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Evaluation of wild tilapia and gift tilapia as biological control against mosquito larvae (*Culex quinquefasciatus and Aedes aegypti)*

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Abstract
In present study experiments were conducted on predation efficiency of Wild and GIFT tilapia on two different mosquito species 4th larval instar (*Culex quinquefasciatus, Aedes aegypti)* in laboratory controlled conditions to consider the number of parameters like fish size, temperature and feeding time at Arid Agriculture University Rawalpindi. Tilapia fish is an efficient biocontrol agent against mosquito born diseases and have been used in controlling mosquitoes. Results showed that Wild tilapia prey consumption rate was greater at higher temperature 30^{o} C (388±4.590) and less at low temperature 20^{o} C (72.5±4.4319). Feeding of Wild tilapia showed maximum perdition efficiency in morning time (246.67±5.03) and minimum at afternoon and evening time (93.66±3.82 and 31.00±4.07 respectively). Considering the fish size in term of body weight predation rate increases with increasing body size. Wild tilapia is more efficient biocontrol agent against mosquito larvae (*C. quinquefasciatus* and *A. aegypti)* at 30^{o} C temperature in morning time as compared to GIFT tilapia.

Keywords: Biological control, fish, *Culex quinquefasciatus, Aedes aegypti* and wetlands

1. Introduction

In humans and mammals, some of the infectious diseases are transmitted by certain vectors, for example, mosquitoes, flies (sand and tsetse), tics, mites and lice. Mosquitoes are the major, wide spread and most common vector of different diseases including malaria, dengue and yellow fever (Pant *et al.*, 1981) [1]. The control of mosquitoes, vector for many human and animal diseases, is important for the control of these vector borne diseases. Several compounds viz, mercuric chloride, Paris Green, phenols and cresols, naphthalene (Gratz, 1988) [2], bordeaux mixture, rosin-fish oil soap, calcium arsenate, nicotine sulfate and dichlorodiphenyltrichloroethane (DDT), were used as conventional pesticides (Raghavendra *et al.*, 2011) [3]. Paris green and petroleum oils were proven the most successfully used chemicals in larval control. The remarkable toxic and persistent effect of these insecticides is the development of insecticides resistance strains of mosquitoes (Brown, 1958) [4]. The biological control is environmental friendly and not hazardous for plants, beneficial insects and humans health. For controlling pest some of the biological controlling agents were used such as parasites, parasitoids, microorganisms and predators (Sarwar, 2014) [5]. Fresh water fish *gambusia affinis, Oreochromis mossambica, Poecilia reticulata* (Mozambique cichlid, Tilapia) was used to control mosquito (Walker, 2002) [6]. *Poecilia reticulata* (guppy) has proven to be effective against all developmental stages of *Aedes* spp. (Chandra *et al.*, 2008) [7]. *Oreochromis niloticus niloticus,* commonly known as Tilapia is used for biological control of mosquitoes for malaria and dengue diseases.

Keeping in view the importance of GIFT tilapia and wild tilapia as an effective biological control against different species of mosquito, the present study was designed to investigate the larval predation efficacy of Wild and GIFT tilapias as a biological control agent against two mosquito species *Culex quinquefasciatus and Aedes aegypti* of 4th larval instar, under laboratory controlled conditions. Some of the parameters like fish size, temperature and feeding time of Wild and GIFT tilapias were also recorded.

2. Materials and Methods

2.1 Mosquito Larval Collection and Morphological Studies

Mosquito larvae used in study were collected from ponds located in Rawalpindi and Islamabad. The mosquito larvae collection was carried out by dipping a small size net into the pond and transferred into beaker filled with tap water (Okorie, 2010) [8]. Morphometery of thirty larvae from each species was conducted. Each larva was individually placed on a slide and added a drop of 70% ethyl alcohol. Total length of body and length and width of siphon tube of larvae were measured under 40X power of light microscope. The larvae counting were performed at the start of experiment and after each 2-hour interval. The counted 500 larvae were transferred into the larger beaker containing five specific size acclimatized fish. The experiment was carried out during 24 hours from 6:00 am until 6:00 pm. Using these experimental procedures, feeding behavior including active periods of the fish, wild and GIFT tilapia could be monitored (Saleeza *et al.*, 2014) [9].

