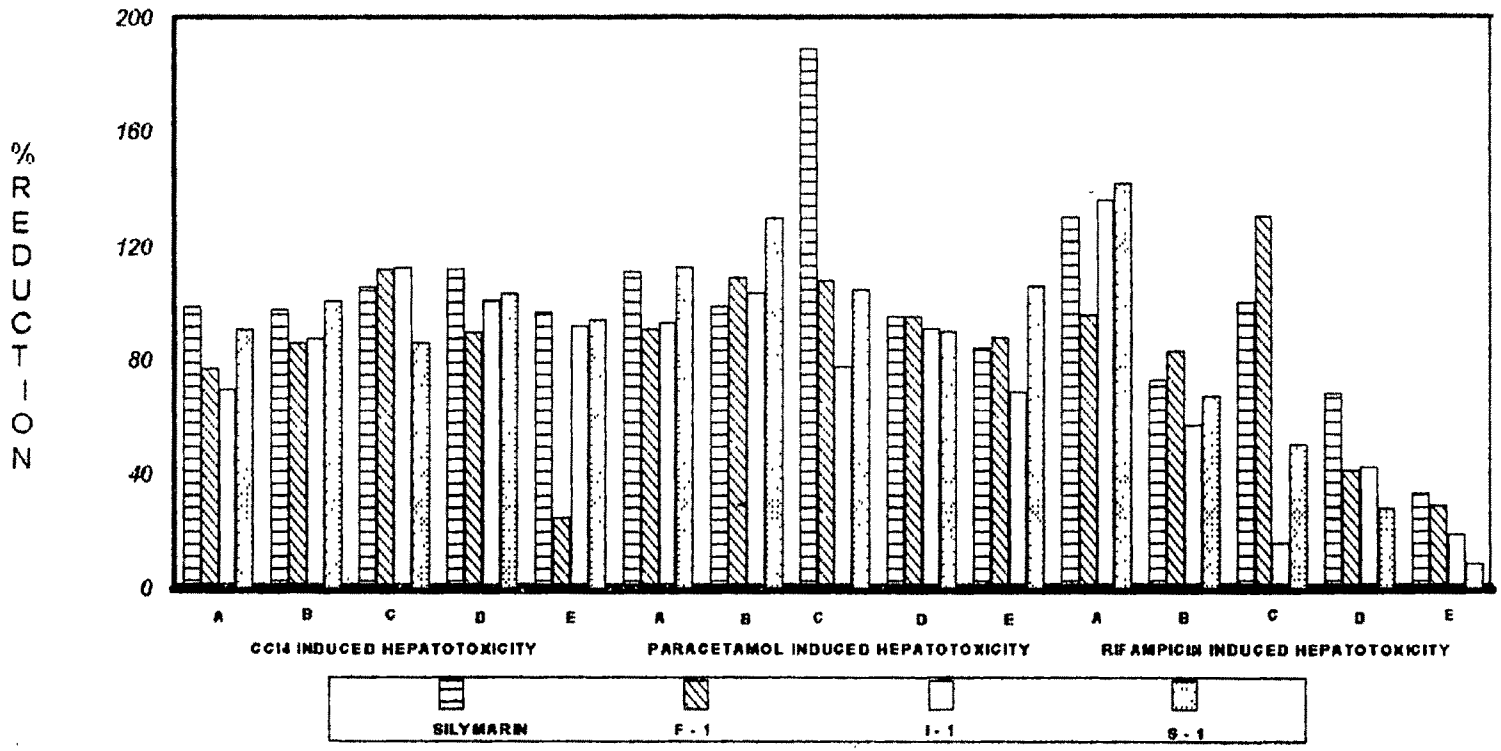
(a) *Effect on normal hepatic functions*: The effect of different compounds isolated from the selected plant drugs showed levels of serum biochemical parameters almost similar to those of control indicating that these are safe at the administered dose regimens (Table 47).

(b) *Effect on CCl_4 intoxicated hepatic functions*: The effect of different compounds isolated from the selected plant drugs on CCl_4 intoxicated rats are recorded in Table 47, Fig.60. All the compounds showed significant reductions ($P < 0.01$) in the elevated levels of serum biochemical parameters when compared to those of CCl_4 The compound S-1 (from *S. cordifolia*) showed maximum significant ($P < 0.01$) hepatoprotective activity (SGPT -91.11%, SGOT 101.36%, ALKP - 86.16%, TBil - 104.31% and DBil 93.85%) followed by the compounds I-1 and F-1. The compound S-1 also showed similar reductions in the elevated levels of SGPT, SGOT and DBil compared to those of silymarin. This was further confirmed by histopathological examinations which indicated almost normal architecture of liver cells without any signs of necrosis (Fig.61). The protective effect of these compounds against CCl_4 intoxication is probably due to their inhibitory activities on free radical formation or on lipid peroxidation.

TABLE:47 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON NORMAL AND INTOXICATED HEPATIC FUNCTIONS

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM (% REDUCTION)				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
NORMAL HEPATIC FUNCTIONS					
CONTROL	56.96±3.24	137.53±12.28	169.05±4.66	1.23±0.03	0.20±0.01
SILYMARIN	37.19±2.14*	122.82±1.10*	90.73±1.40*	1.22±0.02*	0.38±0.01*
F-1	24.59±0.30*	87.74±1.08	84.47±3.32	0.84±0.02	0.27±0.01*
I-1	36.25±1.30*	92.62±1.49	115.20±2.07	0.97±0.01	0.40±0 01
S-1	19.61±2.84*	102.62±2.57	133.97±3.45	0.79±0.04	0.31±0.02
CARBON TETRACHLORIDE INTOXICATED HEPATIC FUNCTIONS					
CONTROL	56.96±3.24	137.53±12.28	169.05±4.66	1.23±0.03	0.20±0.01
CARBON TETRACHLORIDE	725.51±38.03	1160.77 ±52.08	456.70±13.15	3.55±0.11	1.50±0.03
SILYMARIN	65.45±1.54* (98.73)	152.95±2.47* (98.49)	150.63±1.54* (106.40)	0.71±0.02* (122.41)	0.24±0.01* (96.92)
F-1	211.26±5.44* (76.92)	282.87±2.99* (85.80)	134.78±2.48** (111.91)	1.47±0.02* (89.66)	1.18±0.02* (24.62)
I-1	257.02±2.40* (70.08)	259.03±2.74* (88.13)	131.67±3.27** (113.17)	1.21±0.01* (100.86)	0.30±0.01** (92.31)
S-1	116.39±2.20** (91.11)	123.62±1.79** (101.36)	208.87±1.57* (86.16)	1.13±0.01* (104.31)	0.28±0.01** (93.85)
PARACETAMOL INTOXICATED HEPATIC FUNCTIONS					
CONTROL	58.98±0.63	137.53±1.27	182.67±0.79	0.88±0.02	0.25±0.01
PARACETAMOL	265.28±3.14	356.00±5.17	313.49±7.40	3.42±0.17	0.57±0 03
SILYMARIN	36 47±1.16* (110.91)	139.06±1.42* (99.30)	66.20±0.57* (189.03)	1.00±0.01* (95 28)	0.30±0.01* (84.38)
F-1	77.61±2.04** (90.97)	117.76±3.96** (109.05)	171.70±4 17** (108.35)	1.00±0.02** (95.28)	0.29±0.01** (87.50)
I-1	74.08±2.01** (92 68)	128.51±1.79** (104 13)	211.07±4.32 (78.29)	1.12±0.01** (90.55)	0.35±0 01** (68 75)
S-1	32.88±1.50** (112.65)	72.78±1.03** (129.64)	176 07±3.32** (105.05)	1.14±0.01** (89.76)	0.23±0 01*** (106.25)
RIFAMPACIN INTOXICATED HEPATIC FUNCTIONS					
CONTROL	76 24±1.61	85.69±2.16	76.17±1.66	1.01±0.03	0.19±0.01
RIFAMPICIN	195.53±3.50	265.46±2.27	141.05±2.91	2.81±0.05	1.21±0.03
SILYMARIN	41.00±0.66* (129.54)	135.07±1.30* (72.53)	76.03±2.26* (100.22)	1.59±0.02* (67.78)	0.87±0.04* (33 33)
F-1	80.75±4.29* (96 22)	116 31±4.75*** (82.97)	56 47±2 35*** (130.36)	2.08±0.03* (40.56)	0.91±0.02** (29 41)
I-1	33.29±1.39** (136.00)	163.64±1.94* (56.64)	130 57±1.55 (16.15)	2.05±0.01** (42.22)	1.02±0.02 (18.63)
S-1	25.65±1.55** (142.41)	145.18±3 24** (66.91)	108 47±6.55* (50.22)	2.30±0 24* (28.33)	1.12±0.09 (8.62)
Fcalculated					
Normal	37.61	13 63	116.46	63.75	23.44
Carbon Tetrachloride	253.02	334.51	432.55	470.31	1150.60
Paracetamol	2.25	1.11	2.97	192.00	72.31
Rifampicin	627.50	472.56	102.07	36.67	65.83
5% Allowance					
Normal	11 02	26 64	14 92	0 12	0 08
Carbon Tetrachloride	74 44	103.34	28 27	0 22	0 08
Paracetamol	114 27	153 39	135 58	0.33	0.07
Rifampicin	11 86	13 36	15 75	0.48	0.21
Foritical	Normal = 4.18; CCl 4, Paracetamol , Rifampicin = 3.70 (P < 0.01); Dose : F-1, I-1 = 50 mg/kg, p o ; S-1 = 20 mg/kg, p.o				

