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EFFECT OF *GARCINIA MANGOSTANA* FRUIT PERICARP EXTRACTS AS A FEED ADDITIVE ON IMMUNOLOGICAL, BIOCHEMICAL AND GROWTH PARAMETERS OF *CIRRHINUS MRIGALA* AGAINST PATHOGENIC BACTERIA

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ABSTRACT

Aims: *The present study was made to test the effect of Mangosteen (Garcinia mangostana Linn.) fruit pericarp extracts as a feed additive on immunity, biochemical and growth parameters of Indian major carp- (Cirrhinus mrigala Ham.) fingerlings.* ***Methods:*** *Sixty fingerlings were randomly introduced into each tub. Five treatment groups consist of three replicates. Five experimental diets were prepared: Controls, Petroleum ether, Toluene, Ethyl acetate and Methanol extract mixed feed respectively. The 0.10% of Mangosteen fruit pericarp various (petroleum ether, Toluene, Ethyl acetate and Methanol) extracts of mangosteen were included in the experimental diet. The fish were fed with experimental diets for sixty days.* ***Result and conclusion:*** *Results showed that oral administration of various mangosteen fruit pericarp extracts resulted in Superoxide anion production, Bactericidal activity, Lysozyme activity, Blood glucose, Total protein, Albumin, Globulin, SGOT, Total lipid, Cholesterol and Triglycerides Specific growth rate (SGR), Feed conversion ratio (FCR) and Histopathology of liver, kidney, gills, intestine of Cirrhinus mrigala showed the effect of experimental diets. Based on the results, the present study suggests that Mangosteen fruit pericarp extracts of different solvents especially 0.10%/Kg supplemented feed additive enhances the immunological, biochemical and growth parameters of Indian Major Carp Cirrhinus mrigala fingerlings against pathogenic bacteria Pseudomonas fluorescens.*

KEY WORDS

Cirrhinus mrigala. Garcinia mangustana. Pseudomonas fluorescens, Immunological, biochemical and growth parameters.

INTRODUCTION

Aquaculture is considered as one of the most promptly developing food-producing field in the world. The increased expansion of fish culture has led to a vast number of disease outbreaks with an increasing range of organisms causing them. (Kirubakaran *et al*., 2010). Aquaculture has developed as one of the most hopeful business due to the increasing demand for animal proteins to serve nutritional and food safety. There are more than 200 species of fishes trained by aquaculture for economical reason, which has shown an increase in the acceptable economic enterprise in the developed as well as developing countries. In India, *Catla catla, Labeo rohita,* and *Cirrhinus mrigala* are the main freshwater

carp produced, which are essentially consumed as a source of helpful lipids and proteins. (Swapna *et al*., 2010; Dharmaraj *et al.,* 2015).

Plant oriented medicinal treatments have antibacterial activity, and they are possibly suitable and substitute in the field of aquaculture (Abutbul *et al.,* 2005). Plant materials, such as vegetables, fruits, leaves, spices, roots, and barks, have been widely evaluated as potential sources of natural antioxidants (Ellnain-Wojtaszek *et al.,* 2002; Chyau *et al.,* 2002; Picerno *et al.,* 2003; Naczk *et al.,* 2003). The plant extracts can be used as a substitute to control and avoid outbreaks of diseases mainly in fish forms. Since these substances are natural, their harmful possible is less when compared with other products. The outcomes show that the evaluated plants presented a high potential for substitute analysis of bacterial fish diseases (Castro *et al.,* 2008).

Garcinia mangostana Linn. family *Clusiaceae (Guttiferae)* is a tree originate in Sri Lanka and other South East Asian countries, which is very popular due to its yummy fruits. Treatment of diarrhoea, skin infections, dysentery, and as an anti-inflammatory agent are some of the medicinal utilization of this plant. Xanthones, terpenoids and sugars have been reported from the fruit hulls and leaves of *G. mangostana,* and some of them have shown a variety of biological activities (Praveen *et al.,* 1991; Suksamrarn *et al.,* 2002). Among them, antibacterial activity against MRSA of a - mangosteen is significant (Iinuma *et al.,* 1996; Sakagami *et al.,* 2005).

The fruits of *G. mangostana* are the most conserved part of this plant and are essential for the extraordinarily pleasant flavour. Therefore, *G. Mangostana* fruit was named as the 'queen of tropical fruits' (Lim, 1984; Ramage *et al.,* 2004). Mangosteen fruits are a rich source of phenolic acids, xanthones, anthocyanins, and concised tannins (proanthocyanidins) (Pedraza-Chaverri *et al.,* 2008; Zadernowski, Czaplicki, & Naczk, 2009). Phenolic acids detached from soluble esters are the predominant phenolic acids in the mangosteen fruits (Zadernowski *et al.*, 2009). So far, fifty xanthones have been isolated and identified in the pericarp of mangosteen fruit (Jung *et al.,* 2006; Naczk *et al.,* 2011).

Various parts of *G. mangostana,* usually barks, roots and fruit hull, have been used for hundreds of years in Southeast Asia as a medicine for a great variety of medical conditions. In Thailand, China, India, and other parts of Asia dried and powdered fruit hull is used for the antiparasitic treatments in dysentery and antimicrobial agents. (Saralamp *et al.,* 1996; Nakatani *et al.,* 2002b; Moongkarndi *et al.,* 2004b; Yu *et al.,* 2007) as well as suppurations, chronic ulcers and externally for curative wounds (Farnsworth and Bunyapraphatsara, 1992).

The biting qualities of *G. mangostana* are also used for loss of needed nutrients from the gastrointestinal tract in case of diarrhoea and inhibiting dehydration. The fruit hulls of *G. mangostana* have been used for the treatment of painful skin infections and the break of diarrhoea in Thai folk medicine. (Suksamrarn *et al.,* 2002, 2003; Jung *et al.,* 2006). Several studies have demonstrated antiviral, antibacterial and antifungal properties of xanthones and extracts procured from *G. Mamgostana Linn.* (Sakagami *et al.,* 2005; Voravuthikunchai and Kitpipit 2005; Chomnawang *et al.,* 2005; Rassameemasmaung *et al.,* 2007).

Bacteria are one of a chief productive agent of fish disease in both cultured and wild fish and are liable for severe economic losses. Many pathogens are present as skin infections especially *vibrios, pseudomonads, aeromonads* etc. The bacteria of genera *pseudomonas* are universal facultative parasites. These genera belong to the healthy bacterial flora of the hatcheries, aquaria, fish farms and bodies of water for domestic use. These bacteria show the presence of the colonization of in the fins, gills, skin, and the intestinal lumen of fish. *Pseudomonas fluorescens* has been relatted with ulcerative conditions and septicaemia in a wide range of fishes. It has been treated as a fish spoilage organism (Omprakash *et al.,* 2015). As well as a primary, but poor pathogen (Stoskopf *et al.,* 1999). *Pseudomonas fluorescens* is normally found in soil, water, and on the body of fishes. With these findings in view, this work aimed to evaluate the effect of a various extract of *G. Mangostana* fruit pericarp supplemented diets on immunity and biochemical parameters against pathogenic bacterium *Pseudomonas fluorescens* in *Cirrhinus mrigala* during 60 days study.

MATERIALS AND METHODS

Acclimatisation of Fish

Healthy fingerlings of Mrigal carp *(Cirrhinus mrigala)* having an average weight of 8.5 ±1.0g and the total length of 9cm ± 1.0cm were procured from an Aliyar

dam, Tamil Nadu Fisheries Corporation, India. (Located about 65 Km from Coimbatore). Initially, 300 fishes were introduced to the large cement tank containing dechlorinated tap water and kept for 30 days for acclimatization. The stock was fed on the control diet. After acclimatization, fishes were divided into five different groups (1-control, 2, 3, 4, 5-experimental group) of 60 fishes in each treatment. The water exchange rate was 50% of water volume daily.

Plant material

Commercially available healthy fresh fruit of *(Garcinia mangostana Linn.)* that belongs to the family-Guttiferae. *G. mangostana* were collected from local market of Nilgiris, Tamil Nadu, India. Confirmed by comparison with reference herbarium specimens. Initially, the aril or the white pulp of the fruit of *G. Mangostana* was removed, and the pericarp was collected and washed cleanly in pure tap water, rinsed in double distilled water and shade dried for ten days in open air. After that, the dried pericarp was crushed using pestle and mortar reduced to powder using a laboratory mixer for few minutes at high speed and then sieved and saved in airtight closed containers before starting the experiment.

Preparation of *G. Mangostana* fruit pericarp extract

sThe powdered *G. mangostana* fruit pericarp was extracted separately to exhaustion in a Soxhlet apparatus using different organic solvents in the increasing polarity order. Twenty grams of powder was extracted in 450 ml of each solvent (Petroleum ether, Toluene-99.5%, Ethyl acetate-99%, Methanol-99%). The extract was collected carefully and then concentrated by using evaporating beakers at room temperature (27°-35°C) for 2–4 days till the final volume was reduced to one-fourth of the original volume of the solvent and stored at 4° to 6° C in airtight containers until further use. *G. mangostana* fruit pericarp extracts were tested against *Pseudomonas fluorescens* (gram negative rod or oval-shaped bacteria) through invivo method.

