CHAPTER – 6

CONCLUSION
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The three biggest general changes to the detergent industry in the near future are expected to be increasing consumer expectation, environmental concern and inclusion of bleaches and enzymes in the formulations. The single biggest need of consumers will have around the world will be for better value. This means better performance, more benefit, with fewer or no drawbacks. And, all will be necessary at lower prices. The study of detergent products available in Indian market indicated that the demand of low cost of popular grade detergent powder is high. However, these powders gave poor performance compare to regular as well as premier grade powder.

Considering the analytical and performance results of Indian detergents products as well as the trends highlighted above the study was designed for formulation of ecofriendly detergents containing enzymes. In the study, detergent formulations were prepared having low phosphate content which detrimental for eutrophication in water bodies. In these formulation enzyme was incorporated to increase the washing performance of detergent powder. It is evident from the study that the enzyme and zeolite could replace the phosphate in the detergent formulation without compromising the cost as well as washing performance.

It is concluded from the study that enzyme play a very important role in washing of some special types of stain that cannot be removed by conventional detergent. The four types of enzyme viz. Protease, lipase, amylase and cellulase were used to conduct the study.
The protease is a protein degrading enzymes and is very useful for detergent. The study confirmed that the protease enzyme used in the study is obviously alkaline enzyme with pH optima at pH 10.0 and they are very stable at pH 6-12. It was also found that protease enzyme are active at 50°C and stable up to 60°C. Further detergent did not affect the activity of protease enzyme. Thus the protease enzyme is suitable for use as effective laundry detergent additives. It is evident from the study that the protease enzyme had potentially useful effect during the washing of cloths soiled with protienaceous matter such as blood, egg, spinach juice etc. As we know, most stains are easier to remove in water but blood and other proteinaceous stains are difficult to remove. If the blood stain is not removed for longer period, it forms a stubborn stain. The stain of spinach juice is also difficult to remove. The study revealed that the detergent with protease enzyme gave good detergency against blood stain and stains of spinach juice. The enzyme used in detergent at only 1- % wt/wt concentration gave very good performance in comparison to detergent using no enzyme. Synergistic action of protease and surfactant action produced a remarkable improvement in detergency. Alkaline protease probably attacked on proteineous soil and hydrolyses into peptides. which are release from the surface of cloths by the action of surfactant.

Alkaline protease had the potential to partially replace the surfactant and builder in detergent formulation, with the synergistic action of protease and surfactant and the protease could improve detergency even after the washing ability of each ingredient in the detergent has reached a plateau value. We also found that alkaline protease enzyme can save washing time and allow washing at a lower temperature. The pH effect on soil
removal with protease is largely a result of increased enzyme activity at the higher pH level used in this study.

It is concluded from the study that, the lipase is the second useful enzymes for detergent products. It was found that lipase enzyme used in the study was active at high temperature and at alkaline pH value commonly found in laundry detergent process. The study revealed that, for the detergent formulation using lipase enzyme, must contain nonionic surfactant along with anionic surfactants, because higher concentration of anionic surfactant inhibits the lipase activity whereas nonionic surfactant enhance the lipase activity. The presence of lipase in detergent formulation improves the detergency of detergent. Lipase had good effect in removing oily and fatty soils. Lipase enzyme helps in removing stain derived from triglycerides based lipstick, olive oil and synthetic sebum soil. Natural sebum soil consists of about one third part fat and is suitable for removal by lipase. The washing efficiency of lipase in detergent formulation increased by increasing washing time and washing temperature.

Amylase is the useful enzyme in detergent. From the study it is concluded that the amylase enzyme used in the study is suitable for detergent, as it was active at higher temperature and it was thermal stable enzyme, stable up to 70°C. Amylase was also active and stable in alkaline pH range. Amylase enzyme was not inactivated in the presence of most of the detergent ingredients tested and appeared to be potentially useful in washing powders. Amylase enzyme appeared to be good effect on washing of cloths soiled with chocolate stain and soil of cocoa/milk/sugar and starchy soups. It is concluded that amylase gave good detergency against starchy soil. Stains from starchy foods such as rice potato and pasta may not be visible, but they attract dirt. Starch is also a major component of other food materials; amylase enzyme may be used for removing stain from such type of food materials.
Cellulase is a class of cellulose degrading enzyme that is also useful for detergent. The study revealed that cellulase enzyme used in the study was active at alkaline pH with optima at pH 9.5, and they are very stable to incubate at pH 6-11, and temperature up to 50°C. Further the cellulase enzyme was active, when incubated with various detergent ingredients. Thus cellulase enzyme is suitable for the use as effective laundry detergent additives. It was concluded from the results that the cellulase improves the detergency of cotton cloths soiled with clay. The clay can be detached by the action of cellulase. Cellulase had important role in removing particulate soil. It is assumed that by degrading cellulose microfibril on the surface of cotton fabrics, the dirt trapped in microfibril is also removed. Cellulase also gave fabric color clarification on washing the fabrics for a number of time with cellulase containing detergent. Cellulase also had the whiteness maintenance effect of white cotton fabrics.

The study revealed that formulation using more than one enzyme had great effect. As we have seen that each enzyme has the effect on particular type of specific stain, but when we used more than one enzyme in combination, the detergent gave good effect on a number of stains. On comparison, detergent using two enzymes in combination gave better detergency than detergent using only single enzyme. Just like that detergent using three enzymes in combination rather than single or two enzymes had better detergency power. The study confirmed that, as the detergent contained only either lipase or cellulase enzyme had little effect on cotton cloth soiled with particulate matter suspended with synthetic sebum soil. However, when detergent contained lipase and cellulase in combination with protease had very good effect on cotton cloth soiled with particulate matter suspended with synthetic sebum soil. Similarly, when detergent contained protease enzyme in combination with lipase and amylase as well as combination with cellulase and amylase gave very good detergency of cotton cloth soiled with protienous, oily and starchy soil. The study revealed that when the detergent using all four enzymes in combination gave much better effect on cotton cloths soiled with various type of soil.
The study gave evidence that each enzyme has great potential for application to laundering process, because, each enzyme provide the novel possibility of soil removal. The enzyme could shorten the time as well as save energy during home laundering. The phosphate in detergent, which is considered harmful for aquatic environment, could be replaced by enzyme, which is environment friendly thus help to protect the environment.