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Original Research

Evaluation of Different Strains of Eri Silkworms (*Samia cynthia ricini* B.) for their Adaptability and Silk Yield in Ethiopia

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Abstract

Eri silkworms, *Samia cynthia ricini* B., is one of the silkworm races under utilization in Ethiopia. However, it has several strains with wide variation in their commercial traits and selection and utilization of best suited strains of this eri silkworm race that adapt to different agro-ecologies will help to increase silk productivity and profitability. In this experiment, one Vietnamese (Eri-3.4) and three Indian (Eri-yellow, Eri-green and Eri-marked) eri silkworm strains were evaluated in different locations (Melkassa, Hawassa, Wondo-Genet and Jimma) which represents different agro-ecologies of Ethiopia. The experiment was laid out in Completely Randomized Design (CRD) in six replications. Thus, different silkworm strains showed statistical significant silkworm characteristic ranges in different locations which include egg hatchability (62.61% to 89.00%), larval duration (20.67days to 25.83 days), total life cycle duration (50.49 days to 74.00 days), single weight of larva (4.427 grams to 8.155 grams), effective rate of rearing (60.11% to 93.67%), single cocoon weight (1.848 grams to 2.903 grams), single shell weight (0.251 grams to 0.418 grams) and silk ratio (13.06 to 15.05%). However, a Vietnamese eri silkworm strain known by Eri-3.4 have showed an outstanding performance compared to other strains in all the locations especially in cocoon parameters. Therefore, it is recommended for future research and development efforts on eri silkworms in Ethiopia.

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INTRODUCTION

Silk is a functional term used to describe protein fibers that are secreted by arthropods. It is a natural protein fiber and is very soft, lustrous, smooth, strong and durable (Chowdhury, 2006). The practice of silk production involves diverse activities from the cultivation of host plants to silk processing, which engage people of all spectrums. Further, the by-products also have various uses ranging from fertilizers in rural areas to pharmaceutical industries which could be tapped to increase income of the farmers and other societal groups in the long term (Legay, 1958; and Sannappa *et al*., 2004). Silk production has the potential to make significant contribution to the economy of many countries where there is surplus labor, low-costs of production and willingness to adopt new technologies (Hajare *et al*., 2007).

Silk has strong affinity to the people of Ethiopia starting from ancient period of country's civilization. However, the silk yarns used were imported from India, Arabia and China (Spring and Hudson, 2002). Currently, Ethiopia is the second populous country in Africa. There is a general trend of increasing unemployment. Therefore, sericulture, an agro based labour intensive and environment friendly cottage industry, can become an efficient and effective income generating activity. The business holds a greater hope of hope at village level for Ethiopian citizen migrating to cities searching for jobs (Kedir *et al*., 2014). As a result, silk production from eri silkworm is practiced in different parts of the country especially by poor farmers as an additional income source through efficient use of family labor (Metaferia *et al*., 2006).

Eri-silkworm, *S. c. ricini*, is one of the most exploited, domesticated and commercialized non mulberry silkworms. It has many generations per year and feeds on several host plant species (Singh and Das, 2006; Chakravorty and Neog, 2006; Bindroo *et al.,* 2007). It is a domesticated silkworm and can be reared in doors (Joshi, 1992). Among all host plants, castor (*Ricinus communis* L.) is the most preferred host plant for eri-silkworm (Sannappa *et al*., 2004; Kumar and Elangovan, 2010). Moreover, about 25-40% of castor foliage can be defoliated (removed) and used for feeding eri-silkworm without affecting oil seed production (Raghavaiah, 2003).

Castor grows widely and abundantly in many parts of Ethiopia. In addition to cultivated castor on cultivable lands, it is also found wild in waste places, fallow fields, along road sides, farm borders and irrigation canals. It is dominantly used for oil seed production; however, it is also used for rearing of eri-silkworms especially in the rift valley areas and southern Ethiopia (Metaferia *et al*., 2006).