Preparation of Experimental food

1-Control normal balanced feed composed of Corn meal-10gm, Fish meal-15gm, Wheat meal-15gm, Soy bean meal-15gm, fish oil-2gm, Vitamin and mineral mix-2gm, Rice bra-15gm, Ground nut oil cake-20gm, starch-1gm, Egg white-5gm for 100gm feed preparation was used as the control diet. **2-** Treatment diet was prepared by mixing of normally balanced feed composition and Petroleum ether extract of *G. Mangostana* fruit pericarp in ratio 10grams per kilogram of food. (i.e, 0.10 % *G. Mangostana* fruit pericarp petroleum ether extract). **3-** Treatment diet was prepared by mixing of normally balanced feed composition and Toluene extract of *G. Mangostana* fruit pericarp in ratio 10grams per kilogram of food. (i.e, 0.10 % *G. Mangostana* fruit pericarp toluene extract). **4-** Treatment diet was prepared by mixing of normally balanced feed composition and Ethyl acetate extract of *G. Mangostana* fruit pericarp in ratio 10grams per kilogram of food. (i.e, 0.10 % *G. Mangostana* fruit pericarp ethyl acetate extract). **5-** Treatment diet was prepared by mixing of normally balanced feed composition and methanol extract of *G. Mangostana* fruit pericarp in ratio 10grams per kilogram of food. (i.e., 0.10 % *G. Mangostana* fruit pericarp methanol extract).

Pathogen culture

Bacteria cultures of *Pseudomonas fluorescens* (MTPC-103- Chandigarh) were obtained from Microbial biotechnology Department, Bharathiar University. The cultures were maintained on an agar plate at 4°C and activated at 25°C for 48hrs on an agar plate.

Challenge study

The bacterial cells were centrifuged at 600 rpm for 10 to 15 min and prepared in PBS. After 28th day of the experiment, fish in each group were injected through intraperitoneally with 0.1ml of suspension of the bacteria 1.6×10^{7} cfu / fish in PBS. After that, Immunological, biochemical and growth parameters were tested against *Pseudomonas fluorescens.* Pathogenic effect and immune development of the fish were studied through the histopathology of Liver, Kidney, Gills and Intestines.

Determination of immunological parameters

1.Superoxide anion production of blood phagocytes challenged with *Pseudomonas fluorescens* was measured according to the method of Chung and Secombes 1988. 2. Lysozyme activity **-**turbidimetric assay was carried out followed by the method of Parry *et al.,* 1965. 3. Bactericidal activity was done by the following procedure of Kajita *et al.,* 1990.

Determination of blood biochemical parameters

1. Blood glucose was measured by adopting the Enzymatic – colorimetric- End point method described by (Trinder *et al.,* 1972).2. Total protein content was determined via the method described by Lowry *et al.,* 1957.3. Albumin content from blood was estimated by following Doumas *et al.* 1971.4. Globulin content was

measured using a standard albumin estimation kit, and the globulin content was estimated by subtracting albumin from total protein.5**.** AST or SGOT levels were estimated by adopting the procedure of Reitman and frankel 1957.6**.** Cholesterol level was determined by the method described by Folch *et al.,* 1957. 7. Triglycerides level was determined by the method described by Folch *et al.,* 1957.

Determination of Growth parameters

Weight gain percentage, Specific growth Rate, Feed Conversion Ratio of each group was determined by the method of Choudhury *et al.* 2005.

RESULTS AND DISCUSSION

Immunological parameters

Superoxide anion production from the *Cirrhinus mrigala* was reported the highest level (2.80 ± 0.5091) significantly on the 45th day in *G. Mangostana* methanol extract treated group, and it was low level (1.96 ± 0.5657) on the 60th day of the experiment. (Fig-1) When compared with other groups. Lysozyme activity was increased in the *G. Mangostana* methanol extract treated group (368 ± 0.9899), control group (99 ± 0.7071) on the 45th day and significantly decreased on the 60th day (280 ± 0.0000). When compared with the control group. (76 ± 0.4243) (Fig-2) Bactericidal activity was increased in *G. Mangostana* methanol extract group (192 ± 0.4619) on the 45th day of the experiment. At the same time, it was significantly decreased (96 ± 0.3464) on the 60th day of the experiment. When compared with control, petroleum ether, toluene, ethyl acetate groups. (Fig-3).

Biochemical parameters

Blood glucose was increased in the ethyl acetate extract group **(**124 ± 0.2121) and *G. Mangostana* methanol extract treated group (248 ± 0.0000) on the 30th day of the experiment. It was significantly decreased in the ethyl acetate extract group (96 ± 0.5657) and *G. Mangostana* Methanol extract treated group (212 ± 0.7071) on the 45th day of the experiment. When compared with control and other groups. (Fig-4) Total protein was significantly decreased in ethyl acetate extract group (7.90 ± 0.7071) and *G. Mangostana* methanol extract treated group (10.60 ± 0.2887) on 45th day then it was significantly increased in ethyl acetate extract group (11.40 ± 0.1155). Moreover, *G. Mangostana* methanol extract treated group. (13.20 ± 0.7071) on the 60th day when compared with other groups. (Fig-5) Albumin level was increased (4.70 ± 0.1155) in *G. Mangostana* methanol extract treated group on the 60th day of the experiment. When compared with control (3.40 ± 0.0000) and other experimental groups. (Fig-6) Globulin level was significantly decreased (6.50 ± 0.0577) in *G. Mangostana* methanol extract treated group on the 45th day of the experiment. Then it was significantly increased (8.50 ± 0.0346) on the 60th day of the experiment. (Fig-7) AST **(**aspartate transaminase) was significantly increased in *G. Mangostana* methanol extract treated group (95.70 ± 0.0566) on the 45th day, and it was significantly decreased (88.90 ± 0.0283) on the 60th day. When compared other experimental groups. (Fig-8) Cholesterol was significantly increased in ethyl acetate extract group (82.4 ± 0.0173) and *G. Mangostana* methanol extract treated group (84.4 ± 0.1155) on the 60th day when compared with a 15th and 30th day of the experiment of the same groups as well as other groups. (Fig-9) Triglycerides were also increased in ethyl acetate extract group (64.4 ± 0.0283) and *G. Mangostana* methanol extract treated group (71.4 ± 0.0424) on the 60th day of the experiment when compared with 15th, 30th, 45th day of the same experimental groups as well as control, petroleum ether and toluene group. (Fig-10).

Growth parameters

Weight gain percentage was *G. Mangostana* methanol extract treated group **(**32.91 ± 0.0283) and the very lowest range in the control group (15.197 ± 0.0113) when compared with other groups**.** (Fig-11) Specific growth Rate was significantly increased in *G. Mangostana* methanol extract treated group (2.96 ± 0.4808) but very low in the control group (0.307 ± 0.0066)**.** (Fig-12) Feed Conversion Ratio was the highest range in *G. Mangostana* methanol extract treated group **(**19.28 ± 0.1703) and very low in the control group (6.920 ± 0.0424) when compared with other groups. (Fig-13).

FIGURE.1. SUPER OXIDE ANION PRODUCTION (O. D).

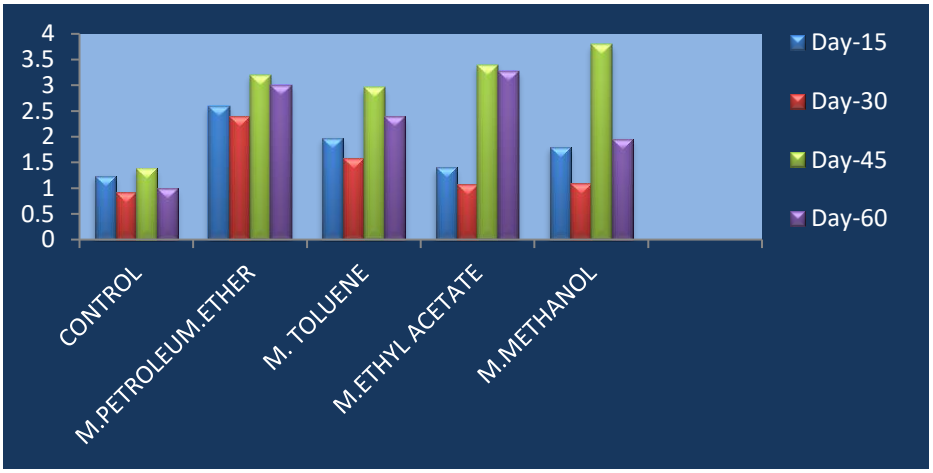


FIGURE.2. LYSOZYME ACTIVITY (U / ML).

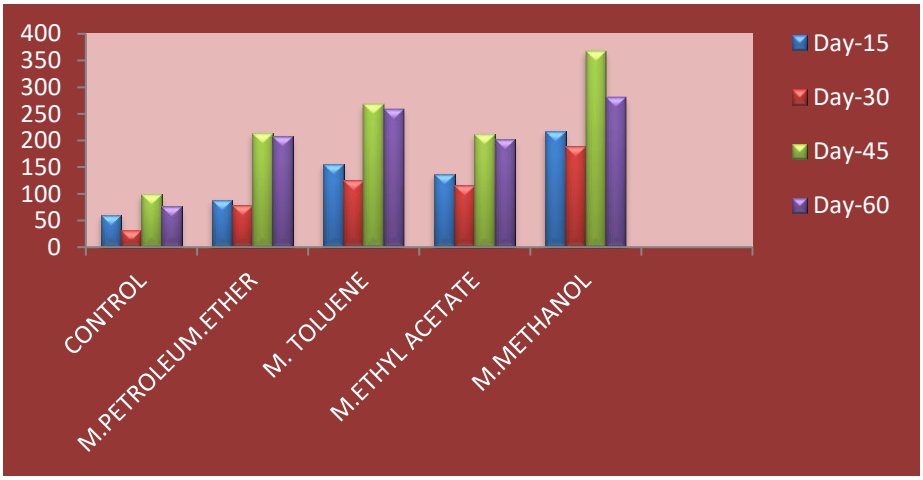


FIGURE.3. BACTERICIDAL ACTIVITY % (CFU)

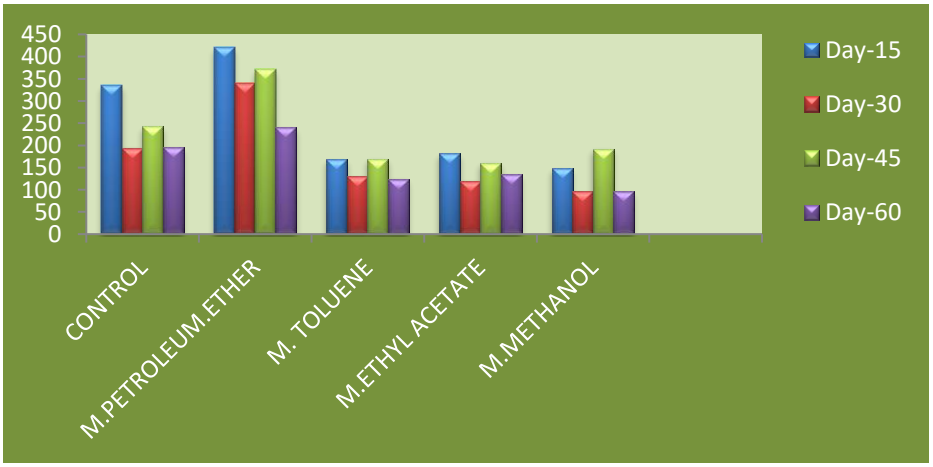


FIGURE.4. BLOOD GLUCOSE (MG L^{-1}).

