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Background colour induced modification in general body coloration of freshwater prawn *Macrobrachium lamarrei* (Crustacea-Decapoda)

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Abstract
Colour changing in animals of different texa is a vital phenomenon, which can also be exploited in term of increasing demand of market therefore can prove economical. Freshwater prawn, *Macrobachium lamarrei* (Crustacea-Decapoda) was exposed to five different background colours *viz.* white, red, green, blue and black along with one control i.e. translucent. Chromatophore density and type was found variable in different background colours accordingly. The number of chromatophores was found significantly increased in darker backgrounds in comparison to control and maximum number was recorded in black background. The order of darkness of prawns was observed as white<red<green<blue<black. Underlying mechanism of colour change and market economy perspective of darker prawns have been discussed.

Keywords: Pangasius, hybrid, digestive system, histology

1. Introduction
To cope with increasing demand of food for increasing human population, aquaculture is most promising and the major hope for future to provide better nutrition specially for developing countries like India. Among aquaculture products other than fishes, crustaceans, specially prawns are a future hope (Janaki Ram *et. al.*, 2003; Jayasankar 2018; FAO, 2019) [9, 10, 6].
Crustaceans includes crabs, lobster, prawns etc, which are relished worldwide. Freshwater prawn aquaculture is a recent one and is more beneficial than marine prawn aquaculture. Fresh water prawn *Macrobrachium lamarrei* (Crustacea-Decapoda) is a smaller prawn, locally available throughout the year, having complete development in freshwater and promising candidate for freshwater aquaculture (Shukla and Sharma, 2010; Shukla *et. al.*, 2017; Ahmad *et. al.*, 2021; Sharma *et. al.*, 2022) [26, 30, 1, 25]. This prawn species is also very important in terms of bio-indicator for environmental monitoring (Sharma and Shukla, 1990; Sharma and Shukla, 2006; Lodhi *et. al.*, 2006; Lodhi *et. al.*, 2004; Lodhi *et. al.*, 2008; Lodhi *et. al.*, 2009; Shukla and Sharma, 2010; Verma *et al*., 2010; Ahmed *et. al.*, 2021) [39, 23, 14, 15, 17, 16, 26, 35, 1]. Market value of prawns depends upon their colour because dark colour prawns are always preferred. By using suitable background colour the body colouration of cultured prawn can be managed and in this way market value can be enhanced (Parisenti *et al*., 2011; Latscha 1989; Tume *et. al.*, 2009; Shukla *et. al.*, 2017; Palomera *et. al.*, 2018) [20, 13, 34, 30, 19]. Considering the above facts present work is considered to observe the effect of background colouration on fresh water prawn, *Macrobrachium lamarrei* (Crustacea-Decapoda), a potential but "untapped" resource for fresh water aquaculture.

2. Material and Methods
Fresh water prawns, *Macrobrachium lamarrei* (Crustacea-Decapoda) (H. Milne Edwards) were collected from river Gomti, Lucknow (U. P.) – India, with the help of local fisherman and brought to the laboratory (N- 26° 49′ 5″ E- 80° 55′ 58″) in large plastic containers. Adult inter-moult staged *M. lamarrei* (Avg. length – 48.6±5.5 mm; weight – 1.107 ±0.26gm.) were

being utilized in experiments after 5-7 days acclimation to laboratory conditions. The animals were maintained in different background coloured containers (*viz*. White, blue, green, red and white) along with one control (translucent) were used to determine effect on coloration of prawn, containing dechlorinated water having physico-chemical characteristics as follows: - pH –7.66 ± 0.27, Temperature – 28±1^{0}C, D.O. – 6.6±0.74 mg/l, Total Hardness –268±2.67 mg/l, Alkalinity – 425±11.36 mg/l (Sharma & Shukla, 1990; APHA *et al.*, 1998) [26, 2]. For experiment 15 animals in each tank were kept under normal photoperiod and controlled laboratory conditions like continuous aeration and feeding on alternate days along with control.

After 30 days coloration of animals of each container were observed with naked eyes as well as with stereoscopic dissecting microscope and photographed. In present study no animal were sacrificed. All the observations were made on live animals. Experiment was replicated thrice.

4. Results and Discussion

Background colour of tank significantly affects prawn colouration. Density, type, distribution and structure of chromatophores vary according to the colour of background. It was observed that density of chromatophores increased in prawns of darker containers in comparison to lighter colour containers (Plate: 1-Fig. 1-12 & Plate: 2- Fig. 13-24).

