and also to the chemistry of the solute in the solution. At lower pH the surface charge may get positively charged, thus making H^+ ions compete effectively with dye cations causing a decrease in the amount of dye adsorbed. At higher pH the surface of ACP particles may get negatively charged, which enhances the positively charged dye cations through electrostatic forces of attraction [23]. Further, the pH increases the removal rate of MB increases but the removal rate of CR decreases with increases the pH. The removal is more in case of MB than CR.

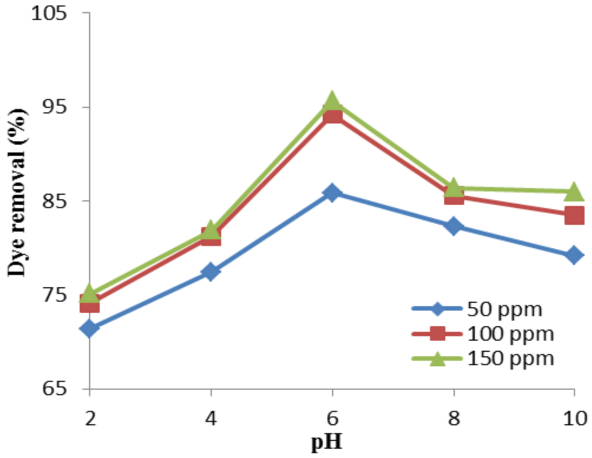

Fig. 1: Effect of pH on MB dye (30 min)

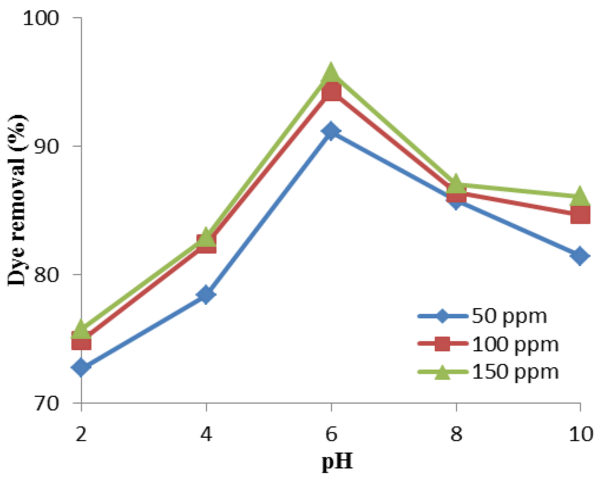

Fig. 2: Effect of pH on MB dye (60 min)

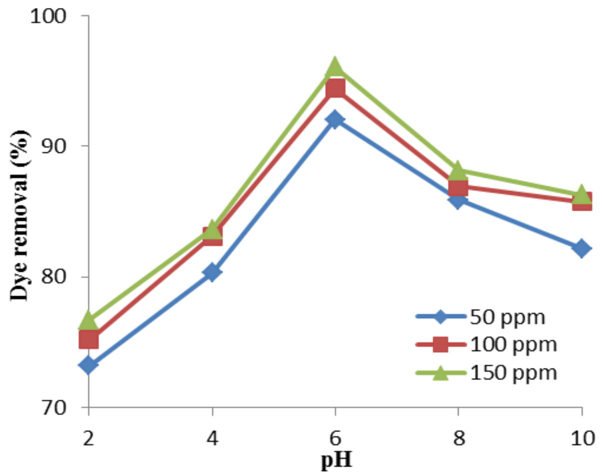

Fig. 3: Effect of pH on MB dye (90 min)

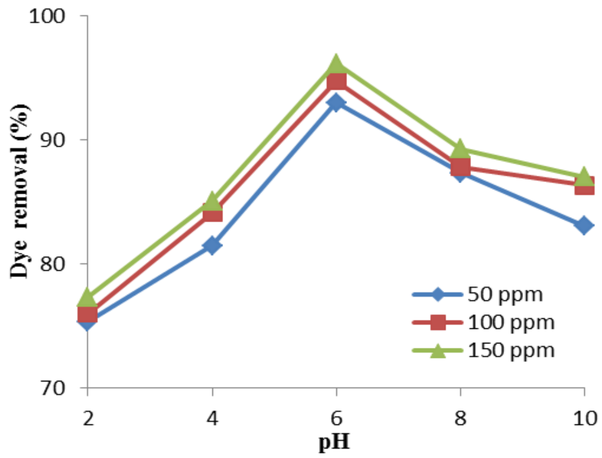

Fig. 4: Effect of pH on MB dye (120 min)