Fig. 60 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON INTOXICATED HEPATIC FUNCTIONS



A = SGPT(U/ml); B = SGOT(U/ml); C = ALKP(U/l); D = TBil(mg/dl); E = DBil(mg/dl)

Photomicrographs of Liver Sections of Rats Treated With:

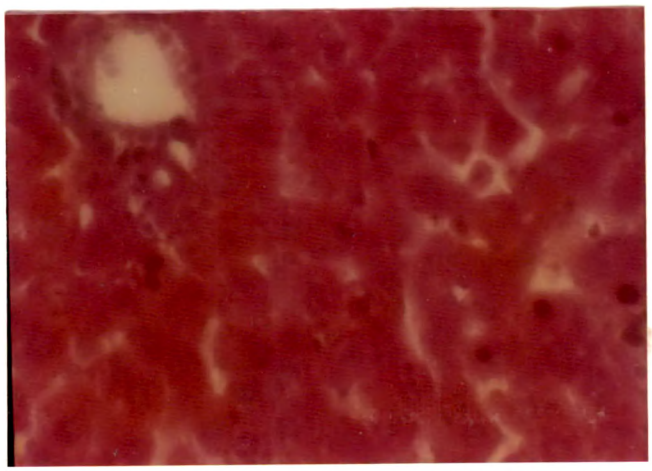


Fig.61 Compound S-1 from S. cordifolia and CCl_4

Fig.62 Compound S-1 from S. cordifolia and Paracetamol

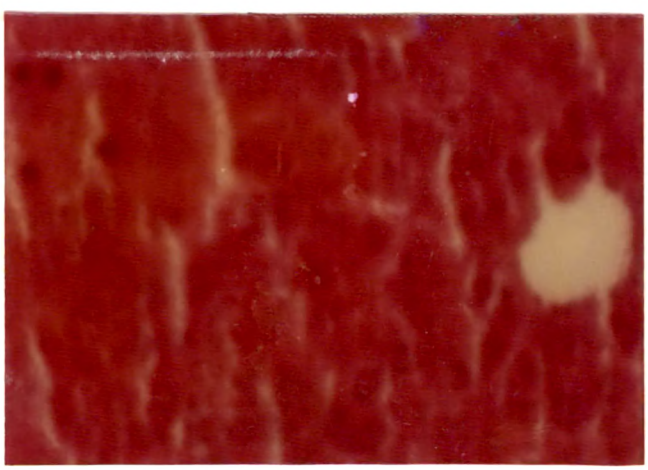


Fig.63 Compound F-1 from F. indica and Rifampicin

(c) Effect on paracetamol intoxicated hepatic functions: Effect of different compounds isolated from the selected plant drugs on paracetamol intoxicated rats provided following information (Table 47, Fig. 60) . All the compounds showed significant reductions ($P < 0.01$) in the elevated levels of serum biochemical parameters compared to those of paracetamol. The compound S-1 (S. cordifolia) showed maximum hepatoprotective activity (SGPT 112.65%, SGOT 129.64%, ALKP 105.05%, TBil 89.76%, DBil 106.25%) followed by that of F-1 and I-1. Almost all the compounds showed similar reductions in the elevated levels of serum biochemical parameters compared to those of silymarin. The histopathological studies also indicated further evidence of hepatoprotective activity of S-1 showing almost normal liver cell architecture without any signs of necrosis (Fig.62). The protective effect of these compounds against paracetamol intoxication might be due to either inhibition of cytochrome P-450 and protein synthesis or by promotion of its glucuronidation or by stimulation of hepatic regeneration and reticuloendothetal system.

(d) Effect on rifampicin intoxicated hepatic functions: The effects of isolated compounds on rifampicin intoxicated rats are recorded in Table 47. Almost all showed significant reduction ($P < 0.01$) in serum biochemical parameters compared to those of rifampicin.(Fig. 60). The compound F-1 showed

TABLE. 48: EFFECT OF DIFFERENT COMPOUNDS ISOLATED FROM THE SELECTED PLANT DRUGS ON CARRAGEENAN INDUCED PAW OEDEMA

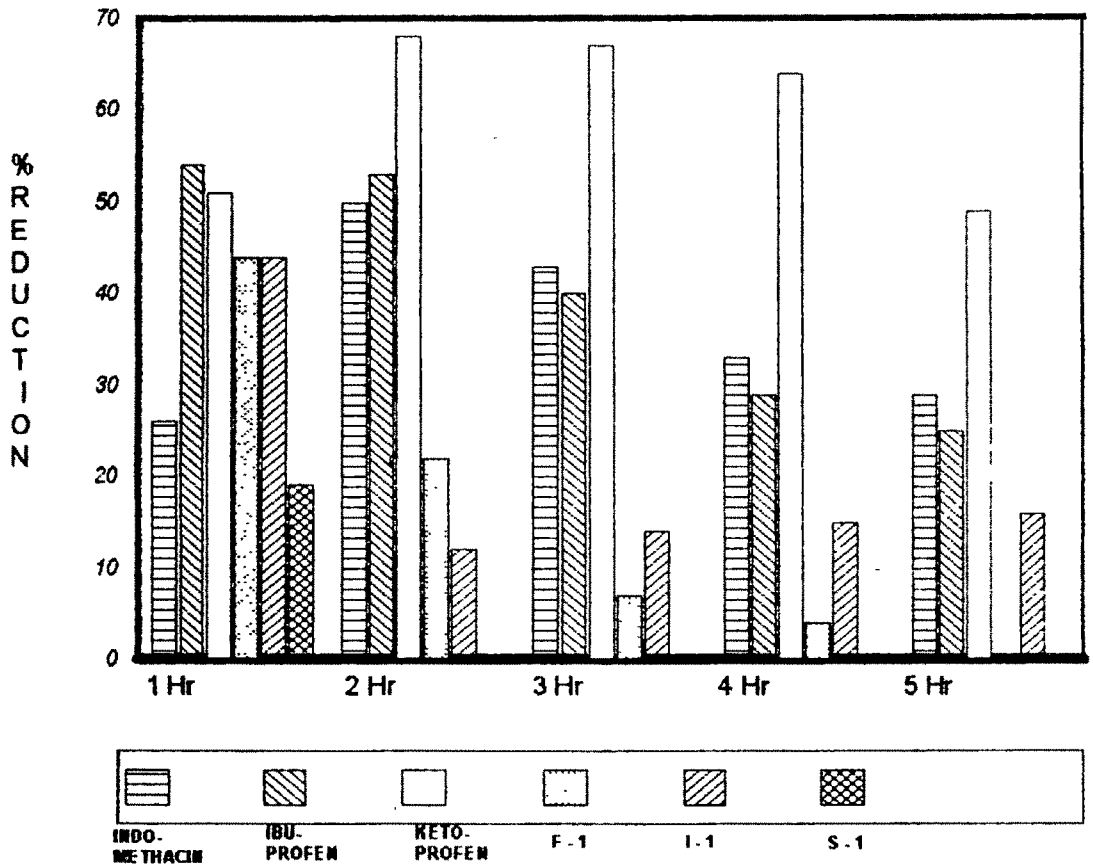
GROUP	MEAN DIFFERENCES IN PAW VOLUMES (ml) ± SEM (% REDUCTION)				
	1 HR	2 HR	3 HR	4 HR	5 HR
CONTROL	0.43 ± 0.01	0.68±0.04	0.73 ± 0.02	0.75 ± 0.03	0.77± 0.02
INDO-METHACIN	0.32 ± 0.02* (25.6)	0.34 ± 0 02* (50.0)	0.42 ± 0.03* (42.5)	0.50 ± 0.04* (33.3)	0.55 ± 0.03* (28.6)
IBUPROFEN	0.20 ± 0.00** (53.5)	0.32 ± 0.01* (52.9)	0.44 ± 0.01* (39.7)	0.53 ± 0.03* (29.3)	0.58 ± 0.02* (24.7)
KETOPROFEN	0.21 ± 0.02** (51.2)	0.22 ± 0.02** (67.7)	0.24 ± 0.02*** (67.1)	0.27 ± 0.03*** (64.0)	0.39 ± 0.03*** (49.4)
F - 1	0.24 ± 0.02* (44.2)	0.53 ± 0.01* (22.1)	0.68 ± 0.01 (6.8)	0.72 ± 0.02 (4.0)	0.78 ± 0.02 (-)
I - 1	0.24 ± 0.01* (44.2)	0.60 ± 0.02 (11.8)	0.63 ± 0.02* (13.7)	0.64 ±0.02 (14.7)	0.65 ± 0.02 (15.6)
S - 1	0.35 ± 0.00 (18.6)	0.68 ± 0.01 (0.0)	0.77 ± 0.01 (-)	0.80 ± 0.02 (-)	0.82 ± 0.02 (-)
$F_{calculated}$	*30.00*	*61.70*	*112.50*	*41.84*	*32 56*
5%Allowance	*0.13*	*0.11*	*0.09*	*0.14*	*0.13*

*$F_{CRITICAL}$ = 3.38 (P<0.01); SIGNIFICANT REDUCTIONS COMPARED TO : CONTROL : *; INDOMETHACIN : **; IBUPROFEN : ***; KETOPROFEN : ****

DOSE: F - 1 and I - 1 = 50 mg/Kg, p.o.