The result shows that prawns are capable to modify their body colouration according to the background colour of experimental tanks. In red, green, blue and black colour backgrounds number of chromatophores are found to be increased while in white background number of chromatophores decreased than control (Plate:1-Fig. 1-12 & Plate:2-Fig. 13-24). Order of darkness in prawns according to background coloration is as follows: white<Red<Green<Blue<Black.

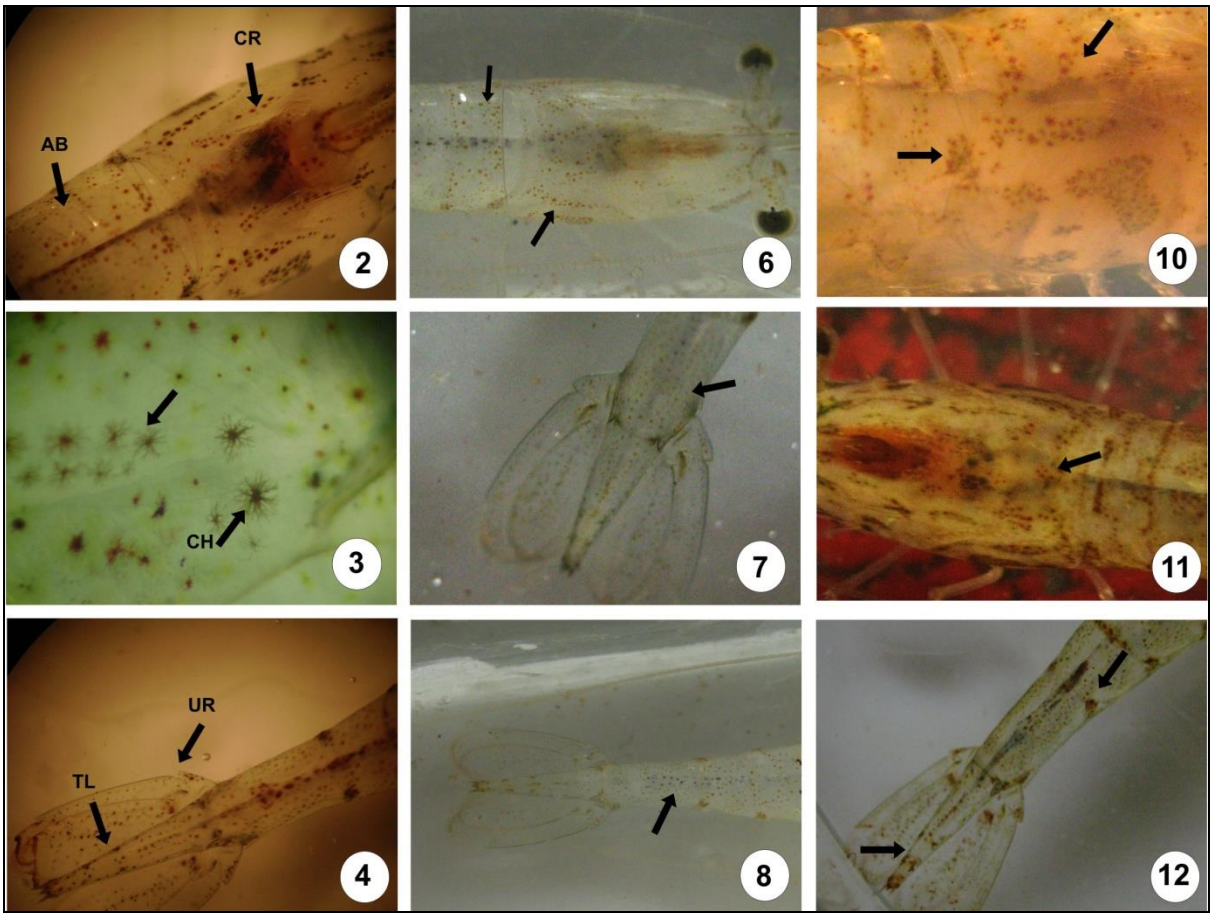
Colouration is a vital phenomenon of an organism as it plays crucial role in biology of organism. Change in pigmentation aid poikilotherms in visual communication, courtship, and survival. Chromatophores of crustacean have been assigned for various functions like photoprotection, cryptosis and/or thermoregulation (Fuhrman, 2011; Shukla *et. al.,* 2017) [8, 28]. The pigment can be either dispersed throughout the cell, which gives a dark appearance, or it can be aggregated around the nucleus, which gives a pale appearance. Background colouration also affects several vital activities of prawn including metamorphosis and survival. It was reported that darker background enhances survival of larvae of *M. resenbergii* (Sebastian and George, 1994; Yasharian *et al.* 2005; Shelke, 2010; Borisov *et al.*, 2022) [22, 36, 27, 5].