2.2 Collection, Maintenance and Grouping of Fish

Two fish species; Wild tilapia and genetically improved farmed tilapia (GIFT) were collected from National Agriculture Research Center Islamabad. The fish identification was based on the taxonomic keys. The experimental fish were kept in these maintained aquariums and supplied proper fish food till the fish was used for experiments (Ungureanu *et al.*, 2010) [10]. For each individual fish, total length (TL) was measured to the nearest 0.01 cm using digital slide calipers (Hassan *et al.*, 2013) [11]. Fish of both species were divided into three groups according to their body size (length). The fish consisted upon the following groups (Okorie, 2010) [8]. Fish were held in the beaker for 24 hours prior to the start of the experiments and was kept without food to standardize the hunger level.

Table 1: Sized based grouping of fish

Group	Fish Size	
	GIFT tilapia	Wild tilapia
1	1.5 cm - 2.5 cm	4.0 cm - 4.5 cm
2	2.5 cm - 3.5 cm	5.5 cm - 6.5 cm
3	3.5 cm - 4.5 cm	6.5 cm - 8.5cm

2.3 Experimental Protocol

The experiment was conducted in the parasitology laboratory in the Department of Zoology, PMAS-Arid Agriculture University Rawalpindi. All experiment was carried out in glass beakers and each of parameter was conducted in 3 replicates.

2.3.1 Fish Size

1st parameter was size based of fish in which fish was divided into three groups. Five hundred Mosquito larvae were counted and put them into the beaker and then five fishes kept in the same beaker. The numbers of Mosquito larvae were counted after every two hours.

2.3.2 Predation efficacy of fish

In 2nd parameter predation efficacy of fish was checked at different water temperature. The same diet was given to fish at water temperature 30 °C. Five fish was used to checked predation efficiency. Numbers of mosquito larvae were counted after every two hours at this temperature. At this temperature fish was observed for 8 hours. Similarly in this way predation efficiency was studies at 25 °C and 20 °C.

2.3.3 Predation efficiency at day timing

In 3rd parameter predation efficiency was checked at different timing of day. The same diet was given to fish at morning, from (6am to 8am) after two hours number of mosquito larvae was counted that fish consumed. Similarly in this way predation efficiency was checked at afternoon and evening time. Three replicates of each experiment were carried out.

2.4 Statistical Analysis

All the data were analyzed by using Micro soft excel software 2007.

3. Results

3.1 Predation Efficiency of Fish (Wild and GIFT Tilapia)

One the size based investigation of mosquito larval consumptions for the duration of the experiment showed that Wild tilapia fish of group 1consumed 118.56±4.70 which increased to 295.94±58.49 for group 2 and group 3 fishes were consumed 199.67±5.21. (Figure 1) GIFT tilapia fish of group 1 devoured 91.33±5.19 which decreased to 61.22±4.49 for group 2 and fish of group 3 had 74.33±5.32 (figure 1).

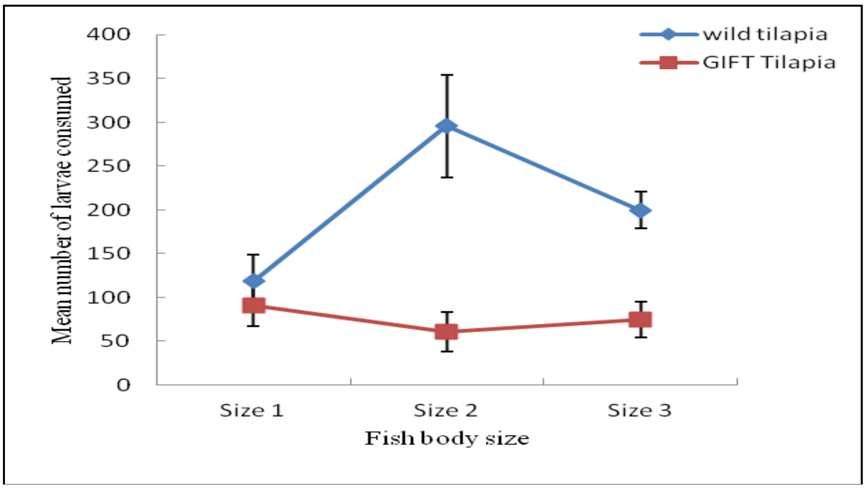

Fig 1: Average number of mosquito larval consumed by Wild and GIFT Tilapia.

3.2 Predation Efficiency of Wild and GIFT Tilapia at Water Temperatures

The temperature based studies of fish was at 30 ºC Wild tilapia consumed average mosquito larvae 388±4.590 which decreased at 25 ºC to 288.25±5.91 and further decreased to 72.5±4.4319 at 20 ºC (Figure 2). In comparison, the GIFT tilapia devoured 89±4.807 larvae at 30 ºC; this consumption was decreased progressively to 60±5.057 at 25 ºC and 23±5.01376 at 20 ºC.