S - 1 : 20mg/Kg, p.o.

Fig. 64 EFFECT OF DIFFERENT ISOLATED COMPOUNDS ON CARRAGEENAN INDUCED PAW OEDEMA



maximum protective activity (SGPT - 96.22%, SGOT 82.97%, ALKP 130.36%, TBil 40.56%, DBil 29.41%) against rifampicin intoxication followed by compounds S-1 and I-1. The compound F-1 showed significant reduction ($P < 0.01$) in SGOT and ALKP compared to that of silymarin. This was further suported by histopathological examinations indicating almost normal liver cell architecture without any necrosis (Fig.63). The protective effect of these compounds against rifampicin intoxication might be due to inhibition of the formation of active metabolite, 25-desacetyl rifampin or by activating RNA polymerases.

(e) Effect of Compounds on Carrageenan induced artificial paw oedema: The effect of different compounds on carrageenan induced paw oedema are recorded in Table 48, Fig.68.

All the compounds showed peak reduction in oedema within the first hour of carrageenan administration like that of ibuprofen. Out of these, the compound I-1 showed the best inhibitory activity followed by the compounds F-1 and S-1, the compounds I-1 and F-1 showed comparable significant ($P < 0.01$) oedema suppressant activity at first hour of carrageenan administration. These might show comparable activity to that of standard drugs by increasing their dose of administration. Their oedema suppressant activity might be due to their inhibitory activity in the release of histamine, serotonin and kinin like substances.

3.5 STUDIES ON MARKETED PREPARATIONS OF THE SELECTED PLANT DRUGS

Some of the available marketed preparation of the selected plant drugs were subjected to hepatoprotective and anti-inflammatory activities even though their labelled claims are different, since these plants exhibited these activities.

3.5.1 Effects on Normal Hepatic Functions

The effects of different marketed preparations of the selected plant drugs on normal hepatic functions are recorded (Table 49). These studies indicated that none of the tested marketed preparations increased the levels of serum biochemical parameters indicating them to be safe at the administered dosage regimen.

3.5.2 Effects on CCl_4 Induced Hepatotoxicity

Effects of different marketed preparations on CCl_4 intoxicated rats are recorded (Table 50, Fig.65). Almost all the marketed preparations showed significant reductions ($P < 0.01$) in the elevated levels of serum biochemical parameters when compared to CCl_4. Out of these 'Safi' showed the most significant ($P < 0.01$) hepatoprotective activity when

TABLE:49 EFFECT OF DIFFERENT MARKETED PREPARATONS OF THE SELECTED PLANT DRUGS ON NORMAL HEPATIC FUNCTIONS

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	56.96±3.24	137.53±12.2	169.05±4.66	1.23±0.03	0.20±0.01
CURCULIGO ORCHIOIDES (RHIZOMES)					
ASHWABAL	17.76± 0.87*	101.05±2.90	111.30±1.40	0.79±0.01	0.16±0.0*
MUSLI CHURNA	8.65±0.17*	109 02±1.98	78.23±2.44	0.78±0.01	0 06±0 00
MUSLI PAK	9.89±0.27*	89.30±1.58	115.50±0.57	0.70±0.02	0.17±0.0*
VIRILEX	40.47±0.98*	115.44±2.43	100.57±2.30	0.94±0.04	0.39±0.01
FUMARIA INDICA (WHOLE PLANT)					
LIV 52	15.66±0.42*	55.18±1.73	135.17±1.83	0.95±0.02	0.28 ± 0.01
LIVFIT SYRUP	9.51±0.26*	60.05±0.82	80.30±1.09	0.74±0.01	0.19±0.0*
LIVFIT TABLET	17.76±0.73*	38.61±1.54	118.83±0.77	0.85±0.01	0.26±0.01
LIVOMYN SYRUP	23.84±0.36*	48.12±1.25	119.80±1.86	1.13±0.01	0.46±0.01
LIVOMYN TABLET	19.31±0 70*	37 91±1 35	118.57±1.80	0.98±0.01	0.30±0.01
LIVPAR	31.35±0.97*	138 51±1.99	109.33±4.61	0 59±0.01	0.22± 0.01*
SAFI	29 32±0.66*	99.92±3.70	148.03±2 46	0.56±0.02	0.19±0.01*
STIMULIV	7.12±0.26*	95.44±2.20	118.23±2.28	0.96±0.02	0 17±0.00*
STYPLON	44.46±0.93*	75 40±1.66	74.97±0.91	1.27±0.01*	0 41±0.01
INULA RACEMOSA (ROOTS)					
PUSHKAR MOOL CHURNA	25.75±1.52*	117 91±1.85	136.17±1 94	0.80±0.01	0 07±0.00
KOFOSTAL	18.71±0.57*	38.31±1.07	117.03±1.52	0 87±0.02	0.29±0.01
KUMARI ASAV	16.57±0.57*	97.78±3.50	134.63±2.31	0 63±0.01	0.25±0.01
MORINGA PTERYGOSPERMA (STEM BARK)					
RUMALAYA	45 06±1.13*	144 27±0.98	150.00±1.81	1 27±0.0*	0.41±0.01
SIDA CORDIFOLIA (WHOLE PLANT)					
ALPITONE	16.80±0.59*	103.13±3.04	143.13±1.45	0.74±0.01	0 18±0.01*
BALANT KADHA	17.45±0.59*	38.92±0.84	120.90±1.36	0.81±0.01	0.31±0 01
BLUMYN	33.02±1.62*	131 57±2.08	138.50±2.10	0.71±0.01	0.14±0.01
TENTEX FORTE	19 31±0.59*	127 82±1.88	100 77±1 84	1.00±0 02	0 06±0.00
Fcalculated	146 93	119 94	117 89	173 33	145 45
5% Allowance	56 99	16 50	10 97	0 08	0 05