Chromatophores of prawns are present in hypodermal layer between the exoskeleton and abdominal muscle. Colour change in crustacean may be either due to physiological or due to morphological mechanisms or both. Physiological mechanisms that influence prawn colour include carotenoid availability in the diet, background substrate colour, photoperiod, light intensity and temperature. Light intensity affects neuro-endocrine system present in eye stalk which via various hormones affects number of various chromatophores and their distribution.

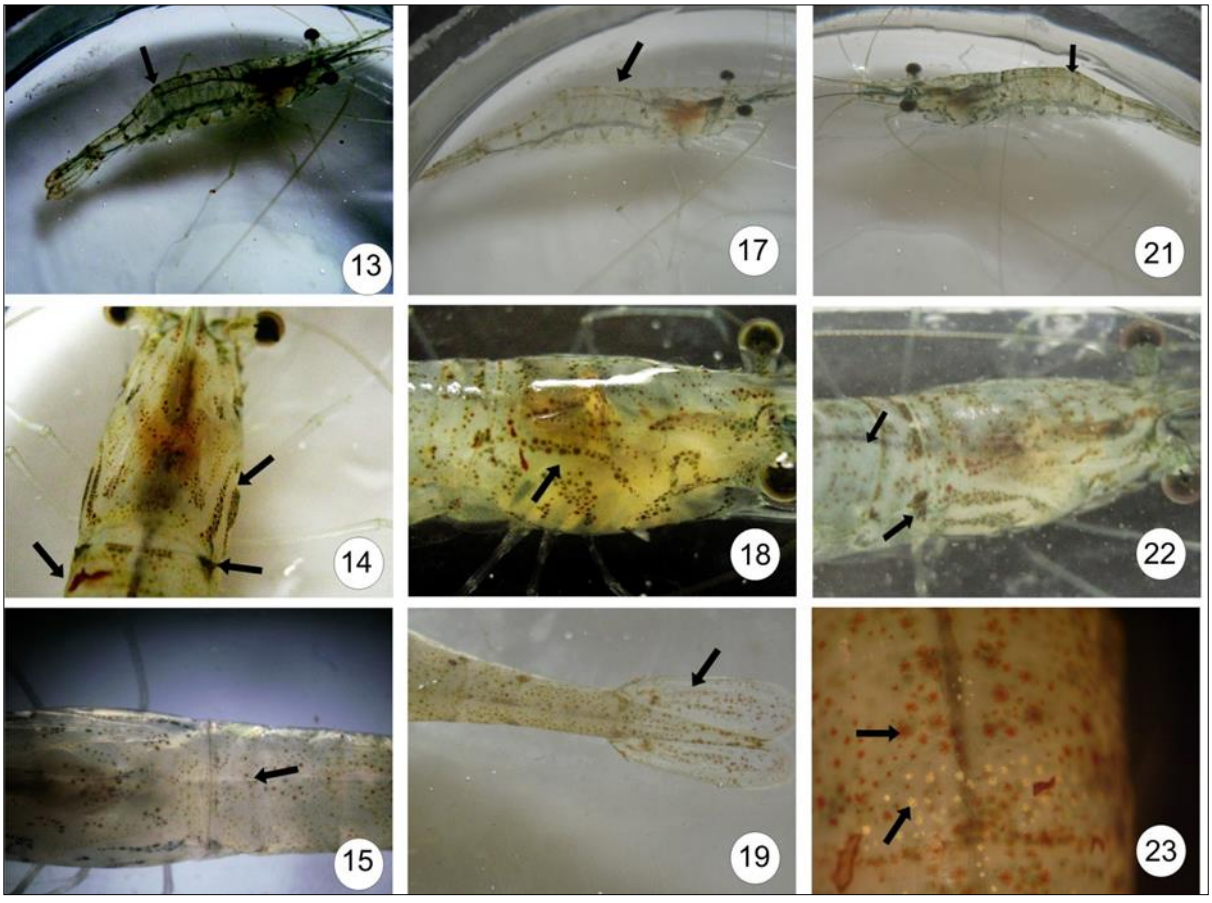
The green/gray colour observed in prawn is due to the accumulation of crustacyanin, a protein-astaxanthin complex that becomes orange with complex dissociation on cooking etc. Astaxanthine is a chemical which is responsible for the colouration in crustaceans (Boonyaratpalin *et. al.,* 2001; Menasveta *et. al.,* 2004; Laohavisuti and Ruangdej, 2014) [4, 18, 12]. It can be either synthesized or obtained from the diet. Manipulation of diet with astaxanthine compound also makes colour darker due to presence of high amount of astaxanthine (Yamada *et al.,* 1990; Boonyaratpalin *et. al.,* 2001; Arredondo Figueroa *et. al.,* 2003; Tume *et. al.,* 2009; Parisenti *et. al.,* 2011; Wade *et. al.,* 2012) [37, 4, 3, 34, 20, 36].