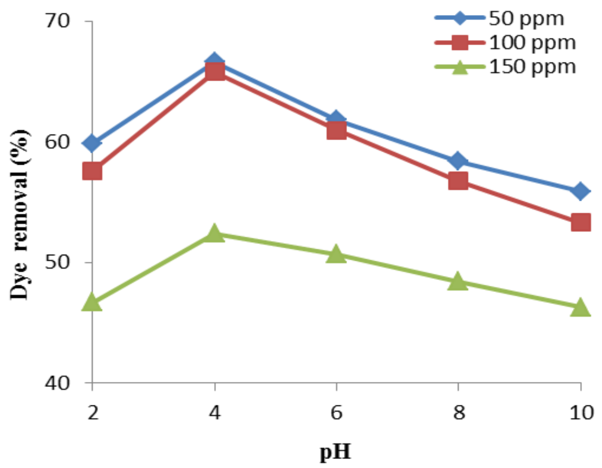

Fig. 5: Effect of pH on CR dye (30 min)

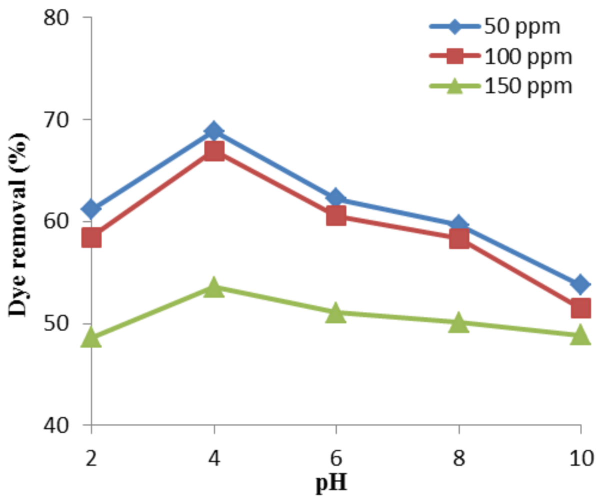

Fig. 6: Effect of pH on CR dye (60 min)

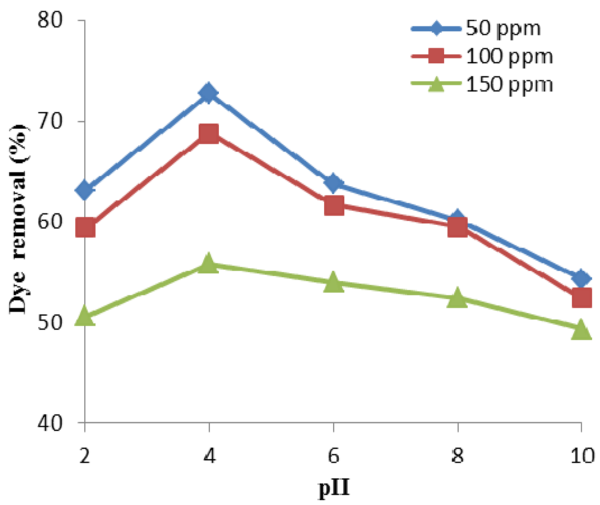

Fig. 7: Effect of pH on CR dye (90 min)

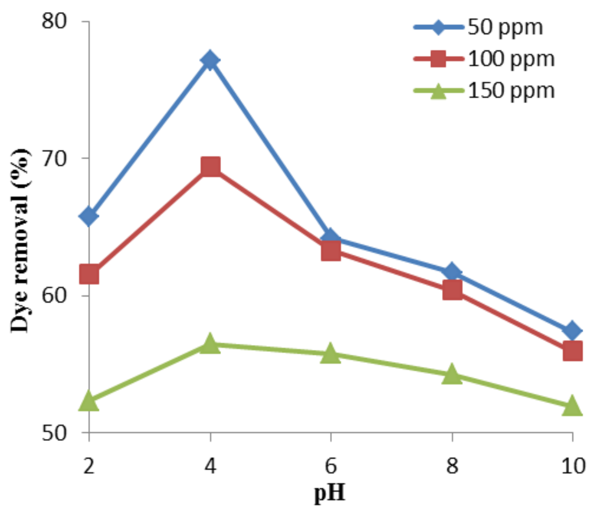

Fig. 8: Effect of pH on CR dye (120 min)