However, rearing of improved silkworm strains that adapt to the local environment is an important method for improving cocoon quality, increasing cocoon yield and enhancing economic benefit (Nguku *et al*., 2009). Differences in climatic conditions of different agro-ecological regions, including the significant distinctions in temperature and humidity, necessitate that the silkworm variety should be both high yielder and adversity resistant (Basavaraja *et al*., 2005). Priyanki and Jorgen (2013) carried out a comparative study on eri silkworm strains in India and reported significant variation in morphological and productivity parameters among strains. Debraj *et al.* (2001) stated phenotypic diversity and characterization of strains of eri silk worm will be useful for selection of breeding components for developing high silk productive breeds of silk worm. Hence, it can be recognized that evaluation of eri silkworm strains is an important beginning for future breeding and improvement efforts and for sericulture inclusive development endeavors. However, the differential performance of eri-silkworm strains has not been studied and documented in Ethiopia. There was no recommended silkworm strain for silk production in the country. This study therefore, assessed the adaptability and silk yield performance of different introduced eri silkworm strains under Ethiopian condition.

MATERIALS AND METHODS

Description of the Study Area

The experiment was conducted at Melkassa, Hawassa, Wondogenet and Jimma Agricultural Research Centers (ARCs) of Ethiopia. These locations represent some of the agro-ecologies of the country assumed suitable for silkworm.

Lay Out and Rearing

As per the rearing recommendations of silkworms by Rajan and Himantharaj (2005), the silkworm rearing room and equipments were cleaned, washed and disinfected with 2% formalin solution at the rate of 800ml per $10m^2$ before the commencement of the experiment (rearing). Different eri silkworm strains viz… Eri-3.4 /Vietnamese White plain strain/, Eri-Yellow/Indian Yellowish White Plain/, Eri-green/Indian Greenish Blue Plain/ and Eri-marked/Indian White Zebra/ were evaluated in the experiment. The experiment was designed in a Completely Randomized Design (CRD) with four replications. In each replication, 200 worms were used and allowed to complete their life cycle. The primary food plant, castor (*Ricinus communis L.*), was used as feed source for these silkworms. Tender leaves of castor were fed four times a day until the larvae ends 2^{nd} instar stage and semi tender leaves at 3^{rd} instar larvae, while more matured leaves were fed to 4^{th} and 5^{th} instar larvae.

Data Collection and Analysis

As adopted by Kedir *et al.* (2014), egg count was made before larval hatching. On the sixth day of spinning, the cocoons were harvested, counted and weighed. Data like larval and total life cycle duration (in days) and mature larval weight (in grams) were recorded. The cocoon weight (with pupa) and cocoon shell weight (without pupa) were documented. The following formulae were used for analysis of egg hatchability (%), effective rate of rearing (ERR %) and silk shell ratio (%) calculations.

$$\text{Egg hatchability} = \frac{\text{No. of Normal Eggs} - \text{No. of nonhatched Eggs}}{\text{No. of Normal Eggs}}$$

$$\text{Shell ratio} = \frac{\text{weight of the cocoon shell}}{\text{weight of the whole cocoon}} \text{x } 100$$

$$\text{ERR} = \frac{\text{Number of cocoon yield}}{\text{Number of larvae brushed}} \text{x100}$$

Finally, data were analyzed using SAS software (SAS, 2000). Least Significant Difference (LSD) was used to test significance of differences among treatment means at 5% probability.

RESULTS AND DISCUSSION

Findings of the present study showed variations in growth and cocoon characters of different eri silkworm strains, *Samia cynthia ricini*. Data on growth, rearing performance and cocoon traits of eri silkworm strains *viz*., egg hatchability (%), larval and total life cycle durations (days), larval weight (g), effective rate of rearing (%), cocoon weight (g), shell weight (g) and shell ratio (%) of different strains are described below. Significant differences were observed in silkworm characters among mulberry silkworm strains in different locations. Varying larval development periods and total life cycle durations were recorded from the strains.

