LITERATURE REVIEW:

Literature review for undertaking study was done from various national and international journals, official standard books and internet.

**Akhtar A. et al., (2008)** investigated in vitro antibacterial activity of 50% (v/v) methanol, acetone and petroleum ether extracts of *Pimpinella anisum* fruit against *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli* and *Klebsiella Pneumoniae* using Disc Diffusion Method. Only aqueous and 50% methanol extracts show fair antibacterial activity against all the test organisms. Acetone and petroleum ether extracts were not observed to inhibit the growth of any of the test bacteria. This study suggests that the aqueous extract shows the activity against gram +ve and gram -ve bacteria.⁶

**Mahesh B. et al., (2008)** studied that *A. nilotica* and *S. cordifolia* leaf extract have highest antibacterial activity against *B. subtilis* and *Z. mauritiana*. Leaf extract showed significant activity against *Xanthomonas axonopodis*. Root and leaf extract of *S. cordifolia* showed significant activity against all five bacteria. This study also revealed that *A. nilotica* bark and leaf extract have significant antifungal activity against *A. flavus*. *Ziziphus mauritiana* and *Tinospora cordifolia* have significant antifungal activity against *D. turcica*. The methanol extract of *Sida cordifolia* recorded significant antifungal activity against *F. verticillioides*.⁷

**Singh K.P. et al., (2011)** evaluated the antibacterial activities of *Chenopodium album* L. against five human pathogenic bacteria Viz. *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Proteus vulgaris* and *Pseudomonas aeruginosa*. In this investigation aqueous extract showed highest antibacterial activity against *Staphylococcus aureus* with 25.00mm zone of inhibition and least antibacterial activity against *Salmonella typhimurium* with 17.75mm zone of inhibition. Methanolic leaf extract showed strongest activity against *Pseudomonas aeruginosa* with 28.30mm zone of inhibition while lowest antibacterial activity was observed in *Salmonella typhimurium* with 14.00mm zone of inhibition.⁸

**Nayak D. P. et al., (2010)** demonstrated the antimicrobial activity and anthelmintic activity of various solvent extract of “*Chenopodium album*” belonging to family Chenopodiace. *Chenopodium album* shows 17.3mm zone of inhibition against *Staphylococcus aureus*, 19.7mm against *Bacillus subtilis*, 18.3mm against *Bacillus polymexia*, 16.7mm against *Streptococcus faecalis*, 17.7mm against *Pseudomonas aeruginosa*, 16.7mm against *Salmonella typhi*, 17.3mm
against Vibrio cholera, 17.3mm against Shigella dysenteriae, 18mm against Escherichia coli, 15mm against Penicillium notatum, 16.3mm against Aspergillus niger and 18.3mm zone of inhibition against Candida albicans.\textsuperscript{9}

**Srikandi Fardiaz (1995)** studied that different concentration of coffee extract inhibits growth of gram-ve bacteria i.e. Escherichia coli, Salmonella typhi and Pseudomonas aeruginosa and gram+ve bacteria i.e. Staphylococcus aureus, Bacillus cereus, Lactobacillus bulgaricus, Streptococcus lactis and Streptococcus faecalis. The study also proved that Caffeine at different concentrations decrease the relative growth of L. bulgaricus, E. coli, S. typhi and S. faecalis. L. bulgaricus was most sensitive to coffee extract and caffeine.\textsuperscript{10}

**Ali Sadeghian et al., (2011)** assessed the antibacterial activity of pomegranate against both Gram positive Staphylococcus aureus and negative Pseudomonas aeruginosa bacteria as well as against pathogenic yeast Candida albicans. They compared the antimicrobial activity of extract with cloxacillin, gentamycin and clotrimazole using S. aureus, P. aeruginosa and C. albicans respectively.\textsuperscript{11}

**Tim Cushnie T.P. et al., (2005)** reviewed on antimicrobial activity of flavonoids commonly found in fruit, vegetables, nuts, seeds, stems, flowers, tea, wine, propolis and honey. Structure–activity data shown in the study suggests that it might be possible to prepare a potent antibacterial flavanone by synthesizing a compound with halogenations, lavandulyl or geranyl substitution.\textsuperscript{12}

**Nitalikar Manoj M. et al., (2010)** determined the antibacterial activities of liquorice root extract in ether, chloroform, acetone on bacteria using well diffusion method. Licorice root extract showed significant antibacterial activity against two gram positive (Bacillus subtilis and Staphylococcus aureus) and two gram negative (Escherichia coli and Pseudomonas aeruginosa) bacteria. Ethereal extract of licorice has shown good inhibitory effect on E. coli strain. The acetone extract has shown excellent inhibitory effect than Streptomycin.\textsuperscript{13}