Effect of adsorbent dose

The batch experiments were performed at constant pH (6.0) for MB and pH (4.0) for CR at different contact times (30, 60, 90 and 120 min) on ACP by increasing the ACP dose from 0.1g to 1.0g. The maximum removal of MB were observed at initial dye concentrations (150mg/l), pH(6) and ACP dose (1 g) by increasing contact time 30min (98.7%), 60min (98.9%), 90min (99.1%)) and 120min (99.2%) are shown in the figure 9-12. In case of CR dye, the maximum removal of CR were observed at initial dye concentrations (150mg/l), pH(4) and ACP dose (1 g) by increasing contact time 30min (90.0%)), 60min (91.6%), 90min (92.4%) and 120min (93.2%) are shown in the figure 13-16. This increase in adsorption capacity with adsorbent dose may be attributed to increased adsorbent surface area and availability of more adsorption sites on ACP. The per cent adsorption capacity was increased with an increase in adsorbent dose. The similar results were also observed by Bilal et al., [13]. The adsorption capacities of studied dyes are given in Table 1. The adsorption capacity of studied dyes were increased with increased the concentration of dyes. The adsorption capacity of dye was achieved maximum level in first 30min and thereafter the rate of adsorption capacity increased slowly as the time progresses. This increase in adsorption capacity with adsorbent dose may be attributed to increased adsorbent surface area and availability of more adsorption sites on ACP. The per cent adsorption capacity was increased with an increase in adsorbent dose. The similar results were also observed by Bilal et al., [13]. From the results it has concluded that the removal of MB was more effective than CR.

Table 1: Adsorption capacity of studied dyes

Time (min)	Methylene Blue (MB)			Congo Red (CR)		
	50 (mg/l)	100 (mg/l)	150 (mg/l)	50 (mg/l)	100 (mg/l)	150 (mg/l)
30	5.37	11.78	17.93	4.16	8.22	9.82
60	5.69	11.79	17.95	4.30	8.36	10.04
90	5.75	11.80	18.02	4.54	8.59	10.46
120	5.81	11.85	18.04	4.82	8.67	10.59

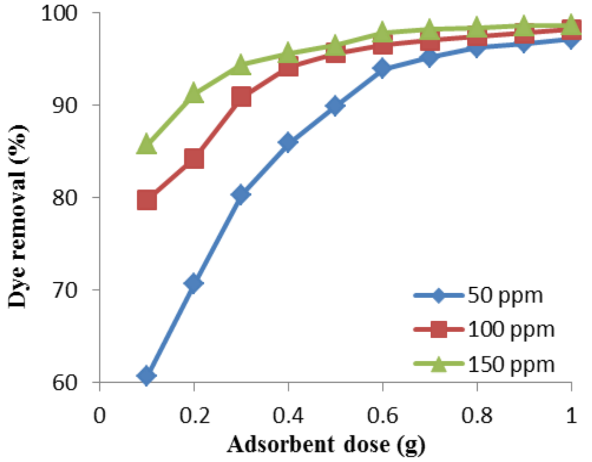

Fig. 9: Effect of ACP dose on MB dye (30 min)

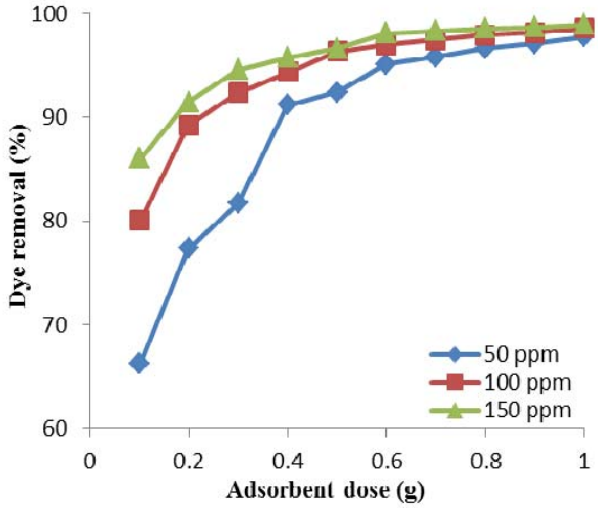

Fig. 10: Effect of ACP dose on MB dye (60 min)

