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Impact of short and long term heat induced treatment on Blow fly egg tolerance (*Lucilia cuprina*, Diptera: Calliphoridae) for an effective control/suppress Program

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Abstract

The farmers of fish drying areas of Bangladesh are facing a great tricky in controlling the pests of sun drying fishes and most of these invasions occurred by blow fly (*Lucilia cuprina*). The present trial is to investigate the blow fly egg tolerance towards a heat induced treatment with a view to develop an effective blow fly control/ suppress program. In this experiment, both a short and long term heat treatment were persuaded through a water bath system on 1.5 hour old blow fly eggs at 35˚C and 37.5 ˚C of temperature respectively. A control batch was also placed at a room temperature (28± 2 ˚C). In case of 5 minutes heat induction, the egg hatching was significantly ($p < 0.01$) higher than that of the 45 minutes of heat exposure. Only 3.6 ± 0.74 % of egg was hatched at 37.5 ˚C through a 4 hour long heat treatment. The observation disclosed that the longer the heat exposure the shorter the percentage of egg hatching. Again, it was revealed that 35 ˚C of temperature is flawless for a higher number of eggs hatching by a short term heat exposure and 37.5 ˚C is acknowledged as the best temperature regime for highest egg mortality.

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Introduction

Blow fly (*Lucilia cuprina,* Diptera: Calliphoridae) is regarded as the most destructive pest for fish drying industries in Bangladesh (Begum *et al.* 2009). Over 25 % of marine fishes are lost due to fly infestation, besides there is also quality deterioration of the product during the process of sun drying (Doe *et al.* 1997). Hence, we are trying to develop an effective SIT for an adequate suppression of blowfly population from coastal fish drying yards. The effects of constant or frequent high temperature on insects have been deliberated for many times. Insects, when exposed to extreme temperatures may respond through changes in morphology, life history and/or physiology (Hoffman *et al.* 1991).

Temperature plays a vital role in the survival and reproductive success of insects and high temperatures can cause direct mortality or reduce fitness caused by heat stress (Cossins *et al.* 1987). Similarly, a strong and positive relationship was examined between temperature and the developmental rate of eggs, larvae and pupal stages of flies (Duyck *et al.* 2004). Several studies have implied that a single heat wave might affect insect survival and fitness traits, including decreasing the egg hatching rate and delaying development in offspring (Luo *et al.* 2005). Tolerance of flies to extreme temperature has been shown to differ depending on temporal scale of exposure (Nguyen *et al.* 2014). It is desirable if females die early in development, as larval diet is a major cost for mass production facilities (Ying *et al.* 2017).

As temperature plays a very important role in the development of *L. cuprina* (Bansode *et al.* 2016), hence, we are trying to establish a precise temperature and a suitable heat exposure for egg hatching. The present study is estimating the percentage of egg hatching and mortality at 35 ˚C and 37.5 ˚C of temperature for a short and long term heat induction which will finally be used not only as a strong background for the female embryonic lethality/ male only production for sterile insect technique but also for the farmers to control/suppress blow fly invasion towards the sun drying marine fish.

Materials and method

Collection of L. cuprina egg

Egg clusters (1.5 hr old) of *L. cuprina* were collected in a petridish from the laboratory stock (reared on fish) maintained at a temperature of 25± 2˚C and 65± 5 % of RH. There were five replications and a control batch also. Each cluster of eggs were immersed into six different small test tubes with normal tap water. The test tubes were vigorously shaked in order to break the cluster of eggs.

Heat treatment

The eggs were exposed to hot water of the water bath ((BS- 06, JEIO TECH) in which the temperature was calibrated at 35˚C and 37.5 ˚C respectively and was confirmed with a standard thermometer. Heat was tempted on egg stage for a short period of 5, 15, 30, 45 minutes and a long period of 1, 2, 3 and 4 hours at 35˚C and 37.5 ˚C of temperature. Eggs for the controlled batch was placed in a test tube containing water of controlled temperature (28± 2 ˚C) for respective time duration.