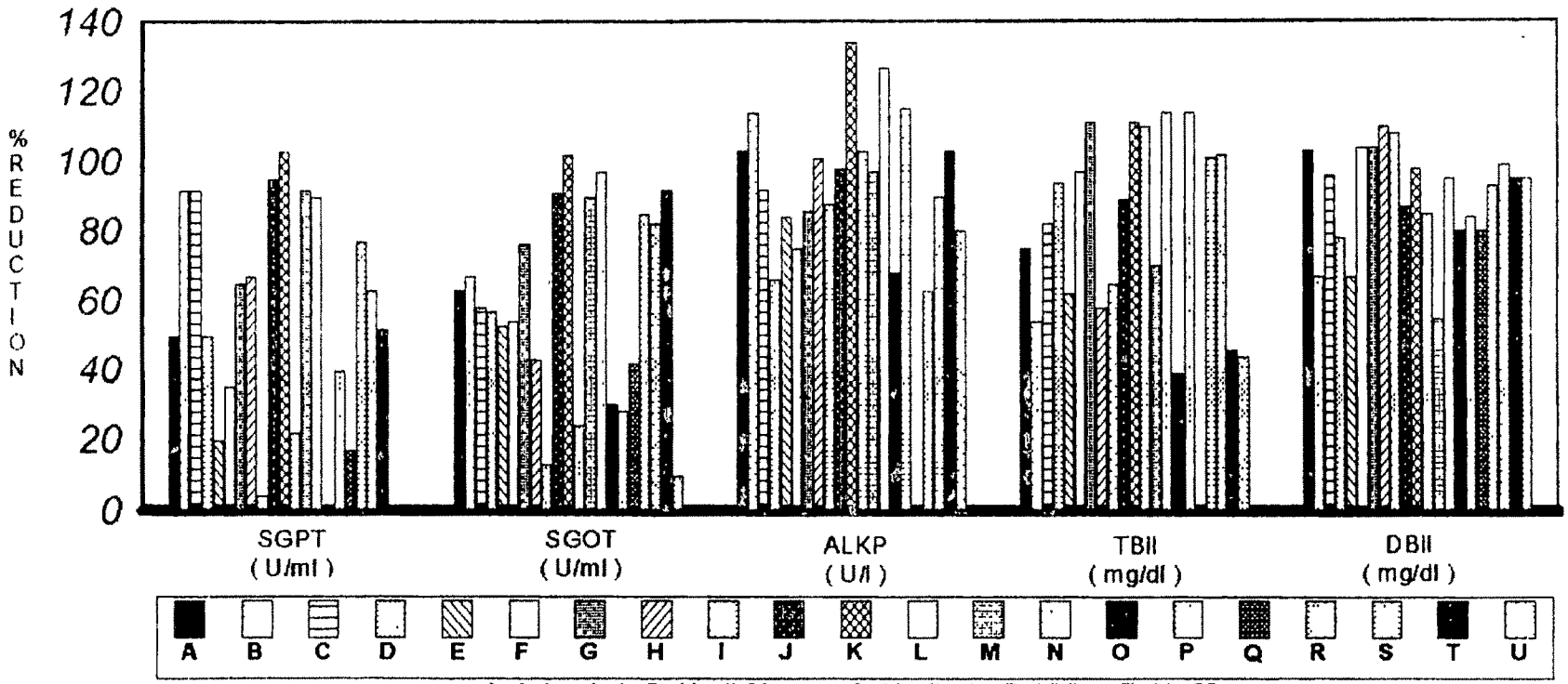
Fcritical = 2 04(P < 0.01) ; NONE OF THE FORMULATIONS SHOWED SIGNIFICANT ELEVATION IN SERUM BIOCHEMICAL PARAMETERS WHEN COMPARED TO CONTROL , NOT SIGNIFICANT = * ; DOSE: LIQUID DOSAGE FORMS = 1 ml / kg, p o , SOLID DOSAGE FORMS=100 mg/kg, p o. ; CHURNA=500 mg/kg, p.o

TABLE:50 EFFECT OF DIFFERENT MARKETED PREPARATONS OF THE SELECTED PLANT DRUGS ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	56.96 ±3.24	137.53±12.28	169.05±4 66	1.23 ± 0.03	0.20 ± 0.01
CARBON TETRACHLORIDE	725.51±38 03	1160.77±52.08	456.70±13 15	3.55 ± 0.11	1.50 ± 0.03
CURCULIGO ORCHIOIDES (RHIZOMES)					
ASHWABAL	389.73±2 67* (50.23)	513 95±3.14* (63.21)	161.07±0.62* (102.77)	1.81 ± 0 01* (75.00)	0.16 ± 0.00* (103.08)
MUSLI CHURNA	108 35±1.94* (92.31)	472.10±3.20* (67.30)	128.33±1.01* (114.16)	2.30 ± 0.02* (53.88)	0 63 ± 0.00* (66.92)
MUSLIPAK	110.02±1 86* (92.06)	564.59±3.46* (58.26)	190.80±1.39* (92.44)	1.64 ± 0.02* (82.33)	0.25 ± 0.01* (96.15)
VIRILEX	388.47±4.39* (50.41)	579.31±3.62* (56.83)	266.90±1.90* (65.98)	1.37 ± 0.01* (93.97)	0.48 ± 0.01* (78.46)
FUMARIA INDICA (WHOLE PLANT)					
LIV 52	591.79±5.54* (20.00)	622.67±4.52* (52.59)	215.17±4.54* (83.97)	2.12±0.02* (61.64)	0.63±0.02* (66.92)
LIVFIT SYRUP	491.65±2.04* (34.98)	608.10±2.01* (54.01)	240.00±3.31* (75.33)	1.31±0.02* (96.55)	0.15±0.01* (103.85)
LIVFIT TABLET	290.90±6 02* (65 01)	385.08±4.71* (75.81)	210.15±4.04* (85 71)	0 98±0 02* (110.78)	0.15±0.01* (103.85)
LIVOMYN SYRUP	274.59±1.38* (67.45)	725 54±3 18* (42 53)	167.50±1.09* (100.54)	2.20±0.01* (58.19)	0.07±0.00* (110.00)
LIVOMYN TABLET	699.88±3 09 (3 83)	1032.46±1.91* (12 54)	202.80±2.45* (88.27)	2.04±0 01* (65 09)	0 09±0.00* (108.46)
LIVPAR	89 06±1 13* (95 20)	232 38±2.41* (90 73)	175.20±1 71* (97.86)	1.49±0 01* (88 79)	0 37±0.01* (86.92)
SAFI	37.90±0 81* (102.85)	116.72±2 05* (102 03)	71 93±1.35* (133.76)	0 97±0 02* (111.21)	0.23±0.01* (97.69)
STIMULIV	579.14±6 19* (21 89)	913.13±2 97* (24 20)	160.93±1.45* (102 82)	0.99±0 01* (110 34)	0 40±0.01* (84 62)
STYPLON	108 77±1.64* (92 25)	236 67±2.88* (90.31)	178.50±2 10* (96.71)	1.93±0 02* (69 83)	0 79±0.02* (54 62)
INULA RACEMOSA (ROOTS)					
PUSHKARMOOL CHURNA	125.84±1.28* (89.70)	173.38±2.19* (96.50)	91.27±1 02* (127.04)	0.91±0.01* (113.79)	0.27±0.01* (94 62)
KOFOSTAL	775.88±5 46 (-)	852.69±3.06* (30.11)	262.42±2.83* (67.54)	2 64±0 03* (39.22)	0.46±0.01* (80.00)
KUMARI ASAV	454.82±4.20* (40.49)	875.68±1.93* (27.86)	124.60±1.16* (115.45)	0.90±0 02* (114.22)	0 41±0.01* (83.85)
MORINGA PTERYGOSPERMA (STEM BARK)					
RUMALAYA	612.82±3.04* (16.86)	727.85±3.92* (42 31)	467.53±2.62 (-)	3.63±0.04 (-)	0 46±0.02* (80.00)
SIDA CORDIFOLIA (WHOLE PLANT)					
ALPITONE	212.86±1 02* (76 68)	289.00±0.78* (85.20)	275.20±2.79* (63.10)	1.20±0 01* (101.29)	0.29±0.01* (93 08)
BALANT KADHA	302.97±2.72* (63 20)	323.18±1.12* (81 86)	197.27±1.57* (90 19)	1.18±0 01* (102.16)	0 21±0.01* (99.23)
BLUMYN	374.38±2 12* (63 20)	323 18±1 12* (81 86)	197.27±1.57* (90.19)	1 18±0 01* (102 16)	0 21±0.01* (99 23)
TENTEX FORTE	890 47±3 45 (-)	1061 69±3.66* (9 68)	227.00±1 74* (79 85)	2 53±0 01* (43 97)	0 26±0.01* (95 38)
Fcalculated	885.38	765 31	696 49	760 00	583.33
5% Allowance	42 80	57 33	17 95	0 14	0 06

Fcritical = 2.01 (P < 0 01); SIGNIFICANT REDUCTION COMPARED TO CCl4 =*.
DOSE LIQUID DOSAGE FORMS = 1 ml / kg , p o ,
SOLID DOSAGE FORMS = 100 mg / kg , p.o.; CHURNA=500 mg/kg,p.o

Fig. 65 EFFECT OF DIFFERENT MARKETED PREPERATIONS ON CARBON TETRACHLORIDE INDUCED HEPATOTOXICITY



A=Ashwabal; B=Musli Churna; C=Muslipak; D=Virilex; E=Liv 52;
F=Livfit Syrup; G=Livfit Tablet; H=Livomyn Syrup; I=Livomyn Tablet;
J=Livpar; K=Safi; L=Stimuliv; M=Styplon; N=Pushkarmool Churna;
O=Kofostal; P=Kumari Asav; Q=Rumalaya; R=Alpitone; S=Balant Kadha;
T=Blumyn; U=Tentex Forte

compared to CCl_4 followed by 'Pushkarmool churna', 'Livpar', 'Livfit tablets', 'Balant kadha', 'Muslipak', 'Alpitone', 'Styplon', 'Ashwabal', 'Blumyn', 'Livomyn syrup', 'Kumari Asav', 'Livfit syrup', 'Musli churna', 'Stimulliv', 'Liv-52', 'Virilex', 'Livomyn tablets', 'Textex forte', 'Kofostal' and 'Rumalaya'. This was further confirmed by histopathological studies which indicated almost normal liver cell architecture without any sight of necrosis and steatosis (Fig.66).