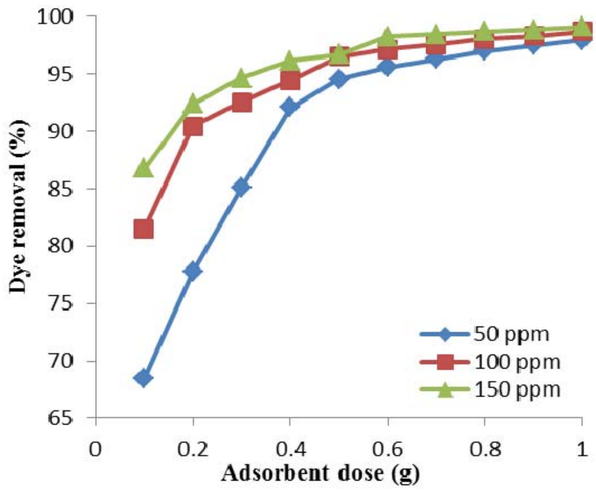

Fig. 11: Effect of ACP dose on MB dye (90 min)

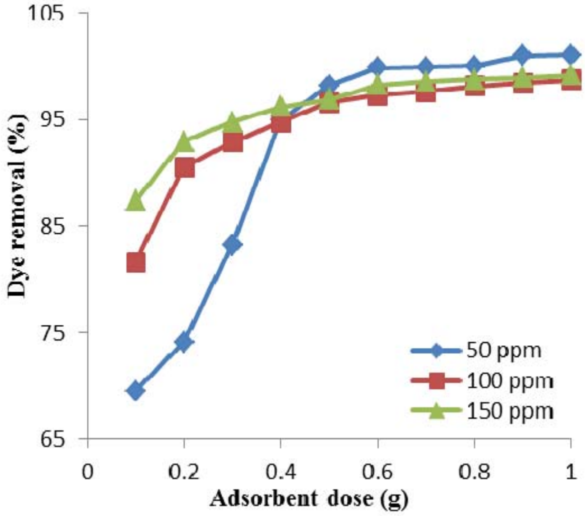

Fig. 12: Effect of ACP dose on MB dye (120 min)

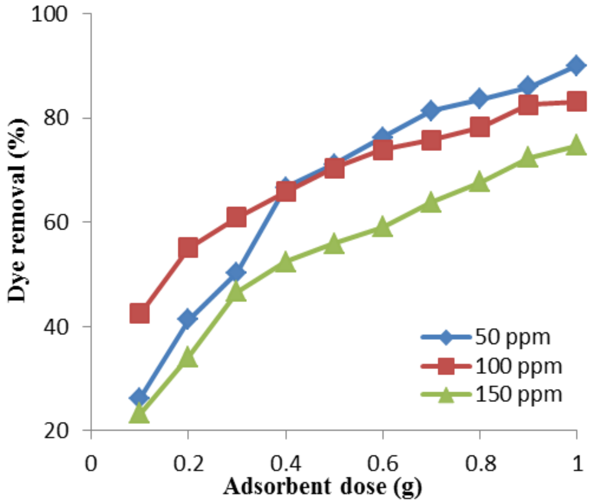

Fig. 13: Effect of ACP dose on CR dye (30 min)

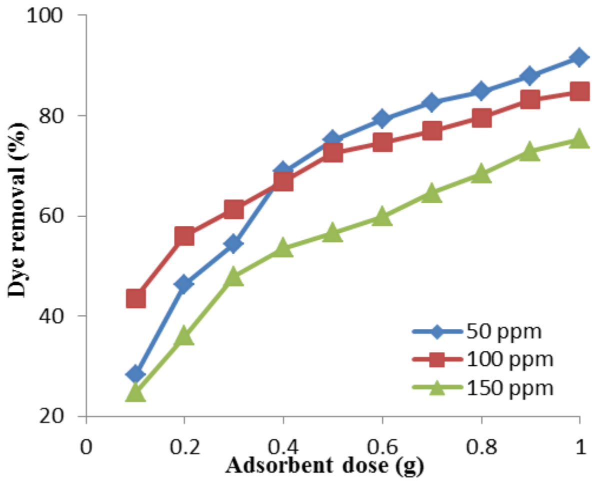

Fig. 14: Effect of ACP dose on CR dye (60 min)

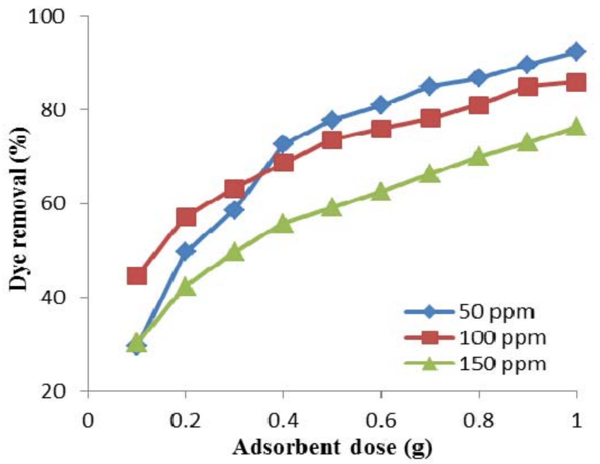

Fig. 15: Effect of ACP dose on CR dye (90 min)