Counting of Egg hatching

After the treatment, the eggs from the test tubes were placed in six different petridish that contained water-soaked cotton and black cloth. 100 eggs were positioned in a line with a brush on the black cloth and kept it for hatching. After hatching the petridish were held under the microscope (Liedet, MZ- 720X) to observe the condition of the eggs and notice the number of hatches.

The number of unhatched eggs were defined as the number of egg mortality. Finally, the percentage of male and female adult emergence will be checked in order to detect the female embryonic lethality.

Data analysis

All the data were analyzed via one-way ANOVA (analysis of variance) by Microsoft Excel (XLSTAT by Addinsoft) and detected as significant through *P* value and *F* value estimation at $p < 0.01$ level.

Result and discussion

Table 1 is describing the percentage of egg hatching at 35 ˚C and 37.5 ˚C of temperature via a short term heat exposure. In a short term heat induction, the optimum temperature for a highest percentage of egg hatching was detected as 35 ˚C other than the control batch. About 73.8± 1.65 % of egg was hatched at 35 ˚C for 5 minutes of exposure to heat while it was counted as only 52± 2.48 % at 37.5 ˚C of temperature. On the other hand, only 9.4± 1.02 % of egg was survived for 45 minutes of heat treatment at 37.5 ˚C of temperature. Whereas still 57± 1.41% of larvae was counted from control batch for the same duration of exposure. For a half an hour of heat induction, the hatching was ranged from 71± 1.43 to 61± 1.14 % at control and 35 ˚C temperature respectively while it was recorded as only 18± 1.78 % in case of 37.5 ˚C.

Table 1. Percentage of blow fly (*Lucilia cuprina*) egg hatching (Mean ± SE) by a short term heat treatment (in min.) at 35 ˚C and 37.5 ˚C besides a control batch.

Exposure time (in minutes)	Egg hatching at different temperature group (Mean ± SE)		
	Temperature group		
	Control (28 ± 2 ˚C)	35 ˚C	37.5 ˚C
5	85.4± 1.59	73.8± 1.65	52± 2.48
15	84± 1.04	68.8± 0.86	39± 1.14
30	71.4± 1.43	61± 1.14	18± 1.78
45	57± 1.41	18.2± 1.24	9.4 ± 1.02

*The p value is 0.00001 and the result is significant at p <0.01.

In figure 1, the percentage of egg hatching was recorded as only 3.6% from 37.5 ˚C of temperature through a 3 to 4 hours long heating exposure while around 36± 1.14 % of egg hatching was revealed from the control batch by same hours of treatment.

In case of 35 ˚C of temperature, percentage of egg hatching was varied from 10.6± 1.43 – 5.6± 1.24 % for 1 to 4 hours of long treatment. The experiment disclosed that the lower the duration of heat exposure, the higher the percentage of egg hatching.

On the other hand, figure 2 is displaying the percentage of egg mortality due to short and long term heat induction.

The highest percentage (96.4%) of egg mortality was attained from maximum heat treatment duration (4 hour) at 37.5 ˚C while the lowest (26.2%) was achieved for 5 minutes of heat exposure at 35 ˚C besides the control batch. An abrupt sharp peak was detected regarding egg mortality from graph 2 for 30 to 40 minutes of short term heat exposure at 35 ˚C of temperature. It is cleared that long term heat exposure of high temperature induces the egg mortality whereas short term heat treatment lessens the egg mortality.

Many studies investigated the biology and ecology and also a wealth of information is available concerning the effects of environmental conditions on the fly's survival and reproduction (Avidov, 1954).