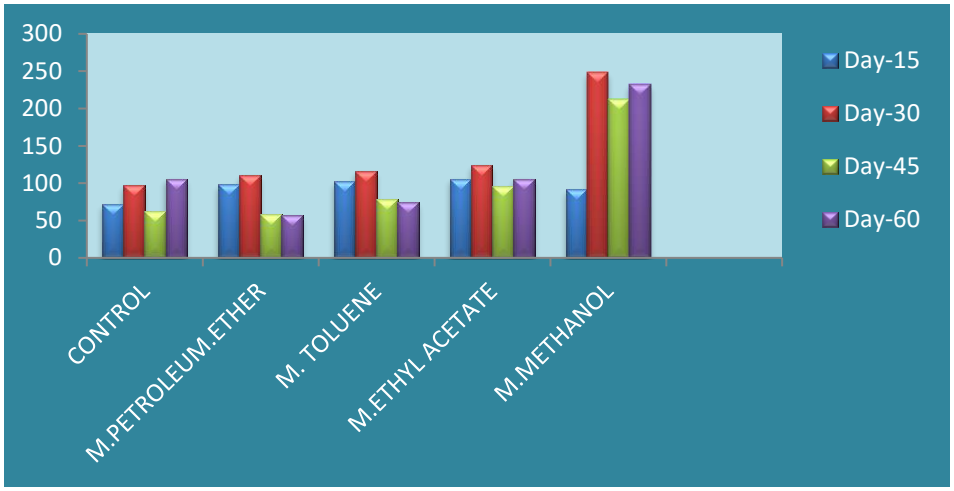


FIGURE.5. TOTAL PROTEIN (G / DL).

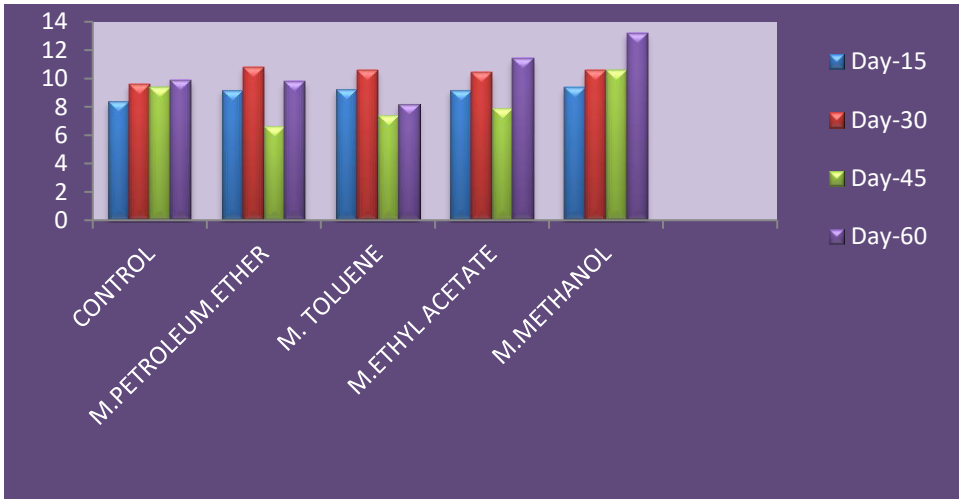


FIGURE.6. ALBUMIN (G / DL).

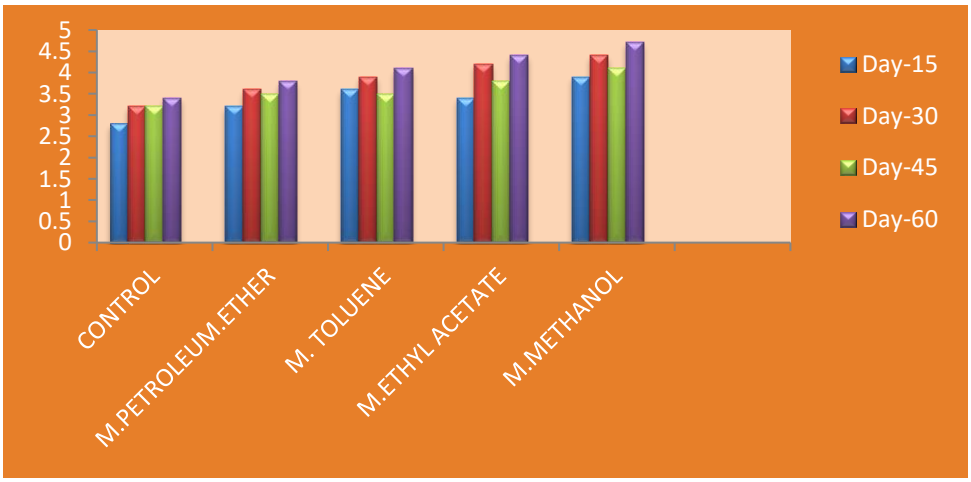


FIGURE.7. GLOBULIN (G / DL).

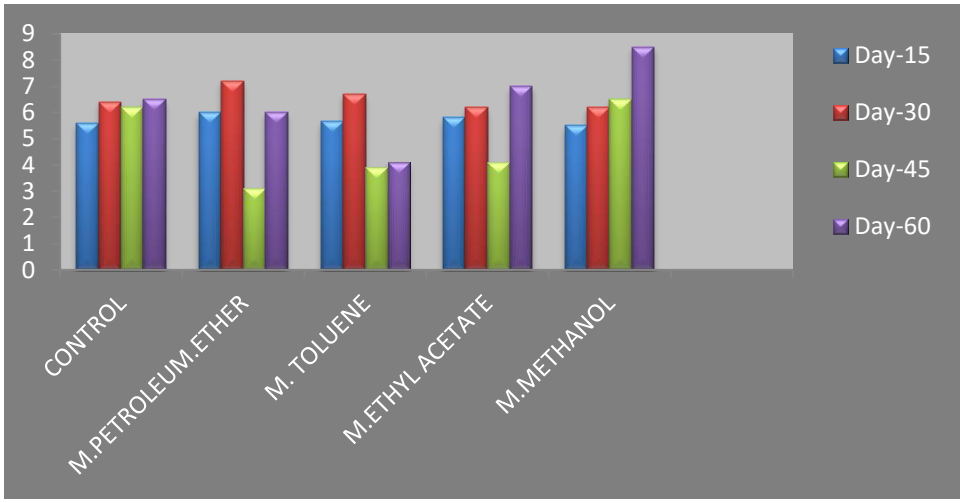


FIGURE.8. ASPARTATE TRANSAMINASE (U / ML).

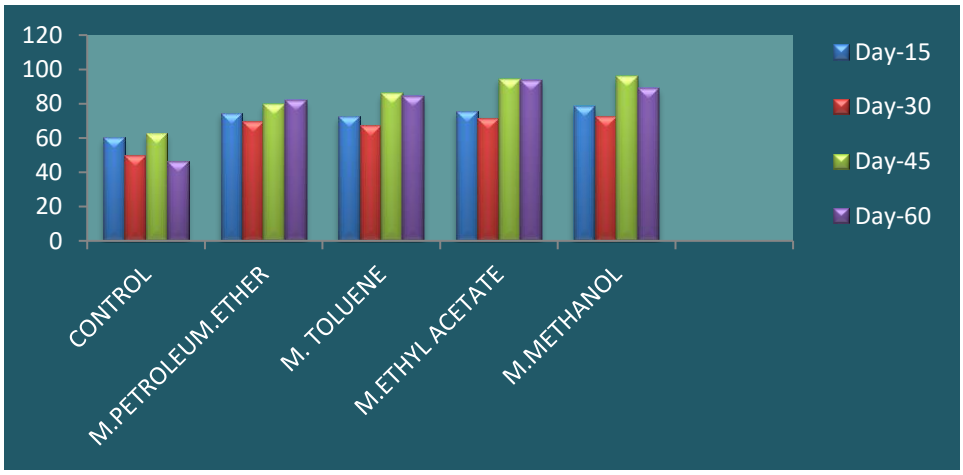


FIGURE.9. CHOLESTEROL (MG/ DL).