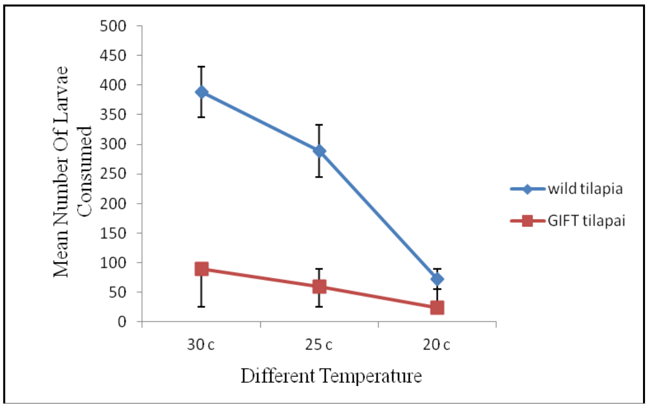

Fig 2: Average number of Mosquito larvae consumed by Wild and GIFT Tilapia at different water temperature.

3.3 Consumption of Mosquito Larvae at Different Timing of Day

The investigation of mosquito larval consumptions based on timing of the day showed that wild tilapia consumed higher number of larvae at morning time 246.67±5.03 that decreased non-significantly at afternoon time (201.4±33.59) which further reduced to the lowest one (93.66±3.82) at evening time (figure 3). While GIFT tilapia consumed 111.66±3.89 larvae at morning time and lowered to 31.00±4.07 and 17.33±3.18 at afternoon and evening times respectively (figure 3).

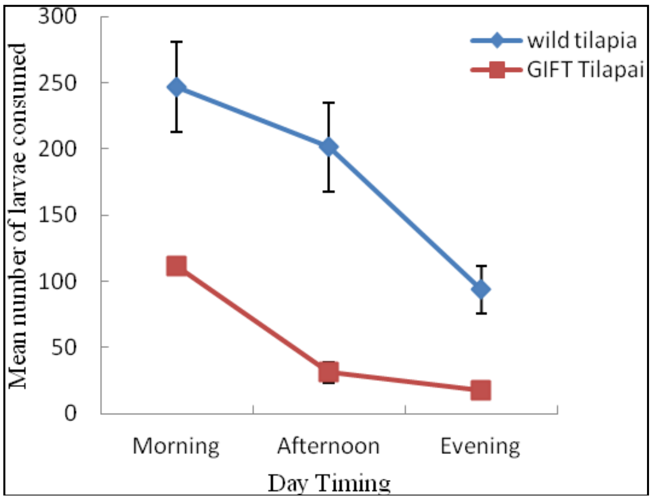

Fig 3: Consumption rate of fish (Wild and GIFT) Tilapia at different timing of day.

4. Discussion

Three different groups of Wild Tilapia fish predated on undifferentiated 4th larval instar of two mosquito species *C. quinquefasciatus,* and *A. aegypti*. It was observed that in the beginning of study the Wild Tilapia fish larvae consumption of mosquito species were greater and consumption reduced with time interval. It was further observed that medium size fish of group II devoured more larvae compared to the Group I fish of small size and largest size fish of group III. Contrary to our study (Jacob *et al.*, 1982) [12] reported that predation declines significantly as size of fish increases. The rate of larval consumption was proportional and dependent to fish size (Pamplona *et al.*, 2004) [13]. All the three groups of GIFT tilapia were also predated on undifferentiated larvae of *C. quinquefasciatus, A. aegypti* and consumed them. Although, the consumption efficiency of GIFT tilapia was comparatively lesser than Wild tilapia. In line to our study (Jacob *et al.*, 1982) [12] reported that predation declines significantly as size of fish increases. The fish size is directly proportional to is rate of larvae consumption (Pamplona *et al.*, 2004) [13].

The number of prey consumed varies with the difference in body size. This means that prey consumption increases with body size (Manna *et al.*, 2008) [14]. This result also supports by finding by (Cavalcanti *et al.*, 2007) [15] who report that the efficacy as predator depends on its weight and sex. (Cavalcanti *et al.*, 2007) [15] used five different fish species as predators against *Ae. aegypti* larvae and found that the larger fish are more effective predators, and female guppies are more capable to eradicate *Ae. aegypti* larvae than male guppies. Therefore, larger fish eat more mosquito larvae than smaller fish do (Saleeza *et al.*, 2014) [9]. Daily feeding patterns were size-dependent. The largest fish fed at a relatively constant level through the day, medium-sized fish fed in a pattern similar to that described above for the population and small fish fed most at first and last light. These differences were due probably to the effect of competitive interactions upon fish of different sizes.