Shamsudin *et al.* (2009) described that the young eggs (*B. Tryoni*) acclimatized at 30 ˚C for 3 hour or 5 hour or at 35˚C for 6 hour showed a significant decreased mortality (p<0.05) compared to that of the control at 26 ˚C of temperature. Again, Choi *et al.* in 2014 showed that in *D. melanogaster*, 25 ˚C treatment had a higher male to female ratio (12:3) than the 30 ˚C (6:4) treatment. Xin Gung *et al.* (2009) presented that 77.3 % of eggs hatched after 3 day of exposure under the control temperature regimen (18.3 – 23.9 ˚C) whereas under 18.3-35 ˚C regimen only 1 of 106 eggs hatched after 3 day exposure but 65.7 % of egg hatched after 6 day of exposure and under (18.3- 37.8 ˚C) regimen no egg hatched after 3, 6 or 10 days of exposure.

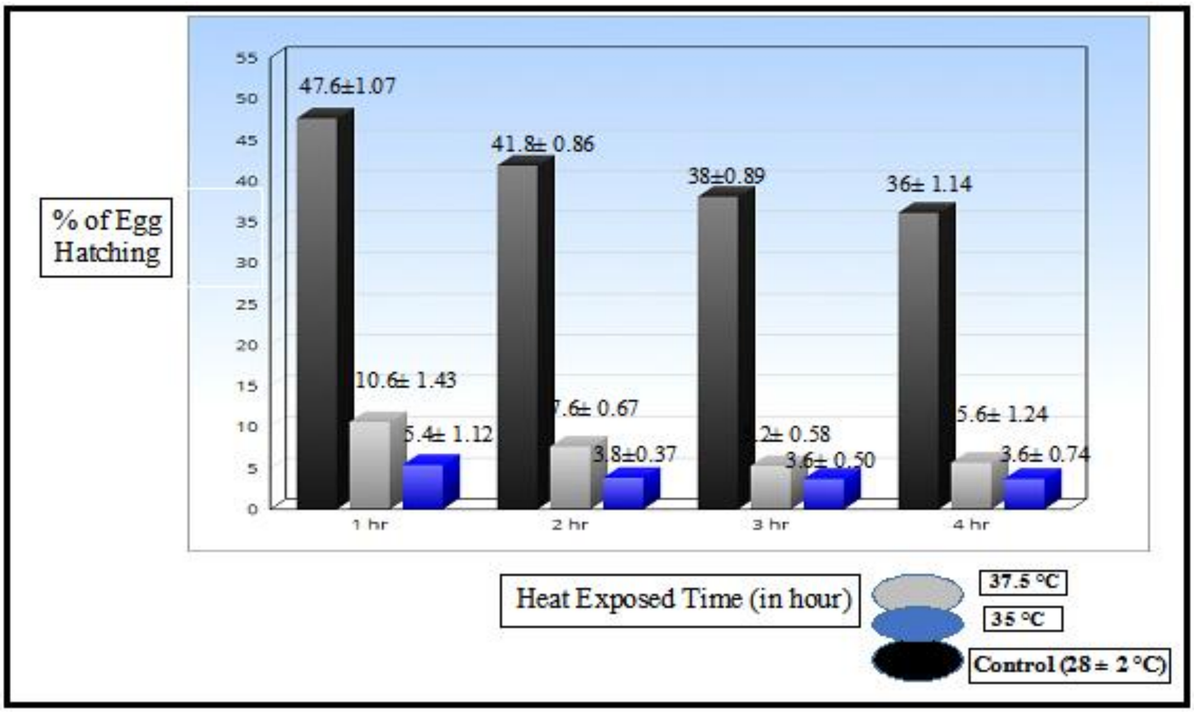

Fig. 1. Percentage of blow fly (*Lucilia cuprina*) egg hatching (Mean ± SE) through a long term heat treatment (in hour) at 35 ˚C and 37.5 ˚C besides a control batch.