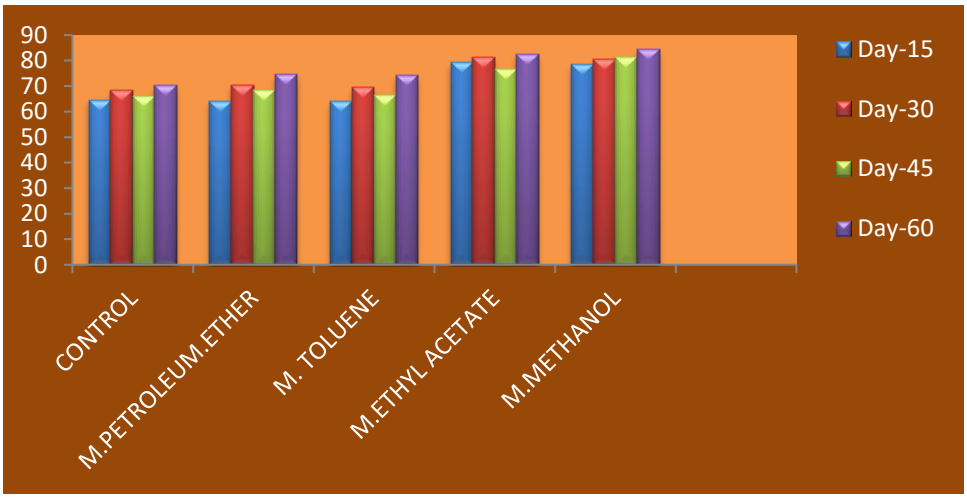


FIGURE.10. TRIGLYCERIDES (MG / DL).

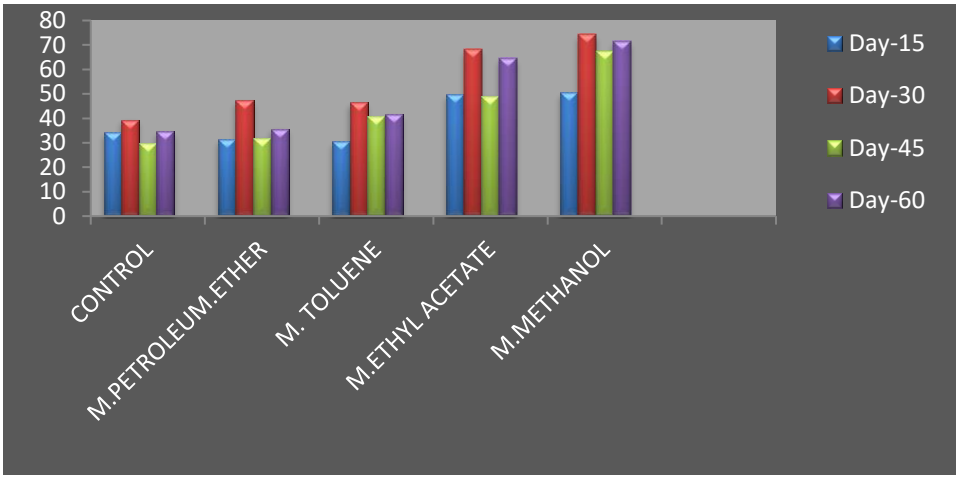


FIGURE.11. WEIGHT GAIN (%)

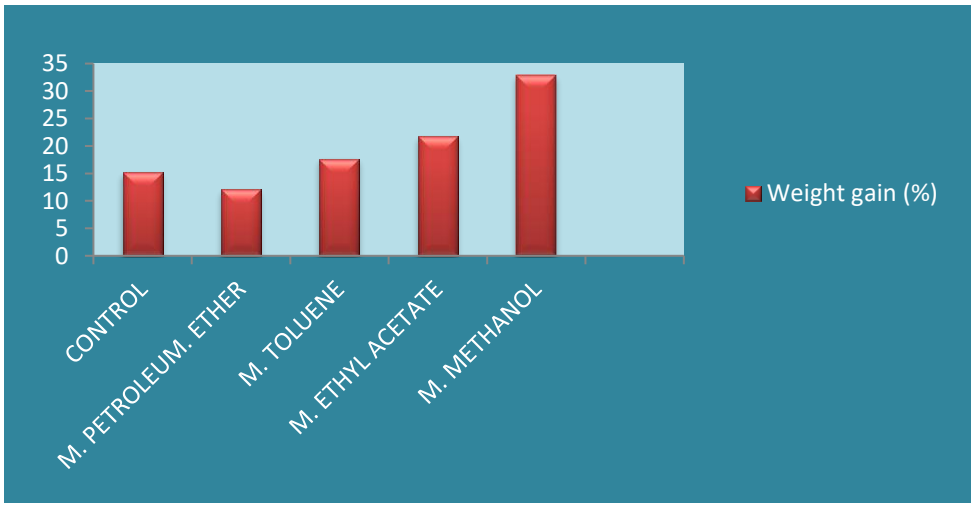


FIGURE.12. SPECIFIC GROWTH RATE (%)

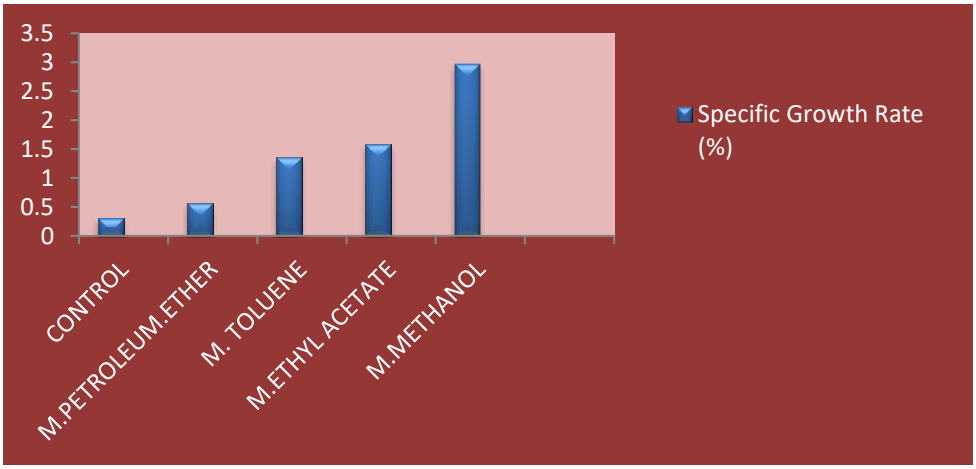


FIGURE.13. FEED CONVERSION RATIO (%)

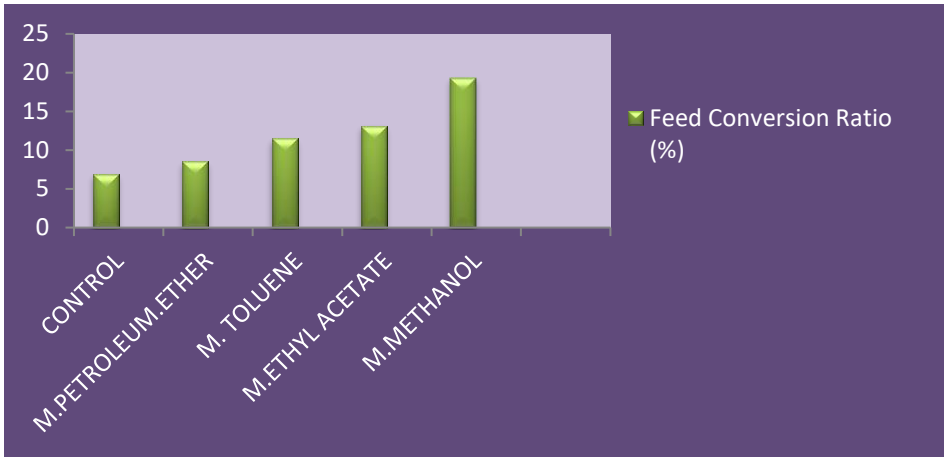


FIGURE. 14. CULTURE OF *PSEUDOMONAS FLUORESENCENS*.

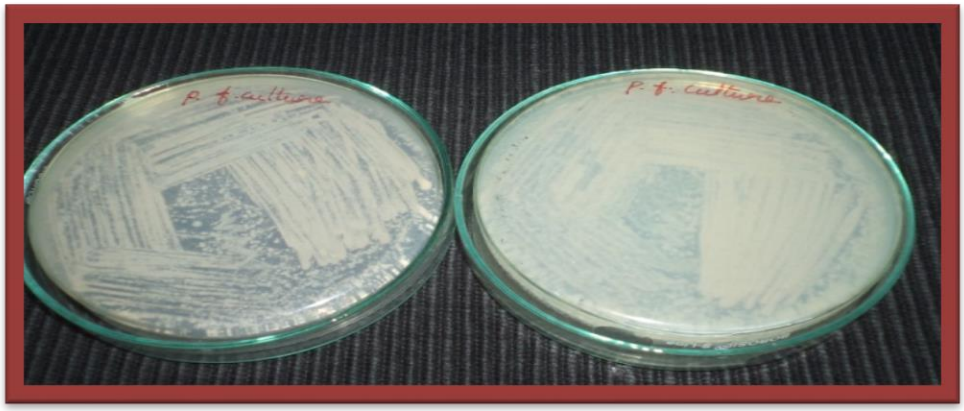


FIGURE.15. MICROSCOPIC VIEW OF *PSEUDOMONAS FLUORESENCENS* (100X).