Colour pattern of prawn are also dependent on physico-chemical properties of water like pH, hardness, temperature etc. (Shukla *et. al.,* 2017) [30]. Central accumulation as well as spreading of pigment in chromatophores is also responsible for colour change under influence of various physico-chemical conditions involving Ca++ influx (Fingerman, 1965; Reibero & McNamara, 2006, Palomera *et. al.*, 2018) [7, 21, 19]. Observations of present study are in accordance of above studies. Darker prawns give bright orange colour after cooking which signifies freshness and relishes all over the world with higher price in market.

Resent study showed that it is possible to improve the overall appearance of prawn (raw and cooked) by manipulating background colour about the time of harvesting. These small freshwater prawns can be a good source of nutrient rich food along with good source of income and entrepreneurship. Size, weight, shape, and colour are the decisive parameters that determine the value of a fish, prawn or an organism in the market. Change in production streatgy using suitable culture techniques can prove benificial. Use of the background colour manipulation may be a lower-cost alternative to intensify the colour of the prawn being cultivated which are not fed with food containing carotenoids or pigments.



Palte 1: Explanation of figures: Photomicrographs of freshwater prawn, *Macrobrachium lamarrei* Plate:1 Fig. 1-4: Control; Fig. 5-8: White Background; Fig. 9-12: Red Background; RS=Rostrum; EY=Eye; CR=Carapace; AB=Abdomen; CH=Chromatophore;TL=Telson; UR=Uropode



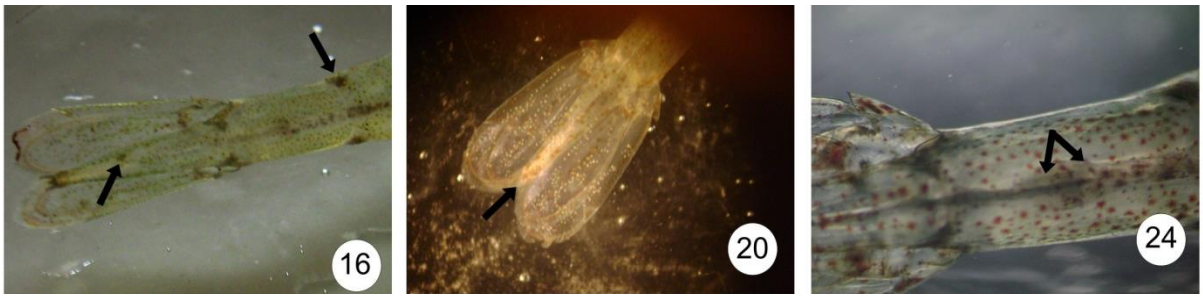


Plate 2: Explanation of figures: Photomicrographs of freshwater prawn, *Macrobrachium lamarrei* Plate: 2 Fig. 13-16: Green Background; Fig. 17-20: Blue Background; Fig 21-24: Blue Background

Conclusion

Outcome of present study indicates that manipulation of rearing tank colour changes prawns in darker colour which will increase its market price and can be used widely in freshwater prawn aquaculture. This technique is cost effective than costly diet manipulation for the same purpose. This technique is unique in terms of food value because pigmentation of prawns can be enhanced without any chemical treatment thus keeping the nutritional value intact and unchanged. This technique is effective, cheap and easy for freshwater prawn farmers so likely to adaptable.

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