Egg Hatchability: egg hatchability of eri silkworm strains to larval stage ranged from 62.608% to 89.0%. However, significant variation (p<0.05) in egg hatchability among eri silkworm strains was observed only at Melkassa. At Melkassa, higher egg hatchability (75.665 %) was recorded in Eri-3.4 strain followed by Eri-Yellow (72.998 %) and Eri-Green (71.330 %). The least egg hatchability was recorded on Eri-Marked strain (62.608 %).

Table 1: Variations in egg hatchability among eri-silkworm strains

Treatments	Melkassa	Hawassa	Wondo-Genet	Jimma
Eri-3.4	75.665^{a}	80.000^{a}	82.333^{a}	82.000^{a}
Eri-Yellow	72.998^{ba}	77.333^{a}	83.223^{a}	85.500^{a}
Eri-Green	71.330^{b}	79.833^{a}	83.447^{a}	82.500^{a}
Eri-Marked	62.608^{c}	79.000^{a}	80.667^{a}	89.000^{a}
Pr	**<.0001**	**0.1839**	**0.7318**	**0.3169**
CV	**3.9567**	**1.862258**	**4.007033**	**5.612477**

Means followed by the same letter within a column are not significantly different from each other (p>0.05)

Larval and Total Life Cycle Duration: The overall larval duration ranged from 20.667 days to 25.833 days. Larval duration of eri-silkworm strains showed significant difference only in Jimma area. In Jimma, the shortest larval period was observed in Eri-3.4 strain /21.0 days/ compared to the other strains. On the other hand, duration of the total life cycle generally ranged from 50.487 days to 74.0 days. However, statistically significant total life cycle duration was recorded only in Hawassa area where Eri-Green strain exhibited the shortest duration of 56.5 days.

(a) Larval duration (in days) (b) Duration of the total life cycle (in days)

Figure 1: Larval (a) and total life cycle (b) duration (in days) of different eri-silkworm strain

ERR (%): The experiment showed a range of ERR (Effective Rate of Rearing) from 60.111 to 93.667%. Eri silkworm strains showed significant variation in ERR at all the study locations except in Wondo-Genet. The highest ERR was recorded for Eri-3.4 strain at all the locations while the lowest ERR was recorded for Eri-marked strain at Jimma.

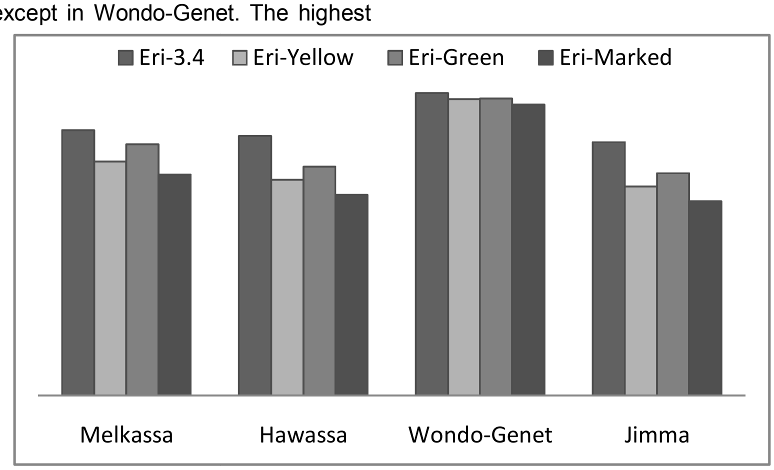

Figure 2: Variability of different eri silkworm strains in effective rate of rearing

Matured Larval Weight: Weight of a single matured silkworm larva was significantly different among eri silkworm strains at all the locations except in Jimma. The result showed that larval weight was significantly highest in Eri-3.4 strain in Melkassa (7.606 g). This strain had better larval weight in Hawassa and Wongo-Genet areas compared to other strains. The lowest larval weight was obtained from Eri-Yellow strain (4.636 g) in Hawassa area.