3.5.3 Effect of Paracetamol Induced Hepatotoxicity

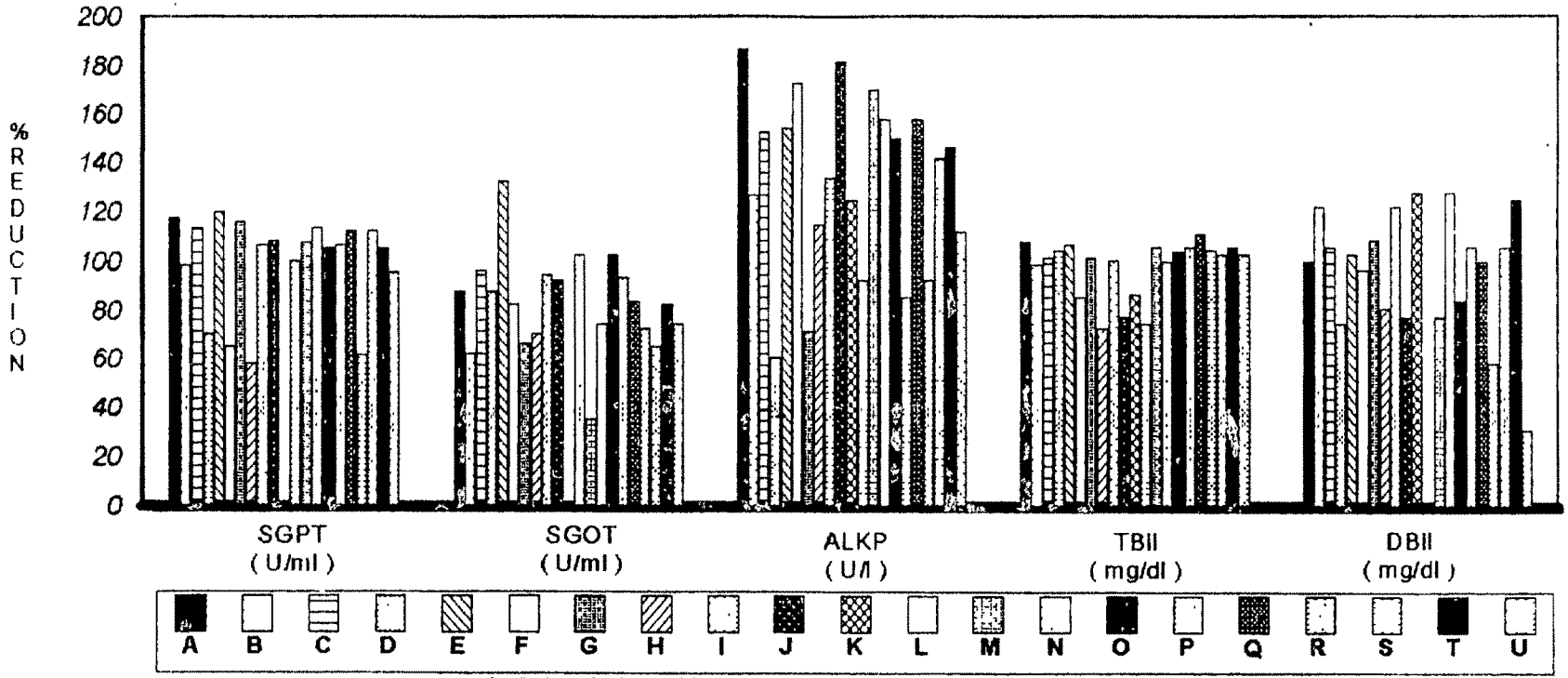
The effects of different marketed preparation on paracetamol intoxicated rats was recorded (Table 51, Fig.67). Almost all the marketed preparations showed significant reduction ($P<0.01$) in the elevated levels of serum biochemical parameters. Out of these, 'Liv-52' showed the best significant hepatoprotective activity compared to other preparations followed by 'Ashwabal', 'Pushkarmoolchurna', 'Muslipak', 'Rumalaya', 'Blumyn', 'Livomyn', 'Kofostal', 'Livpar', 'Balant', 'Kadha', 'Muslichurna', 'Livfit syrup', 'Kumari Asav', 'Styplon', 'Livfit', Tentex forte, Virilex, Livomyn syrup, Alpitone, Stimuliv, and 'Safi'. This was further confirmed by histopathological examinations of the liver sections of the rats treated with 'Liv 52' after paracetamol intoxication which indicated almost normal liver cell architecture (Fig.68).

TABLE:51 EFFECT OF DIFFERENT MARKETED PREPARATONS OF THE SELECTED PLANT DRUGS ON PARACETAMOL INDUCED HEPATOTOXICITY

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	58.98±0.63	137.53±1 27	182.67±0.79	0.88±0.02	0.25±0.01
PARACETAMOL	265.28±3.14	356.00±5.17	313.49±7.40	3.42±0.17	0.57±0.03
CURCULIGO ORCHIOIDES (RHIZOMES)					
ASHWABAL	22.41±1.31* (117.73)	163.73±1.63* (88.01)	69.10±0.95* (186.81)	0.68±0.01* (107.87)	0.25±0.01* (100.00)
MUSLI CHURNA	60.55±1.45* (99.24)	218.02±3.46* (63.16)	147.97±2.53* (126.56)	0.90±0.01* (99.21)	0.18±0.01* (121.88)
MUSLI PAK	29.32±1.31* (114.38)	144.79±2.55* (96.68)	113.67±2.65* (152.74)	0.83±0.02* (101.97)	0.23±0.01* (106.25)
VIRILEX	119.00±1.77* (70.91)	164.41±1.94* (87.70)	234.03±5.40* (60.74)	0.75±0.02* (105.12)	0.33±0.01* (75.00)
FUMARIA INDICA (WHOLE PLANT)					
LIV 52	18.36±0.62* (119.69)	64.41±1.46* (133.51)	110.77±3.75* (154.96)	0.71±0.01* (106.69)	0.24±0.01* (103.13)
LIVFIT SYRUP	129.96±1.81* (65.59)	174.54±1.49* (83.06)	87.83±2.44* (172.50)	1.23±0.01* (86.22)	0.26±0.01* (96.88)
IVFIT TABLET	26.70±0.79* (115.65)	210.31±2.99* (66.69)	219.67±2.74* (71.72)	0.84±0.01* (101.57)	0.22±0.01* (109.38)
LIVOMYN SYRUP	143.37±1.60* (59.09)	200.66±2.98* (71.10)	163.50±1.21* (114.65)	1.56±0.03* (73.23)	0.31±0.00* (81.25)
LIVOMYN TABLET	45.42±1.28* (106.57)	148.71±1.51* (94.88)	138.83±3.05* (133.51)	0.86±0.03* (100.79)	0.18±0.01* (121.88)
LIVPAR	39.46±0.33* (109.46)	152.47±0.83* (93.16)	75.60±1.53* (181.85)	1.45±0.01* (77.56)	0.32±0.01* (78.13)
SAFI	302.59±6.31 (-)	659.05±7.72 (-)	149.95±2.06* (125.01)	1.20±0.01* (87.40)	0.16±0.01* (128.13)
STIMULIV	56.02±1.94* (101.43)	131.08±1.57* (102.95)	191.93±2.17* (92.92)	1.51±0.02* (75.20)	0.66 ± 0.01* (-)
STYPLON	42 91±2.43* (107.79)	276.83±2.33 (36.24)	90.63±1.34* (170.36)	0.72±0.02* (106.30)	0.32±0.01* (78.13)
INULA RACEMOSA (ROOTS)					
PUSHKAR MOOL CHURNA	28.49±1.08* (114 78)	192.62±3.44* (74.78)	106.40±1.72* (158.30)	0.86±0.01* (100.79)	0.16±0.01* (128.13)
KOFOSTAL	46.25±0.48* (106.17)	130.40±2.37* (103.26)	116.67±1.91* (150.45)	0.77±0.00* (104.33)	0.30±0.01* (84.38)
KUMARI ASAV	44.10±1.53* (106.92)	150.82±4.34* (93.92)	201.00±1.60* (85.99)	0.72±0.02* (106.30)	0.23±0.00* (106.25)
MORINGA PTERYGOSPERMA (STEM BARK)					
RUMALAYA	31.71±1.39* (113.22)	171.62±2.04* (84.40)	106.30±1.76* (158.38)	0.61±0.01* (110.63)	0.25±0.00* (100.00)
SIDA CORDIFOLIA (WHOLE PLANT)					
ALPITONE	138.24±2.44* (61.58)	194.67±2.49* (73.85)	192.13±4.42* (92.77)	0.76±0.01* (104.72)	0.38±0.01* (59.38)
BALANT KADHA	32.78±0.95* (112.70)	212.87±3.38* (65.51)	127.70±2.21* (142.02)	0.81±0.02* (102.76)	0.23±0.01* (106.25)
BLUMYN	46 73±2.04* (105 94)	175.69±2.89* (82.53)	121.57±2.19* (146.71)	0.73±0.02* (105.91)	0.17±0 02* (125.00)
TENTEX FORTE	68 06±1 05* (95 60)	192.03±3.98* (75.05)	166.57±2.97* (112.31)	0 80±0.02* (103 15)	0 47±0 02* (31 25)
Fcalculated	26 50	42.12	9.67	231.11	111.49
5% Allowance	62.33	83.97	73.91	0 19	0.06

Fcritical = 2.01 (P < 0.01); SIGNIFICANT REDUCTION COMPARED TO PARACETAMOL = *, DOSE · LIQUID DOSAGE FORMS = 1 ml/ kg , p.o.; SOLID DOSAGE FORMS = 100mg / kg , p.o.; CHURNA=500 mg/kg,p o.