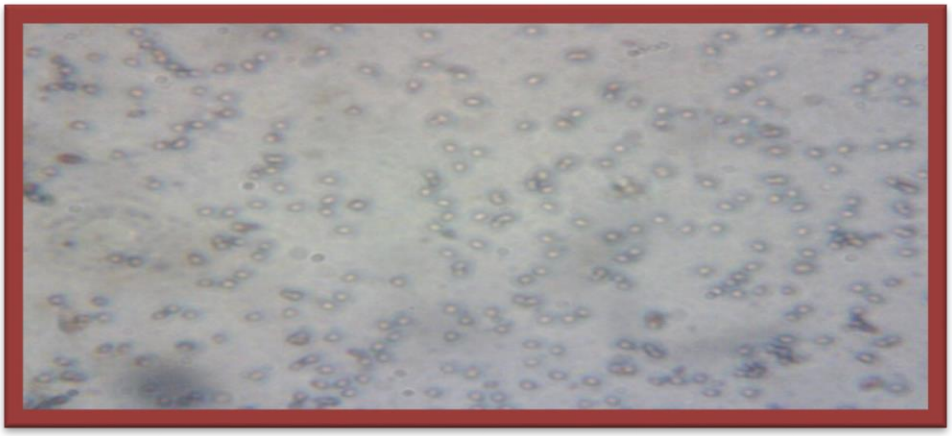
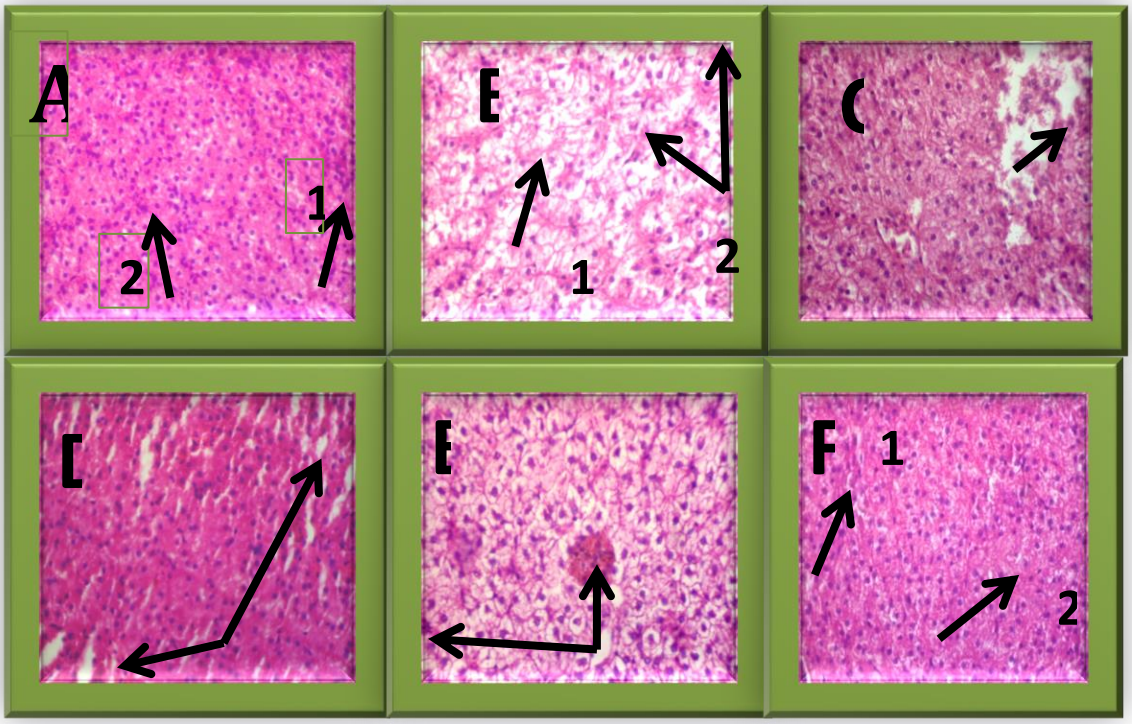


FIGURE.16. FISH AFFECTED BY *PSEUDOMONAS FLUORESENCENS.*

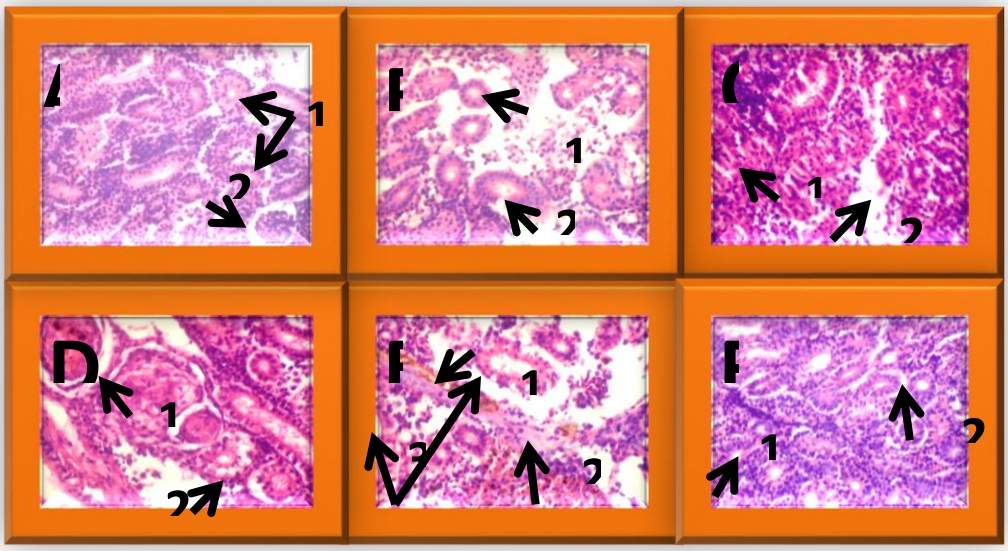
HISTOPATHOLOGY

FIGURE-17. HISTOPATHOLOGY OF LIVER OF *CIRRHINUS MRIGALA* FINGERLINGS.



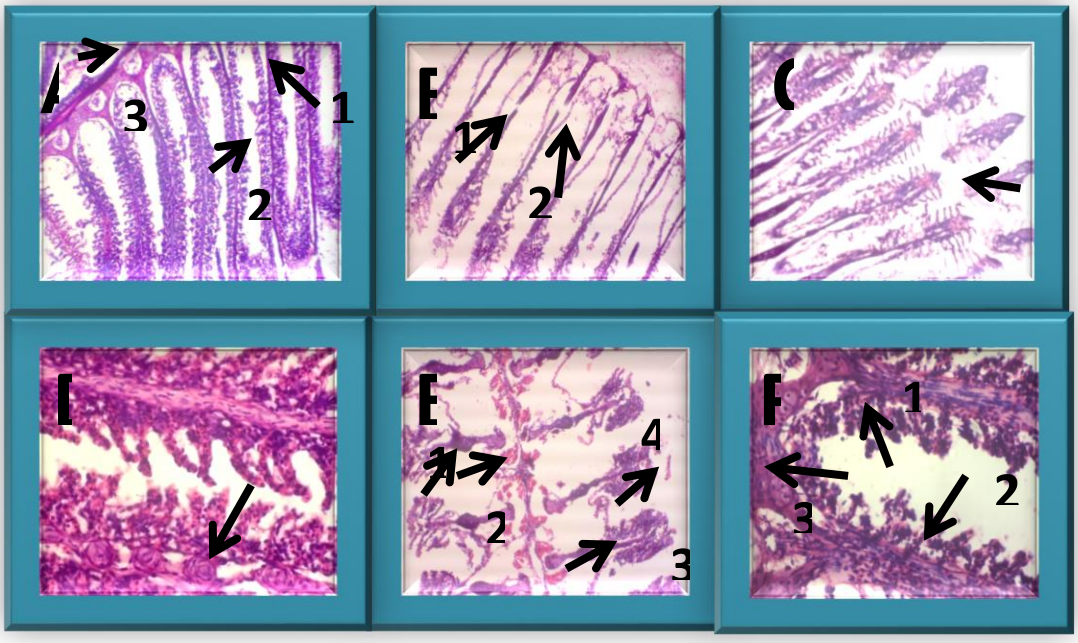
A] Normal liver- Section shows maintained liver architecture with 1-central vein, portal triad, kupffer cell activity, and normal sinusoids, 2- Normal hepatocytes -(40X). B] Control group – Section shows 1-empty space around the nuclei of hepatocytes, 2- abnormal sinusoids in cytoplasm -(40X). C] *G. Mangostana* fruit pericarp petroleum ether extract treated group-Section shows Hepatocytes damage and degeneration-(40X). D] *G. Mangostana* fruit pericarp toluene extract treated group- Section shows Separation of Hepatocytes-(40X). E] *G. Mangostana* fruit pericarp ethyl acetate extract treated group –Area shows Congestion of blood vessel-(40X). F] *G. Mangostana* fruit pericarp methanol extract treated group- Section shows 1-Vacuolization in normal sinusoids, 2-Normal hepatocytes -(40X).

FIGURE- 18. HISTOPATHOLOGY OF KIDNEY OF *CIRRHINUS MRIGALA* FINGERLINGS.



A] Normal Kidney- Section shows kidney tissue with congested glomeruli, 1- Normal proximal convoluted tubules and 2-Distal convolutes tubules - (40X). B] Control group- Section shows 1-Denature of renal tubules architecture, 2-Damaged glomerulous- (40X). C] *G. Mangostana* fruit pericarp petroleum ether extract treated group- Section shows 1- Cracked glomerulus as well as cytoplasm, 2- Vacuolated cytoplasm - (40X). D] *G. Mangostana* fruit pericarp toluene extract treated group- Section shows 1- Affected melano macrophagus aggregation close to a vessel, 2- Vacuolated lumen tubule - (40X). E] *G. Mangostana* fruit pericarp ethyl acetate extract treated group – Section shows 1- Affected cytoplasm, 2-Affected glomerulus, 3- Enlarged size of renal tubules - (40X). F] *G. Mangostana* fruit pericarp methanol extract treated group- Section shows 1- Convoluted tubules are normal and 2- Distal convolutes tubules are also normal structure - (40X).