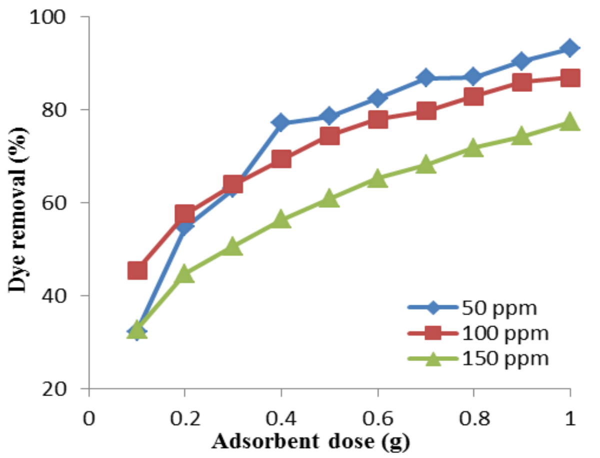

Fig. 16: Effect of ACP dose on CR dye (120 min)

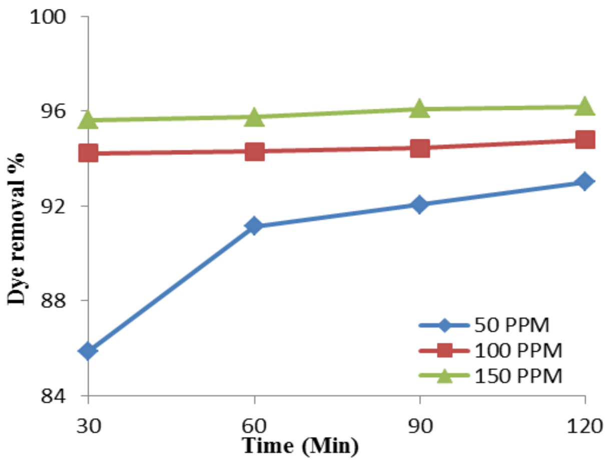

Fig. 17: Effect of time on the removal of MB dye

Effect of contact time

The effects of contact time were carried out using different doses adsorbent (ACP) and selected concentration of adsorbate (MB &CR). The shaker was set at 40 rpm at ambient temperature for different shaking times from 30 to 120min. To determine the optimum shaking time, each solution was filtered after shaking, and the absorbance of the filtrate was determined using UV-Vis spectrophotometer at the appropriate λ_{max} (nm) value for the quantification of the residual dye content. To determine the optimum settling time, the sample was shaken in known concentration of dye solution. The effect of contact time on the removal of MB and CR dyes are shown in Fig. 17 &18. The maximum removal of MB were observed at pH(6) and ACP dose (0.4 g) and contact time 120min at initial dye concentrations (50mg/l) (93.0%), (100mg/l) (94.8%), (150mg/l) (96.2%). In case of CR dye, the maximum removal of CR were observed at pH(4) and ACP dose (0.4 g) and contact time 120min at initial dye concentrations (50mg/l) (77.2%), (100mg/l) (69.4%), (150mg/l) (56.5%). This increase in adsorption capacity with contact time may be attributed to increased adsorbent surface area and availability of more adsorption sites on ACP. The per cent adsorption capacity was increased with an increase in contact time. The similar results were also observed by Bilal et al., [13]. As the contact time increases the removal of rate of MB and CR rate of removal was increased. The percent removal was observed more in case of MB than CR. The dye uptake by ACP for MB dye is rapid for the first 30 min and thereafter it proceeds at a slower rate and finally attains saturation and in case of CR dye, the maximum dye uptake was rapid for the first half hour and there after the removal rate was observed slower. This may be due to the lack of available active sites required for further uptake after attaining the equilibrium [24].