**Doughari J. H et al., (2008)** investigated antibacterial properties of leaf extract of Senna obtusifolia (L) against both clinical and laboratory isolates bacteria and fungi using Disc Diffusion Method. Acetone extracts showed the highest activity followed by dichloromethane, methane and hexane extracts. Water extracts demonstrated the least activity against the test bacteria and fungi.\textsuperscript{14}
Osho Adeleke et al., (2010) demonstrated antimicrobial activity of extracts of Anchomanes difformis against Bacillus subtilis, Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans, Candida stellatoidea and Candida torulopsis using agar well diffusion methods. Pseudomonas aeruginosa was only sensitive to the oils from the stem and root but not to that of leave. Candida torulopsis was sensitive to the oil from stem. All the other Candida species tested were resistant to the essential oils. The stem, root and leaf extract showed minimum inhibitory concentrations ranged from 2.0mg/ml to 4.0mg/ml for Bacillus subtilis, Klebsiella pneumoniae, Pseudomonas aeruginosa and Staphylococcus aureus.15

Leeja L. et al., (2007) demonstrated in-vitro microbicidal activity of the methanol extract of Origanum majorana L. against seven fungi (Fusarium solani, Candida albicans, Aspergillus niger, A. parasiticus, Rhizopus oryzae, Rhizoctonia oryzae-sativae and Alternaria brassicicola) and six bacteria (Bacillus subtilis, B. megaterium, Escherichia coli, Proteus vulgaris, Pseudomonas aeruginosa and Staphylococcus aureus). The methanol extract of Origanum majorana L. showed significant activity against Aspergillus niger, Fusarium solani and Bacillus subtilis. The methanolic extract showed more microbicidal activity than the standard nystatin against Aspergillus niger.16

Agarry O.O. et al., (2005) compared antimicrobial activities of aloe vera gel and leaf against Staphylococcus aureus, Pseudomonas aeruginosa, Trichophyton mentagrophytes, T. schoeleinii, Microsporum canis and Candida albicans. Appearance of zone of inhibition showed that both the gel and the leaf inhibited the growth of S. aureus (18.0 and 4.0mm, respectively). Gel inhibited the growth of T. mentagrophytes (20.0mm), while the leaf shows inhibitory effects on both P. aeruginosa and C. albicans.17

Fomda Bashir Ahmad et al., (2010) investigated the effectiveness of essential oil of lemongrass for the treatment of pathogenic organisms Staphylococcus aureus, Bacillus cereu, Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae and Pseudomonas aeruginosa using Agar Diffusion Method and Broth Dilution method. Lemongrass shows significant activity against the test organisms except P. aeruginosa. Lemon grass showed more sensitivity to gram positive bacteria than gram negative bacteria.18

Rajasekaran C. et al., (2008) screened and evaluated antimicrobial activity of leaf extracts of Azadirachta indica. Ethanolic and dichloromethane leaf extracts of Azadirachta indica were found to be more effective towards the bacterial species among the different extracted used in the
study. Petroleum ether leaf extract and chloroform leaf extracts were not effective against any of the organisms tested. Chloroform leaf extract was moderately active against Bacillus cereus. Growth of Lactobacillus bulgaris was not inhibited by any of the tested leaf extracts of Azadirachta indica except dichloromethane extract.19

Nirmal Sunil et al., (2011) investigated hepatoprotective effect of methanolic extract of arial parts of Delonix regia against CCl$_4$ induced liver damage in rats. The methanolic extract of aerial parts of D. regia (400 mg/kg) was administered orally to the Wistar albino rats. Level of serum enzymes AST (aspartate aminotransferase), ALT (alanine aminotransferase), ALP (alkaline phosphatase), ALB (albumin), TLP (total protein), DBIL (direct bilirubin) and TBIL (total bilirubin) was reduced after administration of test drug.20

Malviya Neelesh et al., (2009) evaluated hepatoprotective effect of Ethanolic and aqueous extracts of Amorphophallus campanulatus tubers against carbon tetrachloride induced hepatic damage in rats. The test drug (500 mg/kg) was administered orally once daily. The elevated serum enzymatic levels were significantly restored towards normal by the extracts. Histopathological examination of rat liver sections was done for biochemical observation. The results of this study showed that Amorphophallus campanulatus tubers have hepatoprotective action against carbon tetrachloride induced hepatic damage in rats.21