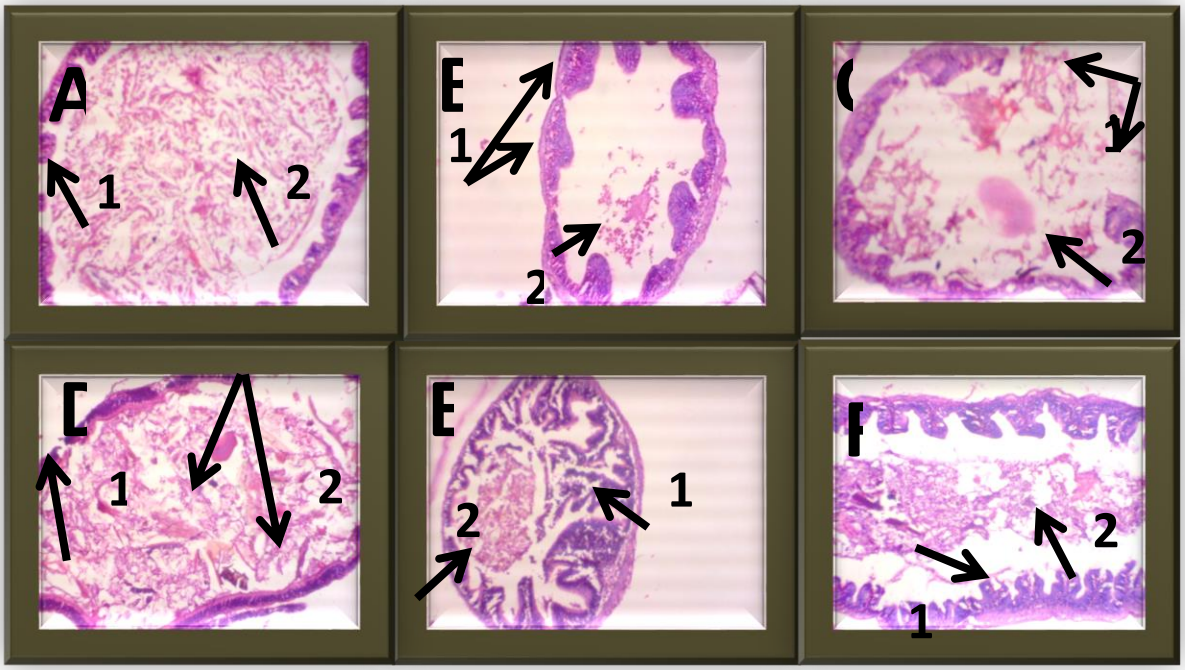
FIGURE- 19. HISTOPATHOLOGY OF GILLS OF *CIRRHINUS MRIGALA* FINGERLINGS.



A] Normal Gills- Section shows Gill tissue with 1-Prominent primary lamellae and 2-Secondary lamellae, 3-Gill arch-(10X). B] Control group-Section shows1-Loss of Structural integrity of lamellae, 2-Separation and breakdown of primary gill lamellae-(10X). C] *G. Mangostana* fruit pericarp petroleum ether extract treated group- Section shows Breakdown of Secondary gill lamellae-(10X). D] *G. Mangostana* fruit pericarp toluene extract treated group- Section shows Ball like appearance of inter

lamellar cells-(40X). E] *G. Mangostana* fruit pericarp ethyl acetate extract treated group – Section shows 1- Bulging of primary gill lamellae, 2- Haemorrhage in the central gill arch, 3-Breakdown of primary gill filament, 4-Desquamation of epithelial cells and pillar cells of secondary gill lamellae -(10X). F] *G. Mangostana* fruit pericarp methanol extract treated group- Section shows 1- Fusion in normal prominent primary lamellae , 2- Fusion in normal secondary lamellae and 3-Gill arch - (40X).

FIGURE- 20. HISTOPATHOLOGY OF INTESTINE OF *CIRRHINUS MRIGALA* FINGERLINGS.



A] Normal Intestine- Section shows cut section of intestine lined by tall columnar cells arranged in 1-Short villi, 2-Lumen contains undigested matters -(10X). B] Control group- Section shows 1-Vcuolization of epithelial cells inside the villi, 2-Lumen content separated and moved into the corner -(10X). C] *G. Mangostana* fruit pericarp petroleum ether extract treated group- Section shows 1-Serosa, longitudinal and circular muscle layer broken and inner lumen content released outside, 2-Denature of lumen content and accumulation of mucus -(10X). D] *G. Mangostana* fruit pericarp toluene extract treated group- Section shows 1- Broken serosa and epithelium, 2-Dissolved and denatured lumen content -(10X). E] *G. Mangostana* fruit pericarp ethyl acetate extract treated group – Section shows 1- Cracked clay appearance of epithelial cells of villi, 2-Cornerd inner lumen content -(10X). F] *G. Mangostana* fruit pericarp methanol extract treated group- Section shows 1- Tip damaged villi, 2-Sepperated lumen content -(10X).

Application of immunostimulators, especially herbal immunostimulants in the aquaculture industry, can be considered a notable advantage because of their safety and the fact that they are treated environmentally friendly (Dugenci *et al.,* 2003; Jian and Wu, 2004). Yoshikawa *et al.,* 1994 found that the methanolic extracts of *G. Mangostana* hulls showed DPPH radical scavenging activity. α and γ mangostins showed antioxidant activity using the ferric thiocyanate method. In the present study, food additive with *G. mangostana (Garcinia mangostana Linn.)* fruit pericarp of methanol extract treated group exhibit significantly highest level on the 45th day. The present findings are in according to the findings of Chomnawang *et al.,* 2007.

Lysozyme activity was increased significantly in the *G. Mangostana*. Methanol extract treated group. When compared with the control group. Similar study where conducted by Swain *et al.,* 2006. Furthermore, this lysozyme is known to generate an opsonin of the complement system and phagocyte cells (Magnadottir, 2006). Bactericidal activity was significantly increased in *G. Mangostana* methanol extract group on the 45th day of the experiment. When compared with the other group, similar studies were executed by Divyagnaneswari *et al.,* 2007.

Blood is a good indicator in deciding the wealth of an organism (Joshi *et al.,* 2002). Certain herbal immunostimulants have been reported to increase total protein as well as total globulin in fish (Vasudeva *et al.,*

2004). In this study, Biochemical parameters such as Blood glucose, Total protein, Albumin, Globulin, AST **(**aspartate transaminase) Similar studies were recorded by (Devi Sampath and Vijayaraghavan, 2007), Cholesterol and Triglycerides were also significantly increased in *G. Mangostana* methanol extract treated group when compared with the other group and other treatment groups.

In the present study, the growth parameters such as weight gain percentage, specific growth rate and feed conversion ratio were the highest range in *G. Mangostan* methanol extract treated group when compared with the other group. The present observation agrees with the report of (Choudhury *et al.* 2005). Therefore, the above results demonstrated that 0.10% of (*Garcinia mangostana Linn.)* fruit pericarp extracts of different solvents as a feed supplement on immunological and biochemical parameters of *Cirrhinus mrigala Ham.* Fingerlings against harmful bacteria.

Histopathology of kidney appeared a normal structure in the fingerlings fed with enrich foods. Whereas, control affected fingerlings appeared dark granule aggregation in tubular cells, vacuole formation in kidney tubules and lethalness. Water contamination first affects the kidney of the fish. (Thophon *et al.,* 2003). Majority of the ordinary modifications present in the kidney of fishes opened to water pollution are degeneration of tubule (droplets of hyaline and swelling of cloudiness) and corpuscle structure changes, such as capillaries dilation of glomerulus and Bowman´s space reduction (Takashima and Hibiya, 1995; John devadoss and Ravichandran 2014). Similar conclusions were recorded by Anitha Kumari and Ram Kumar 1997a; Prashanth and David 2011. In *Channa Striatus* and Heteropneustes skeleton is exhibited to contaminated water of Hussainsagar lake. Liver fibrosis is not frequently, but it is usual to see a cirrhotic reflection caused by toxic agents or inflammation (Wolf and Wolfe 2005). Gill histology may be symbolic of normal stress from exposure to different xenobiotics, organic pollutants, metals, suspended solids and toxic algae (Rendon von Osten and Uso de., 2005; Ruiz-Picos and Lopez-Lopez, 2012).

Herbal based immune system stimulants are biodegradable, biocompatible, and safe for the human health and environment. Hence, this study studied the response of various plant parts of *G. mangostana* extract as an immune development additive in fingerlings of African catfish. Certain plants and general components were proved for their growth improving activities in animals of aquatic ecosystem (Citarasu *et al.,* 2002; Sivaram *et al.,* 2004; Soosean *et al.,* 2010). The latest results were in verification with a few statements in which the Garcinia species contain generally appearing phytochemical compounds which have a very powerful antimicrobial ability against *Staphylococcus aureus* (Sundaram *et al.,* 1983). Resently, number of researches declared that the *G. mangostana* pericarp is the major source of phytonutrients, such as xanthones oligometric proanthocyanins and anthocyanins (Kondo *et al.,* 2009; Zhou *et al.,* 2011) and properties of antimicrobial (Lacombe *et al.,* 2010).

With hints to different diagnosis that advantage to the description of medicinal properties of *G. mangostana,* number of studies are being achieved to identify the probable benefit of this compound. These results have been achieved using synthetic derivatives as well as natural extracts. They have demonstrated to show steady pharmacological and antimicrobial activities. (Valdir *et al.,* 2000; Saraswathi *et al.,* 2010).