Table 2: Variations in larval weight (in grams) of different eri silkworm strains

Treatment	Melkassa	Hawassa	Wondo-Genet	Jimma
Eri-3.4	7.6062^{a}	7.1333^{a}	5.38333^{a}	6.6083^{a}
Eri-Yellow	8.1548^{a}	4.6367^{b}	5.35567^{b}	7.1617^{a}
Eri-Green	6.4076^{b}	5.1250^{b}	5.38900^{ba}	7.2800^{a}
Eri-Marked	6.2545^{b}	5.4983^{b}	5.12667^{c}	7.0433^{a}
Pr	**0.0004**	**0.0009**	**0.0046**	**0.3084**
CV	**10.246**	**8.266093**	**2.215526**	**6.078834**

Means followed by the same letter within a column are not significantly different from each other at 5% level of probability

Cocoon Traits: With respect to cocoon traits, maximum and significantly different single cocoon weight was recorded for Eri-3.4 strain in Melkassa (2.639 g). The lowest cocoon weight (1.848 g) was obtained from Eri-Yellow strain in Hawassa. In addition, eri silkworm strains showed variation in their single cocoon shell weight in different locations. The highest was 0.418 g from Eri-Green strain in Jimma but the lowest was 0.251 g from Eri-Yellow strain in Hawassa. However, the shell ratio which will indicate the quantity of silk that can be spun from cocoons was not significantly different among eri silkworm strains in all the locations (Table 3).

Table 3: Differences in cocoon traits among eri silkworm strains

Treatments	Melkassa			Hawassa			Wondo-Genet			Jimma		
	Single cocoon weight (gram)	Single shell weight (gram)	Silk ratio (%)	Single cocoon weight (gram)	Single shell weight (gram)	Silk ratio (%)	Single cocoon weight (gram)	Single shell weight (gram)	Silk ratio (%)	Single cocoon weight (gram)	Single shell weight (gram)	Silk ratio (%)
Eri-3.4	2.639^{a}	0.3721^{a}	14.106^{a}	2.335^{a}	0.3185^{a}	13.649^{a}	2.642^{a}	0.3890^{a}	14.719^{ba}	2.569^{b}	0.3393^{b}	13.226^{a}
Eri-Yellow	2.407^{b}	0.3334^{b}	13.855^{a}	1.848^{b}	0.2507^{b}	13.569^{a}	2.540^{b}	0.3823^{a}	15.048^{a}	2.903^{a}	0.3840^{ba}	13.221^{a}
Eri-Green	2.438^{b}	0.3362^{b}	13.796^{a}	2.061^{b}	0.2685^{ba}	13.055^{a}	2.344^{c}	0.3243^{b}	13.839^{b}	2.893^{ba}	0.4180^{a}	14.410^{a}
Eri-Marked	2.480^{ba}	0.3471^{b}	13.999^{a}	2.055^{b}	0.2869^{ba}	13.867^{a}	2.259^{c}	0.3343^{b}	14.819^{ba}	2.813^{ba}	0.3907^{ba}	13.899^{a}
Pr	**0.0314**	**0.0123**	**0.7329**	**0.0156**	**0.1606**	**0.8327**	**<.0001**	**0.0001**	**0.0952**	**0.1475**	**0.1498**	**0.3306**
CV	**5.3318**	**5.7475**	**3.7585**	**6.5508**	**11.9039**	**8.1940**	**1.9443**	**3.0062**	**3.6280**	**6.2720**	**9.6453**	**6.3205**

Means followed by the same letter within a column are not significantly different from each other at 5% level of probability

In general, the different silkworm strains showed variations in silkworm characters (p<0.05) in different locations *viz.*, egg hatchability (62.61% to 89.00%), larval duration (20.67 to 25.83 days), total life cycle duration (50.49 days to 74.00 days), single weight of larva (4.427 to 8.155 grams), effective rate of rearing (60.11 to 93.67%), single cocoon weight (1.848 grams to 2.903 grams), single shell weight (0.251 to 0.418 grams) and silk ratio (13.06 to 15.05%).