Fig. 67 EFFECT OF DIFFERENT MARKETED PREPERATIONS ON PARACETAMOL INDUCED HEPATOTOXICITY



A=Ashwabal; B=Musli Churna; C=Muslipak; D=Virilex; E=Liv 52;
F=Livfit Syrup; G=Livfit Tablet; H=Livomyn Syrup; I=Livomyn Tablet;
J=Livpar; K=Safi; L=Stimuliv; M=Styplon; N=Pushkarmool Churna;
O=Kofostal; P=Kumari Asav; Q=Rumalaya; R=Alpitone; S=Balant Kadha;
T=Blumyn; U=Tentex Forte

3.5.4 Effects of Rifampicin Induced Hepatotoxicity

The results obtained from the effects of marketed preparation on rifampicin intoxicated rats were recorded in Table 52, Fig. 69. Almost all the marketed preparations of the selected plant drugs showed significant reduction ($P < 0.01$) in the elevated levels of serum biochemical parameters against rifampicin intoxication. Out of these Kumari Asav showed maximum hepatoprotective activity compared to rifampicin followed by 'Liv 52', 'Livfit tablets', 'Textex forte', 'Kofostol', 'Blumyn', 'Livpar', 'Pushkarmool Churna', 'Stimuliv', 'Alpitone', 'Rumalaya', 'Muslichurna', 'Styplon', 'Muslipak', 'Virilex', 'Safi', 'Livomyn tablets', 'Livomyn syrup', 'Livfit syrup', 'Ashwabal', 'Balant kadha'. This was further supported by histopathological studies which indicated almost normal regenerating structure of liver cell with few vacuoles (Fig.70).

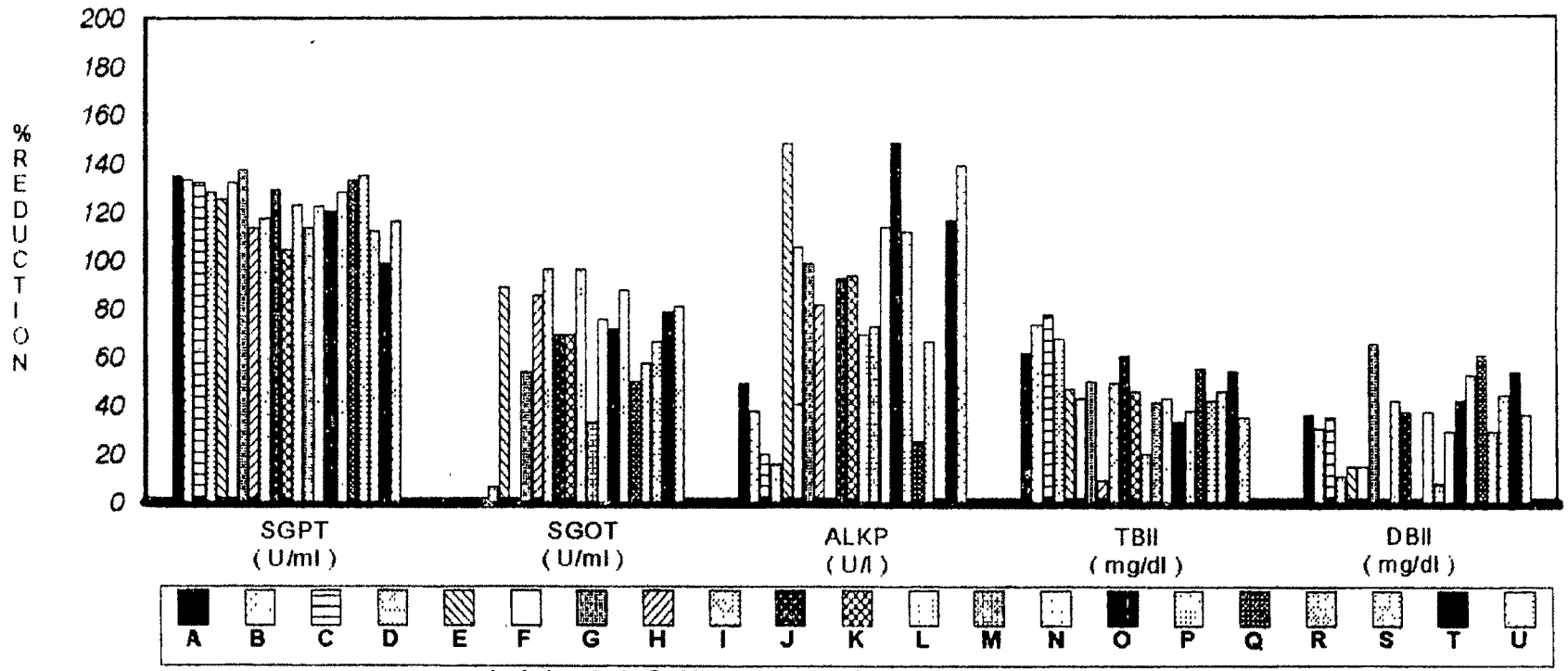
Out of these marketed preparations tested against CCl_4, paracetamol and rifampicin intoxication, the recovery by 'Liv-52' against paracetamol may be called highest in terms of biochemical parameters followed by Safi against CCl_4 and 'Kumari asava' against rifampicin intoxication.

TABLE:52 EFFECT OF DIFFERENT MARKETED PREPARATIONS OF THE SELECTED PLANT DRUGS ON RIFAMPICIN INDUCED HEPATOTOXICITY

GROUP	SERUM BIOCHEMICAL PARAMETERS, MEAN ± SEM				
	SGPT (U/ml)	SGOT (U/ml)	ALKP (U/l)	T.Bil (mg/dl)	D.Bil (mg/dl)
CONTROL	76.24±1.61	85.69±2.16	76.17±1.66	1.01±0.03	0.19±0.01
RIFAMPICIN	195 53±3.50	265.46±2.27	141.05±2.91	2.81±0.05	1.21±0.03
CURCULIGO ORCHIOIDES (RHIZOMES)					
ASHWABAL	33.73±0.53* (135.64)	276.58±0.64 (-)	108.75±1.49* (49.78)	1.70±0.01* (61.67)	0.83±0 01* (37 25)
MUSLI CHURNA	36.83±0.99* (133.70)	265.18±1.86 (0.16)	115.70±0 90* (39.07)	1.48±0.01* (73.89)	0 89±0.01* (31.37)
MUSLIPAK	36.37±0.43* (133.42)	263.13±1.53 (1.30)	127.23±1.14* (21.30).	1.41±0.01* (77.78)	0.84±0 01* (36.27)
VIRILEX	42.20±1.08* (128.54)	253.13±2.55* (6.86)	130.10±3.02* (16.88)	1.58±0.02* (68.33)	1.09±0.02* (11.76)
FUMARIA INDICA (WHOLE PLANT)					
LIV 52	45.65±1.39* (125.64)	105.69±2.28* (88.87)	44.30±0.98* (149.12)	1.95±0.03* (47.78)	1.05±0.01* (15.69)
LIVFIT SYRUP	36.95±0.65* (132.94)	282.62±1.49 (-)	72.13±0.77* (106.23)	2.02±0.02* (43.89)	1.05±0.01* (15.69)
LIVFIT TABLET	31.23±1.59* (137 73)	168.44±1.73* (54.97)	76.77±1.54* (99.08)	1.89±0.02* (51.11)	0.54±0.02* (65.69)
LIVOMYN SYRUP	59 72±1.39* (113 85)	111.59±2.72* (85.59)	87.70±0.59* (82.23)	2.63±0.01* (10.00)	1 49±0 01 (-)
LIVOMYN TABLET	55.19±0.77* (117.65)	90.56±2.68* (97 29)	161.77±0.74 (-)	1.91±0.01* (50.00)	0 77±0 01* (43 14)
LIVPAR	40 18±0.78* (130.23)	139.54±1.42* (70.05)	80.97±1 51* (92.60)	1.72±0.01* (60.56)	0.82±0 02* (38 24)
SAFI	69.86±1.24* (105 35)	139.54±1.74* (70.05)	80.17±1.30* (93 83)	1.97±0.02* (46.67)	1.23±0 01 (-)
STIMULIV	47 92±0 49* (123.74)	90.29±1.18* (97 44)	95.42±0 86* (70.33)	2.43±0.01* (21.11)	0 82±0 02* (38.24)
STYPLON	59 72±1 26* (113 85)	203.64±3.32* (34.39)	93.87±2 24* (72.72)	2.06±0.02* (41.67)	1 12±0 02* (8 82)
INULA RACEMOSA (ROOTS)					
PUSHKAR MOOL CHURNA	49.23±0.90* (122.64)	129.54±0.90* (75.61)	67.10±0.73* (113.98)	2.01±0.02* (44.44)	0.90±0.02* (30.39)
KOFOSTAL	51.26±0.60* (120 94)	136.72±1.28* (71.61)	44.67±1 10* (148.55)	2.19±0.01* (34.44)	0.77±0 01* (43.14)
KUMARI ASAV	42.20±0.58* (128.54)	106.97±0.76* (88.16)	68.10±1.34* (112 44)	2.10±0.01* (39.44)	0.67±0.01* (52.94)
MORINGA PTERYGOSPERMA (STEM BARK)					
RUMALAYA	35.76±0.99* (133 93)	174.49±2.02* (50.60)	124.17±1.82* (26.02)	1.80±0.01* (56.11)	0.59±0 01* (60.78)
SIDA CORDIFOLIA (WHOLE PLANT)					
ALPITONE	32.90±0.76* (136 33)	160 31±1.37* (58.49)	97.37±2.87* (67.32)	2.04±0.03* (42.78)	0.90±0.01* (30.39)
BALANT KADHA	61.27±0.86* (112.55)	144.41±1.52* (67.34)	158.03±1.37 (-)	1.96±0.02* (47.22)	0 75±0 01* (45.10)
BLUMYN	77.17±1.15* (99.22)	123 38±0.89* (79 03)	65.00 ± 0.83* (117 22)	1 82±0.02* (55.00)	0.66±0 01* (53 92)
TENTEX FORTE	56 50±1.21* (116 55)	119 54±1.29* (81 17)	50.20±0.92* (140 03)	2.16±0.03* (36.11)	0 83±0.02* (37.25)
Fcalculated	725 91	1330 07	461.67	300 00	330 77
5% Allowance	6 18	9.21	7.88	0.11	0 07