The freeze- dried pericarp ethyl acetate extract of *G. mangostana* fruit sustained three types of xanthones by silica gel chromatography (Karla Divina *et al.,* 2010). The effective phyto chemical compounds that are found in medicinal herbs like *G. mangostana* were liable for its anti-microbial ability (Priscila Ikeda *et al.,* 2007). Among xanthone by-products from extract of *G. mangostana*, α- mangostin has been known to use the most powerful antimicrobial ability (Suksamrarn *et al.,* 2003; Sakagami *et al.,* 2005; Chomnawang *et al.,* 2005). Kitti Torrungruang (2007) exposed the antibacterial ability of *G. mangostana* pericarp extract against cariogenic chiefly *Streptococcus mutans* (Kitti Torrungruang *et al.,* 2007; Vishnu priya *et al.,* 2010).

Statistical Analysis

Values were presented as (n = 3) arithmetic mean ± Standard Error (SE). The data were statistically evaluated by One-Way Analysis of variance (ANOVA) followed by Post Hoc multiple comparison tests using SPSS software (version-16). The levels of significance P < 0.05 was considered as statistically significant and P < 0.01as highly significant.

CONCLUSION

In the present study food supplement of *Garcinia mangostana Linn.* fruit pericarp extract holds significant

antibacterial activity against pathogenic bacteria *Pseudomonas fluorescens.* This appears to be achieved by improvement of good immunological, biochemical and growth parameters. Therefore, the data reported in this study showed that 0.10% of *G. mangostana* fruit pericarp extract supplementation with a feed could increase the resistance and also improve the survival rate. Further analysis is needed for the isolation and identification of active principles present in the extracts which could be exploited for fish feed formulation use and also the infection prevention method through feed in the fresh water aquaculture ecosystem.

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REFERENCES

Abutbul, S, Golan- Goldhirsh A, Barazani O, Ofir R, Zilberg D. (2005). Screening of desert plants for use against bacterial pathogens in fish. Isr J Aquacult-Bamid; 57 (2): 71-80.

Allen, D, Austin, B, Collen, R. R. (1993). Numerical taxonomy of bacterial isolate associated with a fresh water fishery. J. General Microbial., 129, 2043-2062.

Anitha Kumari S and Sree Ram Kumar N. (1997a). Effect of water pollution on histology of intestine of two freshwater from Hussainsagar Lake (A.P.). Indian J. Toxicol. 7 (2): 68-70.

Barham D, Trinder P. (1972). An improved color reagent for the determination of blood glucose by the oxidase system. Analyst. 97:142-5.

Castro SBR, Leal CAG, Freire, FR, Carvalho DA, Oliveira DF, Figueiredo HCP. (2008). Antibacterial activity of plant extracts from Brazil against fish pathogenic bacteria. Braz J Microbiol; 39 (4): 756-760.

Chomnawang MT, Surassmo S, Nukoolkarn VS, Gritsanapan W. (2005). Antimicrobial effects of Thai medicinal plants against acne-inducing bacteria. J. Ethnopharmacol. 101: 330-3.

Chomnawang, M.T., Surassmo, S., Nukoolkarn, V.S., Gritsanapan, W. (2007). Effect of Garcinia mangostana on inflammation caused by Propionibacterium acnes. Fitoterapia 78, 401-408.

Chung, R.S. and Secombes, R.R. (1988). Determination of immunological analysis of Superoxide anion production of blood. Clini. Immun., 6: 89-94.

Chyau, C.-C., Tsai, S. Y., Ko, P. T., & Mau, J.L. (2002). Antioxidant properties of solvent extracts from Terminalia catappa leaves. Food Chemistry, 78, 483-488.

Citarasu T, Babu MM, Raja jeya sekar R, Marian MP. (2002). Developing Artemia enriched herbal diet for producing quality larvae in *Penaeus mondon Fabricius*. Asian Fish Sci. 15: 21-32.

Consolacion, Y. Ragasa, Camille Joyce, J. Crisostomo, Karla Divina C. Garcia, Chien-Chang Shen. (2010). Antimicrobial xanthones from *Garcinia mangostana L*. philipp Scient. 47: 63-75.

Devi Sampath, P., Vijayaraghavan, K. (2007). Cardioprotective effect of alphamangostin, a xanthone derivative from mangosteen on tissue defense system against isoproterenol-induced myocardial infarction in rats. J. Biochem. Mol. Toxicol. 21, 336-339.

Dharitri Choudhury, Pal, A. K., Sahu, N. P., Shivendra Kumar, Das, S. S., Mukherjee, S. C. (2005). Dietary yeast RNA supplementation reduces mortality by *Aeromonas hydrophila* in rohu (*Labeo rohita L.*) juveniles Fish & Shellfish Immunology 19; 281- 291.

Dharmaraj Ramesh., Annadurai Vinothkanna., Amit Kumar Rai., Venkada Subramanian Vignesh. (2015). Isolation of potential probiotic Bacillus spp. and assessment of their subcellular components to induce immune responses in Labeo rohita against *Aeromonas hydrophila.* Fish and Shellfish immunology., 45: 268-276.

Divyagnaneswari, M. Christybapita, D. and Michael, R. D. (2007). Oral administration of Eclipta alba leaf aqueous extract enhances the nonspecific immune responses and disease resistance of Oreochromis mossambicus, Fish and Shellfish Immunol. 23, p. 840-852.

Dmitriy Obolskiy, Ivo Pischel, Nisarat Siriwatanametanon, Michael Heinrich. (2009). Garcinia mangostana Linn. A Phytochemical and Pharmacological Review Phytother. Res. 23, 1047-1065.

Doumas, B.T., Watson, W., Biggs, H.G. (1971). Albumin standards and measurement of serum albumin with bromocresol green. Clin. Chim. Acta 31, 87-96.

Dugenci, S. K., Arda, N. and Candan, A., (2003). Some medicinal plants as immunostimulants for fish. Journal of Ethnopharmacology. 88: 99-106.

Ellnain-Wojtaszek, M., Kruczynski, Z., & Kasprzak, J. (2002). Variations in the free radical scavenging activity of Gingko biloba L. Leaves. Food Chemistry, 79, 79-84.

Farnsworth RN, Bunyapraphatsara N. (1992). Garcinia mangostana Linn. In Thai Medicinal Plants. Prachachon Co., Ltd.: Bangkok, 160-162.

Iinuma, M. Tosa, H. Tanaka, T. Asai, F. Kobayashi, Y. Shimano, R.. Miyauchi, K. (1996). Antibacterial activity of xanthones from Guttiferaeous plants against methicillinresistant Staphylococcus aureus. J. Pharm. Pharmacol. 48; 861-865.

Ji X, Avula B, Khan IA. (2007). Quantitative and qualitative determination of six xanthones in Garcinia mangostana L. by LC-PDA and LC-ESI-MS. J Pharm Biomed Anal 43: 1270-1276.

Jian, J. and Wu, Z. ((2004). Influence of traditional Chinese medicine on nonspecific immunity of Jian carp. (Cyprinus carpio var. Jian). Fish and Shellfish Immunology. 16: 185-191.

John devadoss Gobinath and Ravichandran Ramanibai. (2014). Histopathological studies in the gill, liver and kidney of the freshwater fish *Labeo rohita* fingerlings. International Journal of Innovative Research in Science, Engineering and Technology. 3: 3.

John Wesly Kirubakaran C., Catherine P., Alexander., Dinakaran Micael R. (2010). Enhancement of non-specific immune responses and disease resistance on oral administration of Nyctanthes arbortristis seed extract in Oreochromis mossambicus (Peters) Aquaculture Research. 41: 1630-1639.

Jordi Folch, Lees, M. and Sloane Stanley, G. H. (1957). Total lipides from animal isolation and purification of a simple method for the tissuesJ. Biol. Chem. 226:497-509.

Joshi, P. K., Bose, M. and Harish, D. (2002). Hematological changes in the blood of clariasbatrachus exposed to mercuric chloride, Ecotoxicalogical Environment Monitoring, 12 (2): 119-122).

Jung HA, Su BN, Keller WJ, Mehta RG, Kinghorn AD. (2006). Antioxidant xanthones from the pericarp of Garcinia mangostana (Mangosteen). J Agric Food Chem 54: 2077– 2082.

Jung, H.-A., Su, B.-N., Keller, W. J., Mehta, R. G., and Kinghorn, D. (2006). Antioxidant xanthones from the pericarp of Garcinia mangostana (mangosteen). Journal of Agricultural and Food Chemistry, 54, 2077–2082.

Kajita, Y., Sakai, M., Atsuta, S. and Kobayash, M. (1990). The immunostimulatory effects of levamisole on rainbow trout, Oncorhnchus mykiss. Fish Pathol., 25: 93-98.

Kitti Torrungruang, Piraporn Vichienroj, Suchada Chutimaworapan. (2007). Antibacterial activity of Mangosteen pericarp extract against cariogenic *Streptococcus mutans*. CU Dent J. 30: 1-10.

Kondo M., Zhang L., Ji H., Kou Y., Ou B. (2009). Bioavailability and antioxidant effects of a xanthone-rich mangosteen (*Garcinia mangostana*) product in humans, J. Agric. Food Chem. 57: 8788-8792.

Lacombe A., Wu V.C.H., Tyler S., Edwards K. (2010). Antimicrobial action of the American cranberry constituents; phenolics, anthocyanins, and organic acids, against Escherichia coli 0157: H7, Int. J. Food Microbiol. 139: 102-107.

Logambal S M., Venkatalakshmi S, Michael R D. (2000). Immunostimulatory effect of leaf extract of *Ocimum sanctum* Linn. In *Oreochromis mossambicus* (Peters). Hydrobiologia, 430: 113-120.

Lopez N, Cuzon G, Gaxiola G, Taboada G, Valenzuela M, and Pascual C. (2003). Physiological, nutritional and immunological role of dietary β 1-3 glucan and ascorbic acid 2-monophosphate in *Litopenaeus vannamei* juveniles. Aquaculture, 224: 223-243.

Lowry, O.H., Rosebrough, N.J., Farr, A.L., Randall, R.J. (1951) J.Biol.Chem 193: 265 (The original method).