Similar findings carried out by Priyanki and Jogen (2013) confirmed such differences among eri silkworm strains. In addition, Singh *et al.* (2011) carried out study on morphological characters of eco races and six strains of eri silk worm and found out variations in their rearing performance, and recommended Yellow Zebra as the best strain in terms of rearing performance, which is not introduced to Ethiopia until today. These differences are justifiable in that rearing performance of silkworms is affected by ecological, biochemical, physiological and quantitative characters, which influence growth and development, quantity and quality of silk they produce in different geographical locations (Virk *et al.*, 2011; Anandakumar and Michael, 2012; and Reddy *et al.*, 2012). The ability of silkworms to produce is mainly affected by temperature and humidity, as verified by the silkworms reared in all locations. In addition, it has been well established that efficiency in silkworm production is often lower during and after the hot season. One reason for the reduction in their productive performance in some locations might be elevated ambient temperatures, which induce heat stress (Scriber and Slansky, 1981). Moreover, the nutritive value of leaves especially the moisture content may also vary to contribute to variability in performance and productivity of silkworm strains at different agro-ecological zones (Jayaramiah and Sannappa, 1998).

CONCLUSION

The evaluated eri silkworm strains exhibited important variability in different locations. Hence, evaluation and identification of eri silkworm strains that adapt to diverse agro-climatic conditions and produce high yield is confirmed to be very essential practice for future interventions in silk production sector.

A Vietnamese white plain eri silkworm strain known by Eri-3.4 showed an outstanding performance compared to other strains in all the locations especially in cocoon parameters and effective rate of rearing. These parameters are very important with respect to commercial terms. The strain was at par level with other strains in regard to other silkworm performance parameters too. Therefore, a Vietnamese white plain eri silkworm strain known by Eri-3.4 was the best strain in terms of growth and cocoon characters. As a result, it is now recommended to be reared in bulk and to be utilized for research and development efforts on eri silkworms in Ethiopia. On the other hand, a a cocoon weight recorded from the present study is lower compared to recent international findings. Therfore, further reserach and improvement works should be carried out on eri silkworm strains to achieve better productivity.

Conflict of Interest

Conflict of interest none declared

REFERENCES

Anandakumar, M.D. and Michael, A.S. (2012). Effect of nutritive additive of mulberry and its impact on nutritional components of silkworm, *Bombyx mori* L. *International Journal of Advanced Biotechnology and Research* 3: 523-529

Basavaraja, H.K., Aswath, S.K., Kumar, N.S., Reddy, N.M. and Kalpana, G.V. (2005). Silkworm Breeding and Genetics. Central Silk Board, Bangalore, pp. 39-341.

Bindroo, B.B., Singh, N.T., Sahu, A.K. and Chakravorty, R. (2007). Eri silkworm host plants. *Indian Silk* 5: 13-16.

Chakravorty, R. and Neog, K. (2006). Food plants of eri silkworm, *Samia ricini* (DONOVAN) their rearing performance and prospects for exploitation. Proceedings of the National Workshop on Eri Food Plants, October 11-12, 2006, Guwahati, India.

Chowdhary, S.N. (2006). Host plants of eri silkworm (*Samia ricini* Boiduval): Their distribution, economic and prospects for exploitation. Proceedings of the National Workshop on Eri Food Plants, October 11-12, 2006, Guwahati, India.

Debraj, Y., Sarmah, M.C., Dutta, R.N., Singh, L.S., Das P.K. and Benchamin, K.V. (2001). Field trail of elite Comparative study on six strains of ERI silk crosses of eri silkworm, *philosamia ricini*, Hutt, *Indian Silk* 40: 15-16.