Hewawasam R.P. et al., (2004) investigated hepatoprotective and antioxidant activity of an aqueous extract of Epaltes divaricata plant (Family-Compositae) against carbon tetrachloride induced hepatic damage in mice. A single dose of carbon tetrachloride (0.5 ml/kg in olive oil) was given to mice intraperitoneally to induce hepatotoxicity and the plant extract at a dose of 0.9 g/kg was administered orally by gavage. Blood and liver tissue were collected for the assessment of serum. There was a marked improvement in the enzyme activities. Liver reduced glutathione level was observed in the Epaltes pre-treated mice 4 days after the administration of carbon tetrachloride.22

Pal Anita et al., (2011) studied hepatoprotective activities of dried whole plant of Chenopodium album Linn against paracetamol induced hepatic injury. Acetone and methanol extract offered significant ($P<0.001$) hepatoprotective action by reducing the serum marker enzymes like serum glutamate oxaloacetate (SGOT), serum glutamate transaminase (SGPT), alkaline phosphatase (ALP) serum acid phosphatase (ACP) and serum bilirubin. The hepatoprotective activity of the
test drug were compared with Silymarin (100mg/kg; oral), the standard drug. Thus this study reveals that acetone and methanol extract at (400mg/kg, oral) showed significant (p<0.001) hepatoprotective activity similar to that standard drug, Silymarin.23

Manjunatha B.K (2005) evaluated the hepatoprotective activity of crude aqueous and ethanol stem bark extracts of *Pterocarpus santalinus* using CCl₄ induced hepatic damage in male Wister albino rats. Serum levels of bilirubin, alanine transaminase, aspartate transaminase alkaline phosphatase were increased in CCl₄ treated animals reflecting liver injury. Serum levels of these enzymes were decreased to normal in aqueous and ethanol extracts of the plant. Histological study of ethanol extract treated animals revealed normal hepatic cords without any cellular necrosis and fatty infiltration.24

Sam Lal *et al.*, (2006) compared the hepatoprotective effect of herbal mixture with Liv-52; a commercially available polyherbal hepatoprotective drug against CCl₄ induced liver injury in Swiss albino mice. The reduction in the enzyme biomarkers (Aspartate and Alanine Transaminase) of liver injury in the herbal mixture treated groups was similar to the reduction initiated by Liv 52. There was an increase in glutathione in the herbal mixture treated groups. This study suggests that herbal mixture protects the liver by virtue of its antioxidant nature along with high regeneration initiation potential.25

Fasalu Rahiman Om *et al.*, (2011) studied hepatoprotective activity of aqueous extract of *Asparagus racemosus* root on liver damage caused by paracetamol in rats. Paracetamol causes a significant increase in wet liver weight, aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), total bilirubin with a reduction of superoxide dismutase (SOD) and catalase. Different doses of plant extracts (150 and 250 mg/kg) significantly reduced serum marker enzymes and antioxidant levels near normal against paracetamol-treated rats. In histopathological study treatment of rat with *Asparagus racemosus* root exhibit normal appearance of hepatic cells with nucleus, less vacuolization and fatty change.26

Achliya G.S. *et al.*, (2003) investigated the hepatoprotective activity of *Panchagavya Ghrita* against CCl₄ induced Hepatotoxicity in albino rats. The histological studies were also carried out on liver sections. Silymarin was used as the standard drug for comparison. *Panchagavya Ghrita* (150-300 mg/kg, *p.o.*) markedly prevented CCl₄ induced elevation of serum enzyme GPT, GOT, ACP and ALP and reduced their level to near normal. Silymarin was used as a standard drug.
Histopathological study of liver showed almost normal architecture, as compared to control group.\textsuperscript{27}

Ahmed Jameel \textit{et al.}, (2011) designed a study to evaluate the possible beneficial effect of methanol extract of aerial parts of \textit{Delonix regia} against CCl\textsubscript{4} induced liver damage in rats. The plant extract protects the liver against the injury induced by carbon tetrachloride in rats. There was significant reduction in serum enzymes AST (aspartate aminotransferase), ALT (alanine aminotransferase), ALP (alkaline phosphatase), ALB (albumin), TLP (total protein), DBIL (direct bilirubin) and TBIL (total bilirubin) with methanol extract of \textit{Delonix regia}. Histopathological observation showed disrupted cords of hepatocytes and few hepatocytes shows feathery change, mild inflammation and moderate degree of macro and micro vesicular steatosis.\textsuperscript{28}