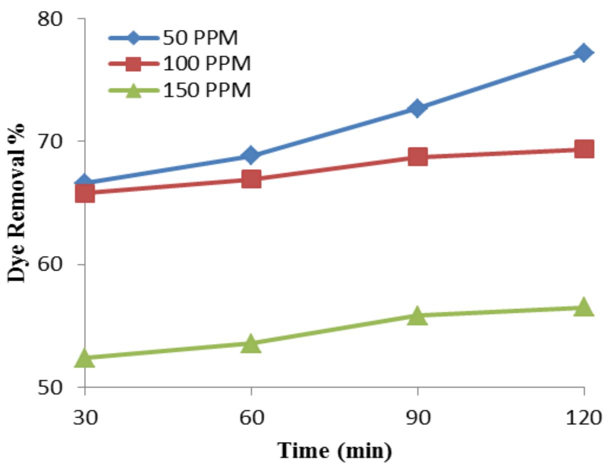

Fig. 18: Effect of time on the removal of CR dye

Effect of initial dye concentration

The maximum removal of MB were observed at initial dye concentrations (150mg/l), pH(6) and ACP dose (0.4g) by increasing contact time 30min (95.6%), 60min (95.7%), 90min (96.1%) and 120min (96.2%) shown in figure 19**.** In case of CR dye, the maximum removal of CR were observed at initial dye concentrations (150mg/l), pH(4) and ACP dose (0.4g) by increasing contact time, 30min (66.60%), 60min (68.8%), 90min (72.7%) and 120min (77.2%) shown in figure 20. Equilibrium adsorption capacity was increased with an increase in concentration of MB & CR. Further increase in dyes concentration showed no significant changes in removal efficiency (Fig. 19 & 20). This may be due to that with increased dyes concentration, the driving force for mass transfer also increases. At low concentrations there will be unoccupied active sites on the adsorbent surface. Above optimal MB & CR concentrations, the active sites required for the adsorption of dye will insufficiency. The per cent adsorption capacity was increased with an increase in initial dye concentration. The similar results were also observed by Bilal et al., [13].

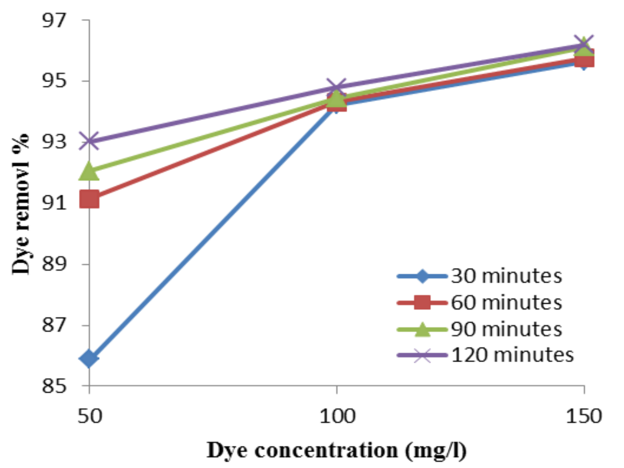

Fig. 19: Effect of initial dye concentration of MB dye

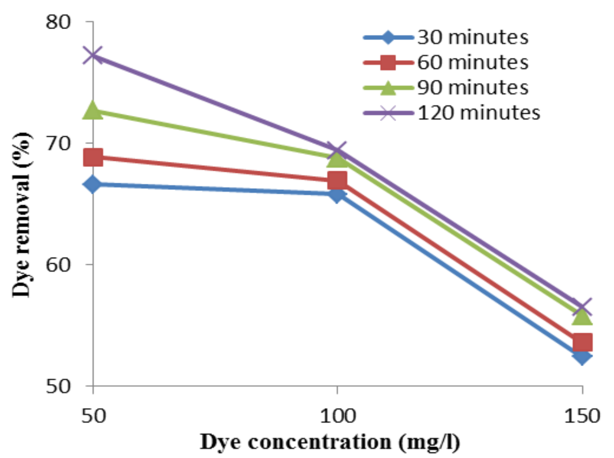

Fig. 20: Effect of initial dye concentration of CR dye

Conclusions

Removal of dyes MB and CR from aqueous solutions by adsorption with activated carbon prepared from Poplar (*Populus*) has been experimentally determined. The prepared activated carbon was characterized by different analysis and test and the following observations are made: The percentage of colour removal increases with increasing adsorbent dose and contact time. Optimum contact time for equilibrium to be achieved is found to be two hours after saturation of the active site which does not allow further adsorption to take place. For MB maximum adsorption was found at pH 6 and pH 4 for CR. Optimum adsorbent dose for MB and CR dye was found 0.4g/50ml. Finally it is concluded that ACP is most vital and economical option to treat the MB and CR dyes presents in wastewater.

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