Hajare, T.N., Jadhav, A.D., Venugopalan, M., Patil, N.G., Chaturvedi, A. and Maji, A.K. (2007). Evaluation of sericulture for augmenting agricultural income of marginal farmers in semi-arid region of India. Proceedings of the International Conference on Sericulture Challenges in the 21st Century and the 3rd BACSA Meeting,. September 18-21, 2007,. Vratza, Bulgaria.

Jayaramaiah, M. and Sannappa, B. (1998). Correlation coefficients between foliar constituents of castor genotypes and economic parameters of the eri silkworm, (*Samia cynthia ricini*) Boisduval (Lepidoptera: Saturniidae). Proceedings of the 3rd International Conference on Wild Silkmoths, November 11-14, 1998, Bhubaneshwar, India.

Legay, J.M. (1958). Recent Advances in Silkworm Nutrition. *Annual Review of Entomology* 3:75-86.

Kedir Shifa., Emana Getu and Waktole Sori. (2014). Rearing Performance of Eri-Silkworm (*Samia cynthia ricini* Boisduval) (Lepidoptera: Saturniidae) Fed with Different Castor (*Ricinus communis* L.) Genotypes. *Journal of Entomology* 11:25-33

Kumar, R. and Elangovan, V. (2010). Assessment of the volumetric attributes of eri-silkworm (*Philosamia ricini*) reared on different host plants. *International Journal of Science and Nature* 1: 156-160.

Metaferia H/Yimer., Amanuel Tamiru and Kedir Shifa. (2006). Scaling up of silk production technologies for employment and income generation in Ethiopia. Proceedings of the International Conference on Scaling Up and Scaling Out of Agricultural Technologies in Ethiopia, May 9-11, 2006, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Priyanki, S.H. and Jogen, C.K. (2013). A comparative study on six strains of Eri silkworms (*Samia ricini* Donovan) based on morphological traits. *Global Journal of Bio-science and Biotechnology* 2: 506-511.

Raghavaiah, C.V. (2003). Prospects of Eri silk (*Philosomia ricini*) production along with castor beans (*Ricinus communis* L.) and tapioca (*Manihot utilisimma*) production in Andhra Pradesh. *Indian Silk* 42: 33-35.

Rajan, R.K. and Himantharaj, M.T. (2005). Silkworm Rearing Technology. Central Silk Board, Bangalore, pp. 15-136.

Reddy, N.M., Kumar, S.N., Naseemabegum, A.R., Moorthy, S.M. and Qadri, S.M.H. (2012). Performance of bivoltine silkworm hybrids of B*ombyx mori* L. involving parental foundation crosses of different generation. *International Journal of Research in Zoology* 2:1-5.

Sannappa, B., Naika, R., Govindan, R. and Siddagangaiah, (2004). Ericulture: A venture for rural betterment. *Journal of Current Science* 5: 137-140.

SAS, (2000). SAS/STAT User's Guide. SAS Institute Inc., Cary, NC., USA.

Singh, B.K. and Das, P.K. (2006). Prospects and problems for development of Eri culture in non-traditional states. In: Proceeding of Regional Seminar on Prospects and Problems of Sericulture: An Economic Enterprise in North West India, November 11-12, 2006, Dehradun, India.

Scriber , J.M. and Slansky, J.F. (1981). The nutritional ecology of immature insects. *Annual Review of Entomology* 26:183-211.

Spring, C. and Hudson, J. (2002). Silk in Africa: Ethiopia. University of Washington Press, Seattle, USA.

Virk, J.S., Kaur, L., and Singh, B. (2011). Evaluation of different strains of mulberry silkworm and eri silkworm for the development of sericulture in Punjab. *International Journal of Agricultural Sciences* 7: 266-269.