Fcritical = 2.01 (P < 0 01). SIGNIFICANT REDUCTION COMPARED TO RIFAMPICIN =*, DOSE : LIQUID DOSAGE FORMS = 1 ml / kg ,p.o. SOLID DOSAGE FORMS = 100mg / kg , p o., CHURNA=500 mg/kg, p o

Fig.69 EFFECT OF DIFFERENT MARKETED PREPERATIONS ON RIFAMPICIN INDUCED HEPATOTOXICITY



A=Ashwabal; B=Musli Churna; C=Muslipak; D=Virilex; E=Liv 52;
F=Livfit Syrup; G=Livfit Tablet; H=Livomyn Syrup; I=Livomyn Tablet;
J=Livpar; K=Safi; L=Stimuliv; M=Styplon; N=Pushkarmool Churna;
O=Kofostal; P=Kumari Asav; Q=Rumalaya; R=Alpitone; S=Balant Kadha;
T=Blumyn; U=Tentex Forte

Photomicrographs of Liver Sections of Rats Treated With:

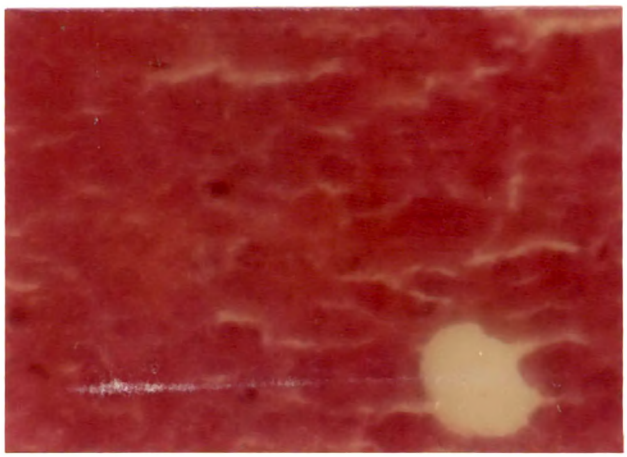


Fig.66 " Safi " and Carbon Tetrachloride

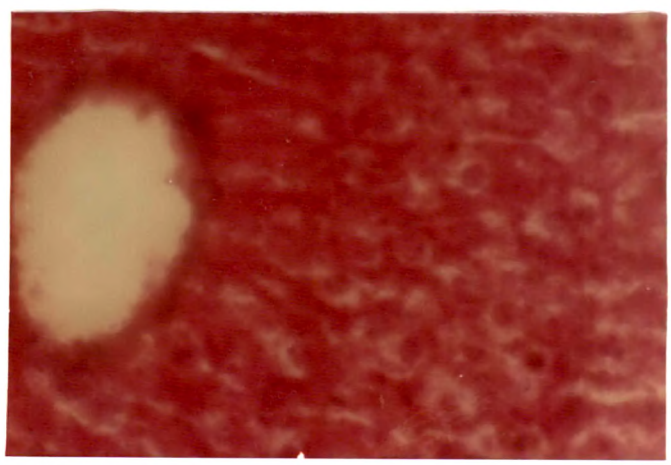


Fig.68 " Liv-52 " and Paracetamol

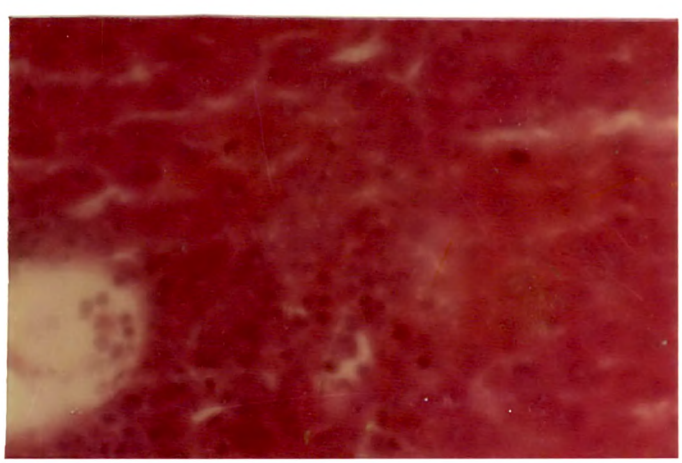


Fig.70 " Kumari Asav " and Rifampicin

3.5.5 Effect of Different Marketed Preparations on Carrageenan Induced Artificial Root Paw Oedema

Effect of different marketed preparations of these selected plant drugs against carrageenan induced rat paw oedema were recorded in Table 53, Fig.71.

All the tested marketed preparations showed peak reduction in oedema within two hours of carrageenan administration like those of standard drugs such as indomethacin, ibuprofen and ketoprofen. Out of these, Kumari asava showed the highest siginificant reduction in paw oedema followed by 'Styplon', 'Kofostal', 'Pushkarmool churna', 'Textex forte', 'Balant Kadha', 'Livfit syrup' in comparison to control.