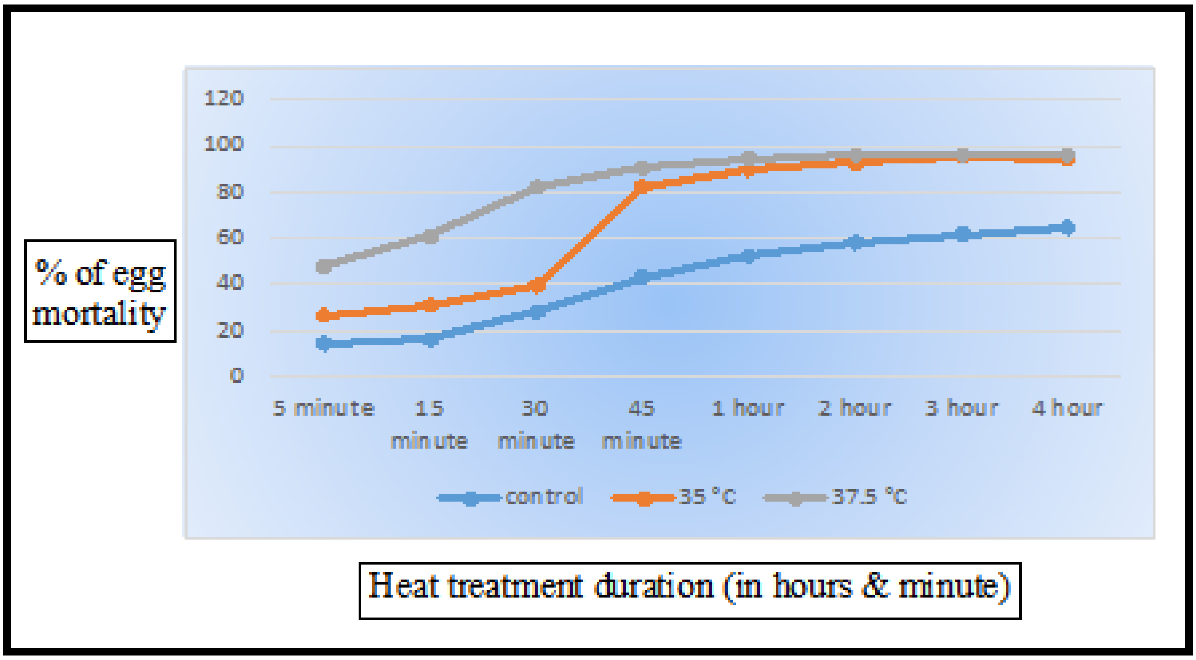

Fig. 2. Percentage of blow fly (*Lucilia cuprina*) egg mortality at different temperature via different short and long term heat exposure.

These findings are in a common agreement with our conclusions. Further, Younes *et al.* (2010) clarified that the optimum and favorable temperatures for female fertility ranged between 25 and 30 ˚C, where the average of egg hatching was 186 and 174.8 respectively. Dahi *et al.* 2003 studied the relationship between constant temperatures and developmental rates of different insect species. Similarly, Cavieres 2018 narrated that eggs exposed to 24 hr cycles of thermal fluctuation had a higher proportion of eggs that hatched than those acclimated to shorter (6 and 12 hour) and longer cycles (48 hour). Contrary, Chidawanyika *et al*. 2011 reported increases of 70% in the survival of moths exposed to high temperature for short periods of time (37 ˚C/ 1hr) which is opposing our findings and this is due to the variance in temperature tolerance level for different insect species. But according to Roberts *et al.*, 2000 prolonged duration of thermal exposure has negative effects on performance and fitness; specially, chronic exposure to high temperatures reduces insect survival and rate of development.

From the above-mentioned trials, we can justify that 35 ˚C is the flawless temperature through short term heat induction for rescuing a healthy number of blow fly egg hatching.

Conclusion

The present study and the above literatures from the previous discussions indicate a contextual signal for the production of male flies by heat induction on eggs and also a proposition for the farmers for rescuing their sun drying marine fish from blow fly infestation in coastal area of Bangladesh.

References

Avidov Z. 1954. Further investigation on the ecology of the olive fruit fly (*Dacus Oleae* Gmel.) in Israel. Agricultural Research Station, Rehovot. Ktavin **4,** 39-50.