Magnadottir, B. (2006). Innate immunity of fish (over-view). Fish and Shellfish Immunology 20, 137-151.

Moongkarndi P, Kosem N, Kaslungka S, Luanratana O, Pongpan N, Neungton N. (2004a). Antiproliferation, antioxidation and induction of apoptosis by Garcinia mangostana (mangosteen) on SKBR3 human breast cancer cell line. J Ethnopharmacol 90: 161-166.

Moongkarndi P, Kosem N, Luanratana O, Jongsomboonkusol S, Pongpan N. (2004b). Antiproliferative activity of Thai medicinal plant extracts on human breast adenocarcinoma cell line. Fitoterapia 75: 375–377.

Naczk M. Towsend M. Zadernowski R. Shahidi F. (2011). Protein-binding and antioxidant potential of phenolics of mangosteen fruit (Garcinia mangostana) Food Chemistry 128; 292–298.

Naczk, M., Amarowicz, R., Zadernowski, R., Pegg, R., Shahidi, F. (2003). Antioxidant activity of crude phenolic extracts from wild blueberry leaves. Polish Journal of Food and Nutrition, 53, 170S–173S.

Nakatani K, Nakahata N, Arakawa T, Yasuda H, Ohizumi Y. (2002b). Inhibition of cyclooxygenase and prostaglandin E2 synthesis by gamma-mangostin, a xanthone derivative in mangosteen, in C6 rat glioma cells. Biochem Pharmacol 63: 73–79.

Omprakash Darak and Ravi Dhondiraj Barde. (2015). *Pseudomonas fluorescens* associated with Bacterial Disease in Catla catla in Marathwada Regian of Maharastra. International journal of Advanced Biotechnology and Research, 6; 2; 189-195.

Parry, R.M., Chandan, R.C., Shahani, K.M. (1965). A rapid and sensitive assay of muramidase. Proc. Soc. Exp. Biol., (N.Y.) 119: 384-386.

Pedraza-Chaverri, J., Cárdenas-Rodríguez, N., Orozco-Ibarra, M., and Pérez-Rojas, J. M. (2008). Medicinal properties of mangosteen (Garcinia mangostana). Food and Chemical Toxicology, 46, 3227–3230.

Picerno, P., Mencherini, T., Lauro, M. R., Barbato, F., and Aquino, R. (2003). Phenolic constituents and antioxidant properties of Xanthosoma violaceum leaves. Journal of Agricultural and Food Chemistry, 51, 6423–6428.

Prashanth M.S and David M. (2011). Histopathological changes in the intestine of freshwater fish, *Cirrhinus mrigala* exposed to cypermethrin. International Journal of Recent Scientific Research. 2, 2: 67-73.

Praveen, M., Khan, N.U., Achari, B., Dutta, P.K. (1991). A triterpene from Garcinia mangostana. Phytochemistry 30; 361–362.

Priscila Ikeda Ushimarul, Mariama Tomaz Nogueira da Silva, Luiz Claudio Di Stasi, Luciano Barbosa, Ary Fernandes Junior. (2007). Antibacterial activity of medicinal plant extracts Brazilian Journal of Microbiology. 38: 717-719.

Rassameemasmaung, S., Sirikulsathean, A., Amornchat, C., Hirunrat, K., Rojanapanthu, P., Gritsanapan, W. (2007). Effects of herbal mouthwash containing the pericarp extract of Garcinia mangostana L. on halitosis, plauque and papillary bleeding index. J. Int. Acad. Periodontol. 9, 19–25.

Reitman, S. and Frankel, F. - Am. J. Clin. Path. 28: 56 (1957).

Rendon von Osten, J., and Uso de. (2005). Biomarcadores ecosistemas acuáticos. En: Golfo de México, Contaminacion Impact ambiental Diagnostic Tendencias. 2ª ed. Univ. Auton. De Campeche Univ. Nal. Auton. México Instituto Nacional Ecología. pp. 121-40.

Ruiz- Picos, R. and Lopez- Lopez, E. (2012). Gill and Liver Histopathology in Goodea atripinnis Jordan, Related to Oxidative Stress in Yuriria Lake, Mexico. Int. J. Morphol., 30 (3): 1139-1149.

Sakagami Y, Iinuma M, Piyasena KG, Dharmaratne HR. (2005). Antibacterial activity of alpha-mangostin against vancomycin resistant Enterococci (VRE) and synergism with antibiotics. Phytomedicine. 12: 203-8.

Saralamp P, Temsiririrkkul R, Clayton T. (1996). Medical Plants in Thailand: Amarin Printing and Publishing Public Co., Ltd.: Bangkok, Thailand.

Sivaram V, Babu MM, Immanuel G, Murugadass S, Citarasu T, Marian MP. (2004). Growth and immune response of juvenile greasy groupers (*Ephinephelus tauvina*) fed with herbal antibacterial active principle supplemented diets against *Vibrio harveyi* infections. Aquaculture. 237: 9-20.

Soosean, C. Marimuthu, K. Sudhakaran, S. Xavier, R. (2010). Effect of mangosteen (*Garcinia mangostana L.*) extracts as a feed additive on growth and hematological parameters of African catfish (*Clarias gariepinus*) fingerlings. European Review for Medical and Pharmacological Sciences. 14: 605-6011.

Stoskopf, K.M. (1999). Fish Medicine, W.B. Saunders Company, Harcourt Brace, Jovanovich, Inc.

Suksamrarn S, Suwannapoch N, Phakhodee W,Thanuhiranlert J, Ratananukul P, Chimnoi N. (2003). Antimycobacterial activity of prenylated xanthones from the fruits of *Garcinia mangostana.* Chem Pharm Bull. (Tokyo). 51: 857-859.

Suksamrarn S, Suwannapoch N, Ratananukul P, Aroonlerk N, Suksamrarn A. (2002). Xanthones from the green fruit hulls of Garcinia mangostana. J Nat Prod 65: 761-763.

Sundaram B.M., Gopalakrishnan C., Subramanian S., Shankaranarayanan D., Kameswaran L. (1983). Antimicrobial activities of *Garcinia mangostana*, Planta Med. 48: 59-60.

Swain, P. S., Dash, P. K., Sahoo, P., Routray, S. K., Sahoo, S.D., Gupta, P. K., Meher, N., Sanrangi, A. (2006). Non-specific immune parameters of brood Indian major carp Labeo rohita and their seasonal variations. Fish and Shellfish Immunology. 22: 38-43.

Swapna, H.C. Amit, K.R. Bhaskar, N. Sachindra, N.M. (2010). Lipid classes and fatty acid profile of selected Indian fresh water fishes, J. Food sci. Technol. 47, 394-400.

Takashima, F. and, Hibiya, T. (1995). An atlas of fish histology normal and pathological Features, 2nd Edition. Kodansha Ltd., Tokyo. Fischer Verlag, Stuttgart. New York.

Thophon, S., Kruatrachue, M., Upatham, E.S., Pokethitiyook, P., Sahaphong, S., Jaritkhuan, S. (2003). Histopathological alterations of white seabass, Lates calcalifer, in acute and subchronic cadmium exposure. Environmental Pollution, 121: 307-320.

Valdir P, Nagem TJ and Oliveira FFD (2000). Tetra oxygenated naturally occurring xanthones. Phytochemistry, 55: 683-710.

Vasudeva, Y.R., Romesh, M., Singh, A. and Chakrabarti, R. (2004). Potentiation of antibody production in Indian major carp Labeo rohita, rohu, by Achyranthes aspera as a herbal feed ingredient. Aquaculture. 238: 67-73.

Vijayakumari pratheepa and Natarajapillai Sukumaran. (2014). Effect of *Euphorbia hirta* plant leaf extract on immunostimulant response of *Aeromonas hydrophila* infected *Cyprinus carpio.* Peer J, 2: e671: 1-17.

Vishnu Priya V, Mallika Jainu, Surapaneni Krishna Mohan, Karthik B, Saraswathi P, Chandra Sada Gopan V. S. (2010). Toxicity Study of Garcinia Mangostana Linn. Pericarp Extract in Rats. Asian j. Exp. Biol. 1 (3): 633-637.

Vishnu priya, V., Mallika jainu, Surapaneni krishna mohan, Saraswathi P, Chandra sada gopan, V S. (2010). Antimicrobial activity of pericarp extract of *Garcinia mangostana linn*. International Journal of Pharma Sciences and Research. Vol. 1 (8); 278-281.

Voravuthikunchai, S.P., Kitpipit, L. (2005). Activity of medicinal plant extracts against hospital isolates of methicillin-resistant Staphylococcus aureus. Clin. Microbiol. Infect. 11, 510-512.

Wolf, J. C and Wolfe, M. J. (2005). A brief overwiew of nonneoplastic hepatic toxicity in fish. Toxicol. Pathol., 33 (1): 75-85.

Yoshikawa, M., Harada, E., Miki, A., Tsukamoto, K., Si Qian, L., Yamahara, J., Murakami, N. (1994). Antioxidant constituents from the fruit hulls of mangosteen (Garcinia mangostana L.) originating in Vietnam. Yakugaku Zasshi 114, 129-133.

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Yu L, Zhao M, Yang B, Zhao Q, Jiang Y. (2007). Phenolics from hull of Garcinia mangostana fruit and their antioxidant activities. Food Chem 104: 176-181.

Zadernowski, R., Czaplicki, S., Naczk, M. (2009). Phenolic acid profiles in mangosteen fruits (Garcinia mangostana). Food Chemistry, 112, 685-689.

Zhou H. C., Lin Y. M., Wei S. D., Tam N. F. Y. (2011). Structural diversity and antioxidant activity of condensed tannins fractionated from Mangosteen pericarp, Food Chem. 129 (4): 1710-1720.

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