Saravanakumar A \textit{et al.}, (2009) investigated the phytoconstituents, acute oral toxicity and hepatoprotective activity of ethanol (90\%) extract of \textit{Cordia subcordata} Lam. (EECS) using CCl\textsubscript{4} induced hepatotoxicity in male Wistar albino rats. The \textit{Cordia subcordata} Lam (100, 200 and 400mg/kg, p.o) and the standard drug Liv.52 (40mg/kg, p.o) were administered for 7 days in CCl\textsubscript{4} intoxicated rats. Test drug significantly decrease ($P<0.001$) the elevated levels of the hepatic enzymes, total bilirubin and urea in a dose dependent manner after 3days and return towards near normal after 7days indicating the recovery of hepatic cells. In the liver sections of the rats treated with test drug extracts for 7 days, the normal hepatocytes architecture was retained as compared to Liv.52.\textsuperscript{29}

Chandrasekhar K.S. \textit{et al.}, (2010) studied hepatoprotective activity of the aerial parts of \textit{Leucas lavandulaefolia} against CCl\textsubscript{4} in rats. The ethyl acetate extract of \textit{Leucas lavandulaefolia} produced significant decrease in the serum enzymes like SGOT and SGPT in rats intoxicated with CCl\textsubscript{4}. The rats treated with Silymarin and extracts along with toxicants showed sign of normal hepatic cards and absence of necrosis and vacuoles.\textsuperscript{30}

Kumar B. Shyam \textit{et al.}, (2010) demonstrated hepatoprotective activity of \textit{Coccinia indica} leave extract at dose 400 mg/kg body weight against carbon tetrachloride induced liver toxicity in rats. The results showed hepatoprotective activity of \textit{Coccinia indica} leave extract at dose 400 mg/kg body weight. The results were compared with standard treatment 125 mg/kg body weight of Silymarin, a known hepatoprotective drug.\textsuperscript{31}
Ganga Rao B. et al., (2010) tested ethyl acetate and methanolic extracts of Spondias pinnata for its hepatoprotective effect against carbon tetrachloride induced in rats. Determination of the levels of biochemical markers of hepatic damage like SGPT, SGOT, ALP, bilirubin were tested in both treated and untreated groups. Ethyl acetate extract of S. pinnata stem heart wood (100, 200 and 400 mg/kg) has brought back the altered levels of biochemical markers to the near normal levels in the dose dependent manner. Histopathological study also revealed hepatocellular protection activity of Spondias pinnata.32

Qureshi Mohammad N. et al., (2010) evaluated ethanolic extract of Leucas ciliata leaves for possible antioxidant and hepatoprotective potential. Diphenyl picryl hydrazyl (DPPH) radical scavenging, Nitric oxide (NO) radical scavenging, Iron chelation and reducing power methods were used to evaluate antioxidant activity. Carbon tetrachloride (CCl₄) induced liver damage model was used to evaluate hepatoprotective activity. rats treated with Ethanolic extract of L. ciliata (100, 200 and 400mg/kg po) inhibited the increase in serum levels of SGPT, SGOT, ALP and total bilirubin and the inhibition was comparable with Silymarin (100mg/kg po).33

Gupta Nishant Kumar et al., (2009) evaluated the hepatoprotective activity of ethanolic extract of Cleome viscosa Linn. (Capparidaceae) against carbon tetrachloride (CCl₄) induced hepatotoxicity in rats. The extract shortened the thiopental induced sleep in mice poisoned with CCl₄. The hepatoprotective effect of ethanolic extract was comparable to that of standard hepatoprotective agent, Silymarin. The histopathological studies also performed to exhibit the efficacy of drug as a hepatoprotective. Treatment of ethanolic extract with CCl₄ and Silymarin with CCl₄ produces lesser degree of damage to the liver cells as compared to the animals treated with CCl₄ alone. Histopathological study of the liver treated with extract (200 mg/kg b.w.) and CCl₄ reveal better hepatocellular protection activity almost similar to the standard (Silymarin) group.34

Usman L.A. et al., (2010) worked on chemical constituents and anti inflammatory activity of essential oil of Nigerian grown Chenopodium album. This study reveals that hydrodistilled leaves of Chenopodium album yielded 0.64 % v/w of essential oil. GC and GC/MS study revealed that the bulk of the oil was constituted by aromatic compounds (60.1 %). The abundant constituents of the plant were: p- cymene (40.9 %), ascaridole (15.5 %), pinane-2-ol (9.9 %), α-pinene (7.0 %), β-pinene (6.2 %) and α-terpineol (6.2 %).35