It was observed that the larval consumption of Wild tilapia was higher to GIFT tilapia at all the temperatures during the whole intervals of the study. The consumption was highest at 30ºC that progressively reduced significantly for all the time durations at 25 ºC and 20 ºC respectively. However, the GIFT tilapia fish consumption was significantly reduced compared to Wild tilapia. As the water temperature fluctuates in which the mosquito breeds from time to time the evaluation of the predatory efficiency of this fish in different temperature is naturally essential. However, it must be mentioned that (Maglio and Rosen, 1969) [16], reported the feeding behavior of other larvicidal fishes such as *G. affinis, P. reticulata* and *A. lineatus* to be in direct response to water temperature. The increase in temperature causes enhanced fish activity and metabolism that leads in the increased feeding activity said by (Elliott, 1975 and Rozin and Mayer, 1961) [17 and 18]. A positive correlation of the consumption rate of the guppy with that of the water temperature was observed. At the higher temperature ranges, both the male and female guppy fish consumed higher number of mosquito larvae (Elias *et al.*, 1995) [19]. Similar findings were also observed by other workers (Ahmed *et al.*, 1985) [20]. Therefore, one of the reasons that fish enhance its feeding may be linked to the increase in temperature.

The predation efficiency was found minimized at low temperature of 20 ºC. It increases to higher numbers of larvae as the temperature rises to 25 ºC and then further increased to the considerably highest larvae numbers at 30 ºC. The finding that the amount of food were consumed by the fishes generally an increase with rising temperature till an optimum is reached is supported by the works of (Brett, 1971 and Gerald, 1976) [21 and 22]. It was also noted that the predatory efficiencies of *Aplocheilus panchax* was higher than that reported for other larvivorous fishes like *Gambusia affinis* by (Brett, 1971) [21] at 20 ºC (12.6 larvae), 25 ºC (16.1 larvae) and 30 ºC (20.5 larvae). The predatory efficiency of *O. nitlus* is higher than that reported by (Reddy, 1973) [23] for *G. affinis* in tropical waters, at 20°C (12.6 larvae per individual), 25°C (16.0 larvae per individual) and 30 °C (20.5 larvae per individual), but is lower than that reported by (Jacob *et al.*, 1982) [12] in *A. lineatus* at 22.5 °C, 27.5 °C and 32 ºC (47.3, 61.2 and 67.7 larvae per individual).

It was also evident from the results that both fish species (Wild and GIFT) of tilapia devour more larvae in the morning times compared to evening times. In conjunction to our results, the feeding pattern for the fish in an earlier study that highest levels of feeding activity in the early morning and late evening. Differences between our and other studies may be due to variation in climate, season or life-history stage. These results are in consistent to the earlier studies that a nocturnal depression in feeding was observed and the fish ceased feeding in the evening without commencing feeding again until 5 a.m. or later when it is getting quite light. The feeding activity increased in intensity throughout the morning but often slackens off during mid-day. Parr fish species usually have another period of active feeding in the evening (Hoar, 1942) [24]. There were similar observations to our study that in a semi natural stream were carried out during the day and night comparing diet and seasonal differences in behavior between fish and the fish were found to be foraging at surprisingly low light levels (Valdimarsson and Metcalfe, 2011) [25]. It also showed a feeding depression during the hours of darkness, with fish feeding in lower intensity light during the evening rather than during the early morning hours (Hoar, 1942) [24]. Some studies reported a daily appetite rhythm, with an early-morning peak after a slow start at first light, a trough in the early afternoon, and a second peak in the late afternoon/early evening. It was assumed previously that the afternoon drop in appetite found in these studies was a response to higher light levels at this time of day (Hoar, 1942) [24].

5. Conclusion

According to the present research Wild tilapia fish specie is more efficient biological control agent then GIFT tilapia against mosquito larval instar of (*C. quinquefasciatus and A. aegypti).* at 30 ºC temperature in morning time. The numbers of parameters like fish size, different temperature and different feeding time also showed the maximum result on Wild tilapia fish specie. On the basis of above parameters Wild tilapia fish specie has been recommended as biological control agent against mosquito larvae and mosquito born diseases.

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