Bansode SA, More VR, Zambare SP. 2016. Effect of different constant temperature on the life cycle of a fly of forensic importance *Lucilia cuprina*. Entomology Ornithology & Herpetology: Current Research **5,** 183. http://dx.doi.org/10.4172/2161-0983.1000183.

Begum S, Khan RA, Mazumder MZR. 2009. Some biological aspect of the Australian Sheep Blow fly, *Lucilia cuprina* Wiedemann (Diptera: Calliphoridae). Bangladesh Journal of Zoology **37(1),** p 123- 132.

Cavieres G, Bogdanovich JM, Toledo P, Bozinovic. 2018. Fluctuating thermal environments and time- dependent effects on fruit fly egg- hatching performance. Ecology and Evolution. doi: 10. 1002/ ece3.4220.

Chidawanyika F, Terblanche JS. 2011. Rapid thermal responses and thermal tolerance in adult codling moth *Cydia pomonella* (Lepidoptera: tortricidae). Journal of Insect Physiology **57,** 108-117. http://dx.doi.org/10.1016/j.jinsphys.2010.09.013.

Choi JJ, Han D, Yang W. 2014. The effect of temperature on the number and gender of fruit flies (*Drosophila melanogaster*) reaching adulthood. The Expedition, **4.**

Cossins AR, Bowler K. 1987. Temperature biology of animals. Chapman and Hall, New York.

Dahi HF. 2003. Predicting the annual generations of the spicy bollworm, *Earias insulana* (Boisd.) (Lepidoptera: Noctuidae). PhD thesis, Faculty of Agriculture, Cairo University.

Doe PE, Ahmed M, Muslemuddin M, Schithananthan K. 1997. A polythene tent diet for improvement sun drying of fish. Food technology Australia **29(11),** 437-441.

Duyck PF, Sterlin JF, Quilicis S. 2004. Survival and development of different life stage of *B. zonata* (Diptera: Tephritidae) reared at fire constant temperatures compared to other fruitfly species. Bulletin of Entomological Research **94,** 89-93. http://dx.doi.org/10.1079/ber2003285

Hoffmann AA, Parsons PA. 1991. Evolutionary Genetics and environmental Stress. Oxford University Press, New York, p 24- 40.

Luo J, Zhan XX, Zhai BP, Guo YR, Zhu JH. 2005. Effect of high temperature on the growth, survival and reproduction of a laboratory population of the rice stem borer *Chilo suppressalis* walker. Acta Ecologica Sinica **25(4),** 931-936.

Nguyen C, Bahar MH, Baker G, Andrew NR. 2014. Thermal tolerance limits of diamondback moth in ramping and plunging assays. PLos One, **9**, eB7535.
http://dx.doi.org/10.1371/journal.pone.0087535

Roberts SP, Feder ME. 2000. Changing fitness consequences of hsp 70 copy number in transgenic Drosophila larvae undergoing natural thermal stress. Functional Ecology **14,** 353-357.
http://dx.doi.org/10.1046/j.13652435.2000.00429.x.

Shamsudin O, Heather NW, Cribb B. 2009. Thermosensitivity and the acquisition of thermotolerance in eggs of *B. tryoni* (Diptera: Tephritidae). Journal of Tropical Agriculture and Food Science **37(2),** 257- 262.

Xin-Gung W, Marshall JW, Kent DM, Hannah N. 2009. High Summer Temperature affect the survival and reproduction of Olive Fruit Fly (Diptera: Tephritidae). Journal of Environmental Entomology, **38(5),** 1496- 1504.

Ying Y, Linger RJ, Scott MJ. 2017. Building early-larval sexing systems for genetic control of the Australian sheep blow fly *Lucilia cuprina* using two constitutive promoters. Scientific reports **7,** Article number: 2538.
http://dx.doi.org/10.1603/022.038.0518

Younes WF, Akel FA. 2010. Effect of temperature on development and reproduction of peach fruit fly, *Bactrocera zonata* Saund. (Diptera: Tephritidae). Egyptian Journal of Experimental Biology (Zool.), **6(2),** 255- 261.