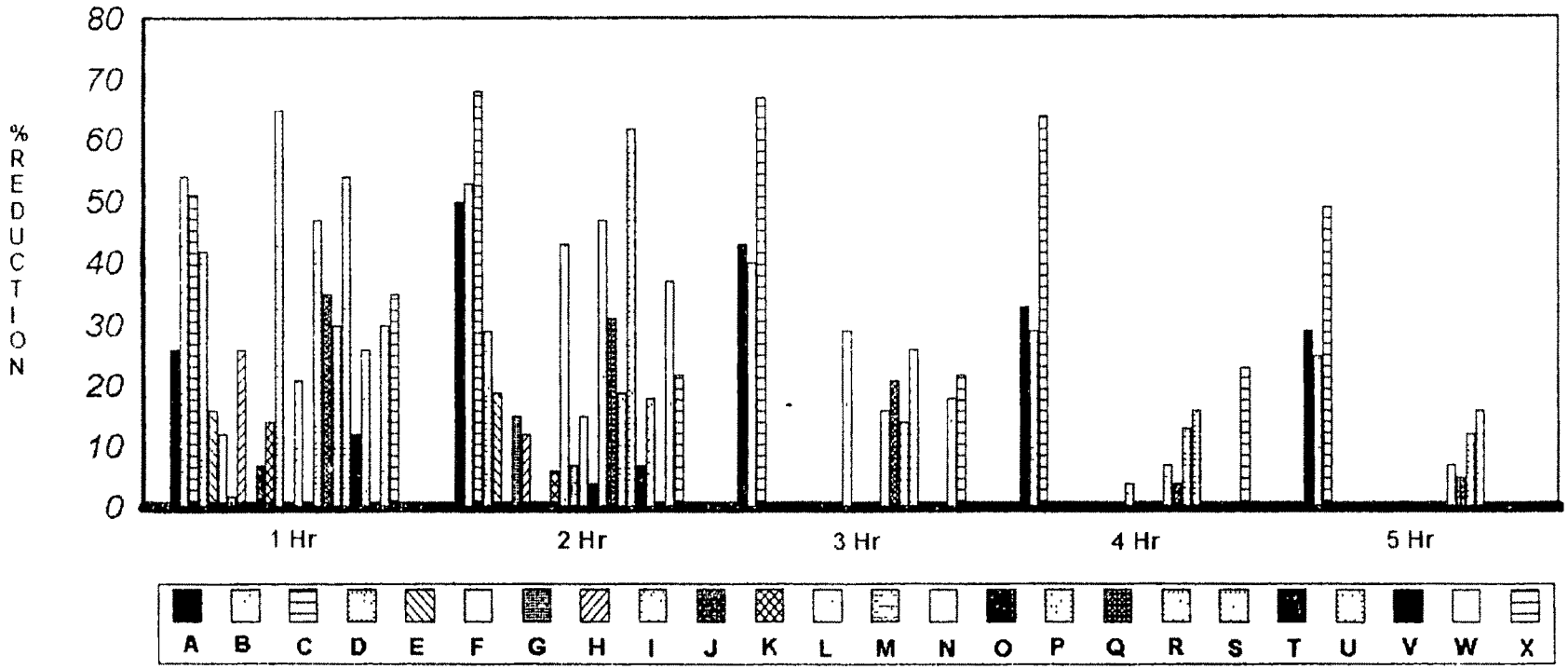
The present studies were undertaken with an objective to assess the various claims endowed upon the selected plant drugs as cure for variety of diseases in alternative and traditional systems of medicine with special effects on liver disorders. The drugs were, therefore, tested for their effects against variety of toxicants inducing liver damage, in either powdered form, the extracts made from them or the isolated compounds from the active extracts and finally in the form of marketed preparations containing these drugs as one of the components. A few of these drugs, their extracts,

TABLE:53 EFFECT OF DIFFERENT MARKETED PREPARATIONS OF THE SELECTED PLANT DRUGS ON CARRAGEENAN INDUCED PAW OEDEMA

GROUP	MEAN DIFFERENCES IN PAW VOLUMES(ml) ± SEM (% REDUCTION)				
	1 Hr	2Hr	3Hr	4Hr	5Hr
CONTROL	0.43±0.01	0.68±0.04	0 73±0.03	0.75±0.03	0.77±0.02
INDOMETHACIN	0.32±0.02* (25.6)	0 34±0.02* (50.0)	0.42±0.03* (42.5)	0.50±0.04* (33.3)	0.55±0.03* (28.6)
IBUPROFEN	0.20±0.00** (53 5)	0.32±0.01* (52.9)	0.44±0.01* (39.7)	0.53±0.03* (29.3)	0.58±0.02* (24.7)
KETOPROFEN	0.21±0.02** (51.2)	0.22±0 02*** (67.7)	0.24±0.02*** (67.1)	0.27±0 03*** (64.0)	0.39±0.03*** (49 4)
CURCULIGO ORCHIOIDES (RHIZOMES)					
ASHWABAL	0.25±0.00* (41.9)	0.48±0 01** (29.4)	0.88±0.02 (-)	0.93±0.01 (-)	0.99±0.01 (-)
MUSLI CHURNA	0.36±0.02 (16.3)	0.55±0.02* (19.1)	0 73±0.02 (0.0)	0.79±0.02 (-)	0.98±0 03 (-)
MUSLIPAK	0.38±0.02 (11.6)	0.75±0.01 (-)	0.82±0.02 (-)	0.88±0.02 (-)	0.97±0.02 (-)
VIRILEX	0.42±0.02 (2.3)	0.58±0.02* (14.7)	0.82±0.02 (-)	0.87±0.02 (-)	1.13±0.02 (-)
FUMARIA INDICA (WHOLE PLANT)					
LIV 52	0.32±0.02* (25.6)	0.60±0.02 (11.8)	0.90±0 02 (-)	1.05±0.03 (-)	1.13±0.02 (-)
LIVFIT SYRUP	0.43±0.02 (0.0)	0.86±0.02 (-)	0.91±0 02 (-)	0.99±0.02 (-)	1.01±0.03 (-)
LIVFIT TABLET	0.40±0.01 (7.0)	0.70±0.01 (-)	0 80±0 04 (-)	0.88±0 03 (-)	1.01±0.03 (-)
LIVOMYN SYRUP	0.37±0.01 (14 0)	0.64±0.02 (5.9)	0 74±0.02 (-)	0.85±0 02 (-)	1 01±0 01 (-)
LIVOMYN TABLET	0.15±0.01** (65.1)	0.39±0.01* (42.7)	0 52±0.02* (28 8)	0 72±0.02 (4.0)	0 80±0 02 (-)
LIVPAR	0 51±0 02 (-)	0.63±0.02 (7 4)	0 73±0 01 (0 0)	0.83±0 02 (-)	1.03±0.02 (-)
SAFI	0.34±0 02* (20.9)	0 58±0 01* (14 7)	0 76±0.02 (-)	0.79±0 02 (-)	0.88±0.02 (-)
STIMULIV	0 51±0 02 (-)	0 65±0.01 (4.4)	0 74±0.02 (-)	0.83±0 03 (-)	1 08±0 02 (-)
STYPLON	0 23±0.02** (46.5)	0.36±0.01* (47.1)	0.61±0 02* (16 4)	0.70±0 03 (6 7)	0.72±0.02 (6 5)
INULA RACEMOSA (ROOTS)					
PUSHKAR MOOL CHURNA	0 28±0.01* (34.9)	0 47±0.02* (30.9)	0.58±0 02* (20 6)	0.72±0 02 (4.0)	0.73±0 02 (5.2)
KOFOSTAL	0.30±0.01* (30.2)	0.55±0 02* (19 1)	0.63±0 02 (13 7)	0.65±0 02 (13.3)	0.68±0.03 (11.7)
KUMARI ASAV	0 20±0.01** (53.5)	0.26±0 02* (61 8)	0.54±0 02* (26.0)	0.63±0.02 (16 0)	0.65±0 03 (15.6)
MORINGA PTERYGOSPERMA (STEM BARK)					
RUMALAYA	0.38±0.02 (11.6)	0 63±0.02 (7 4)	0.81±0.05 (-)	0.84±0.05 (-)	0.91±0.03 (-)
SIDA CORDIFOLIA (WHOLE PLANT)					
ALPITONE	0.32±0.01* (25.6)	0 56±0 01* (17.7)	0.83±0.01 (-)	0.88±0.02 (-)	0.91±0 02 (-)
BALANT KADHA	0.47±0.02 (-)	0 84±0 02 (-)	1 04±0.02 (-)	1.07±0.02 (-)	1.07±0 01 (-)
BLUMYN	0 30±0 02* (30.2)	0 43±0 03* (36 8)	0.60±0 03* (17 8)	0.75±0.02 (0.0)	0 80±0 02 (-)
TENTEX FORTE	0 28±0 02* (34.9)	0 53±0 03* (22 1)	0.57±0 04* (21 9)	0 58±0 03* (22 7)	0 77±0 03 (0 0)
Fcalculated	30 98	73 28	53 98	44.44	65 34
5% Allowance	0 09	0 10	0 12	0.13	0 12

Fcritical = 1 96 (P<0 01) , SIGNIFICANT REDUCTION COMPARED TO CONTROL = * , INDOMETHACIN = ** , IBUPROFEN = *** , KETOPROFEN = ****

Fig. 71 EFFECT OF DIFFERENT MARKETED PREPERATIONS ON CARRAGEENAN INDUCED PAW OEDEMA



A=Indomethacin; B=Ibuprofen; C=Ketoprofen;D=Ashwabal; E=Musli Churna; F=Muslipak; G=Virilex; H=Liv 52;I=Livfit Syrup; J=Livfit Tablet; K=Livomyn Syrup; L=Livomyn Tablet; M=Livpar; N=Safi; O=Stimuliv; P=Styplon; Q=Pushkarmool Churna;R=Kofostal; S=Kumari Asav; T=Rumalaya; U=Alpitone; V=Balant Kadha;W=Blumyn; X=Tentex Forte

and isolated chemical compounds, although exhibited significant activities against artificially induced liver damage and inflammation, still offer scope to further investigate upon them for deducing the mechanism of their action. These drugs, as indicated from the present studies, stand by the claims made to some extent and therefore could remain as the item of importance in alternative medicine. These studies also substantiate the incorporation of these drugs as a whole or in prepared form in the multicomponent system recommended for therapy in traditional systems of medicine.