SUMMARY AND CONCLUSION

Aquaculture plays a vital role all over the world by offering better nutrition, source of income, tool to rural development, earning foreign exchange and better employment opportunities. Paralleling the growth of the aquaculture industry has been attaining expansion in the feed production dramatically. In order for aquaculture to continue the growth, the dependence on fish meal should be minimized or reduced. The rapid decline of the fish stocks in the market due to overfishing and poor management resulted in reduced quantities of fish for human consumption, fish meal and fish oil for aquaculture feed production. Nevertheless, fish meal is excellent source of protein and other essential nutrients for aquaculture feeds; their demand is subject to competition from other sectors of the agriculture industry. However, the supply, quality and price often fluctuate year to year due to both market and environmental constraints.

The use of microalgae (S. platensis and C. vulgaris) and A. pinnata as protein sources are the obvious solution to partially overcome this problem by reducing the amount of fishmeal used in prawn diets but optimal growth and efficiency must be maintained at the same time.

*Proximate composition of S. platensis, C. vulgaris and A. pinnata included feeds*

In the present study, the cultivated freshwater microalgae such as S. platensis, C. vulgaris and floating fern A. pinnata nutritional contents like protein, carbohydrate, lipids, essential amino acids and minerals were compared with fishmeal and were found to have equivalent level.

In this study, the experimental feed was formulated by fishmeal replacement with cultured freshwater algae (S. platensis and C. vulgaris) and A. pinnata. The adequate level of protein, carbohydrate, lipid and moisture content were showed in formulated feed
when compared with fishmeal feed. The higher ash content indicated the presence of higher concentration of total minerals in experimentally formulated feed. The formulated feeds contained protein, carbohydrate and lipid composition sufficient for the growth and culture of *Macrobrachium*.

**Growth, Nutritional indices and Energy utilization**

In the present study, the increased level of length and weight were observed in *S. platensis, C. vulgaris* and *A. pinnata* incorporated feed fed *M. rosenbergii* PL. The nutritional indices parameters such as survival rate, weight gain, specific growth rate and feed conversion efficiency showed significantly increased in experimental feed fed group and as well the decreasing trend of condition factor and feed conversion ratio indicated that the formulated feeds were well utilized by the prawn PL. The energy utilization parameters, such as feeding rate, absorption rate and conversion rate were significantly higher in experimental feed fed prawns. This can be correlated with increased food consumption, which in turn indicates elevated protein consumption.

**Biochemical constituents**

The increase in biochemical constituents such as total protein, amino acids, carbohydrate, lipids, ash and moisture contents were elevated in *S. platensis, C. vulgaris* and *A. pinnata* incorporated feed fed *M. rosenbergii* PL. The increase of total protein in experimental groups indicated that the *S. platensis, C. vulgaris* and *A. pinnata* protein were efficiently used by prawn PL. The increase in carbohydrate content indicates the protein sparing effect on growth was higher in experimental feed fed PL. The elevation of lipid content in experimental PL confirmed the quality of formulated feeds which might have helped to achieve maximum growth and survival of prawn PL. The elevated level of
biochemical constituents indicates these feeds appear to provide good quality of nutrients for the growth of prawn PL.

**Activities of Digestive enzymes**

In this study, the activities of digestive enzymes like protease, amylase, lipase and cellulase were significantly elevated in experimental feed fed group. The elevations of digestive enzymes activities were higher in 50% of *C. vulgaris* incorporated feed followed by the 50% of *S. platensis* and *A. pinnata* incorporated feed fed prawn PL when compared with control PL. The present results showed, 50% of fishmeal replaced with 50% of *C. vulgaris, S. platensis* and *A. pinnata* supplementation feeds well utilized by the prawn PL. Actually, the ingredients such as *C. vulgaris, S. platensis* and *A. pinnata* possess easily digestible and enhanced the secretion of digestive enzymes.

**Non enzymatic and enzymatic antioxidants**

The non enzymatic antioxidants like vitamin C and E play very crucial role in larval growth, metabolism and stress resistance. In the present study, the significant elevation of vitamin C and E were observed in experimental feed fed groups. The elevation of vitamin C and E were recorded higher in 50% of *C. vulgaris* incorporated feed fed PL group followed by the 50% of *S. platensis* and *A. pinnata* incorporated feed fed PL. Generally, the increased level of enzymatic antioxidants (superoxide dismutase and catalase) and lipid peroxidation are indicators of stress, toxicity and disease infection. In this study, SOD, catalase and lipid peroxidation showed no significant variation between control and experimental groups. The present results revealed that the feeds were well utilized by the prawn PL and it is also worthy to
mention that the experimentally formulated feeds were not showed any toxic effects to M. rosenbergii PL.

Profiles of protein, amino acids and fatty acids

The increase in protein, essential amino acids and essential fatty acids quality in experimental feed fed prawns indicated the superior quality of formulated feed. It indicates the supplementary ingredients such as C. vulgaris, S. platensis and A. pinnata is a rich source of essential amino acids and fatty acids. Most of the amino acids and fatty acids were also elevated in experimental feed which could help in the enhanced growth and survival of PL.

Concentration of electrolytes and minerals

In the present study, the essential minerals and electrolytes were identified in the formulated feeds and experimental PL. The levels of minerals and electrolytes were significantly higher in experimental feeds and these feeds fed prawn PL. This may be reason for elevated ash content in experimental PL and feed. Among the three feeds, C. vulgaris incorporated feed fed group PL showed better performance followed by the S. platensis and A. pinnata incorporated feed fed groups when compared with control PL. Hence, these ingredients can be taken as replacement materials in the place of fishmeal in aqua feed formulations.

Gut microflora

In the present study, six genus of common gut microflora (Bacillus sp., Pseudomonas sp., Escherichia coli, Streptococcus sp., Proteus sp. and Salmonella sp.) were identified in control feed fed PL, whereas the Salmonella sp. was not identified in experimental feed fed PL groups. The probiotic bacteria Bacillus sp. diversity was
dominant in experimental feed fed PL gut. It was found that pathogenic bacteria, *Salmonella* sp. was absent in the prawn fed with experimental feed and it was due to feeding with *C. vulgaris*, *S. platensis* and *A. pinnata*.

In *S. platensis* and *C. vulgaris* included feeds fed PL, the survival and growth were appreciable than that of the control even when the fish meal was completely replaced. However, in the case of *A. pinnata* fed group only 25% and 50% levels of replacements produced higher performance when compared with control. Hence, 100% replacement of fishmeal can be made with *S. platensis* and *C. vulgaris* and not in the case of *A. pinnata*. The overall results revealed that 50% replacement of fishmeal with these ideal novel protein materials produced maximum appreciable results. Among these feeds *C. vulgaris* incorporated feed fed group produced the best performance followed by *S. platensis* and *A. pinnata*. The present results revealed that the partial replacement of fishmeal with these ingredients enhanced the survival, growth, nutritional indices, tissue biochemical components, digestive enzymes activities and beneficial gut microflora in *M. rosenbergii* PL. Therefore, *C. vulgaris*, *S. platensis* and *A. pinnata* can be taken as ingredients in low cost feed formulation for promoting sustainable aquaculture of freshwater prawns in general and *M. rosenbergii* in particular.