RESEARCH ARTICLE

Nutritional Composition of Castor Genotypes and its Influence On Growth Attributes of Eri Silkworm (*Philosamia ricini*)

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ABSTRACT

Eri silkworm (*Philosamia ricini*) is one of the most exploited, domesticated, and commercialized Vanya silkworms. Eri silk yield and productivity depend heavily on the feeds ingested by Eri silkworms, which will vary depending on the feed sources. A study was undertaken to evaluate different castor genotypes viz., GCH 4, GCH 7, DCH 519, TMV 5, along with local variety for the nutritional composition and its influence on the growth and economic attributes of Eri silkworm. The treatments were laid out in a Completely Randomized Design (CRD) with three replications. The performance of eri silkworm viz., growth attributes, and economic parameters were studied by feeding them with the leaves of five castor genotypes separately in the tray rearing method. The genotypes showed significant differences in growth and economic parameters of eri silkworm. Among the various genotypes, GCH 4 genotypes showed superior among all the other genotypes on nutritional composition, growth attributes, and economic parameters, followed by genotype DCH 519.

Keywords: *Eri silkworm; Castor genotypes; Nutritional composition; Growth parameters;* Economic parameters

INTRODUCTION

Sericulture is an agro-based enterprise that entails the nurturing of silkworms for the production of raw silk, a yarn made from cocoons spun by specific species of lepidopteran insects. In India, four varieties of silk are commercially exploited. Aside from the wonderful mulberry silk, which is well-known worldwide, a few additional variations are equally appealing. Tasar, eri, and muga are called Vanya silk, or non-mulberry silk. Vanya silk provides the necessary input assistance to the vanya silk sector in the areas of domestic and international market promotion. Vanya silk industry's major goal is to design and manufacture marketable products through research, development, and collaboration with fashion designers. Among the commercially exploited vanya silkworms, the eri silkworm, *Philosamia ricini* is the only vaya silkworm adopted to complete indoor rearing throughout the year (Reddy *et al*., 1989; Debaraj *et al*., 2002).

The Eri silkworm, *Philosamia ricini* Donovan, is a domesticated multivoltine silkworm that is one of India's most important silk components. Since the dawn of time, this insect has been exploited for its silk. The name eri is derived from the Sanskrit word "eranda," which means "castor plant." Eri silk is thought to have originated in India, and Vedic literature dates it back to 1600 B.C. During the reign of King Bhaskar Burman, Eri silk was transported from Assam to Northern India as early as 600-650 B.C. Assam's Brahmaputra river valley is the birthplace of the farmed eri silkmoth. (Singh and Saratchandra, 2012).

Eri silkworm is an exclusive privilege and agro-based small-scale industry of North Eastern States of India. As an additional income-generating avocation which has recently spread over to some non-traditional states of India like Tamil Nadu, Andhra Pradesh, and Karnataka. Eri silkworm is a multivoltine and polyphagous feed on a wide range of food plants. However, Castor is considered the primary food plant rich in varietal composition, and many local and high-yielding varieties/genotypes are widely grown in Tamil Nadu and the rest of India.

The nutritional parameters of leaves are well-thought-out and a foremost factor in the survival of non-mulberry silkworms (Pandey, 1995). The better the quality of leaves, the greater would be the chances of getting a good cocoon harvest. In connection with the above line, the present investigation was carried out to evaluate the nutritional composition of genotypes and their influence on the growth attributes of eri silkworm in the non-traditional area of Tamil Nadu.

MATERIALS AND METHODS

The present investigations deal with studies on the Nutritional composition of different castor genotypes and its influence on the growth and rearing performance of eri silkworm fed with different castor genotypes, so as to evaluate the suitable castor genotypes for obtaining better cocoon productivity and also to improve the farmer's income. Based on this, the study was carried out at Department of Sericulture, Forest College and Research Institute, Mettupalayam, Coimbatore district, Tamil Nadu state.

Castor genotypes

Four castor genotypes, viz., GCH 4, GCH 7, DCH 519, and TMV 5 were procured from Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur, Salem, along with a local variety was sown at a spacing of 3 x 3' and the crop was raised as per recommended package of practices. The field experiments during both years were laid out in a randomized complete block design (CRBD) with three replications.

Nutritional composition of castor genotypes

The leaf samples at three different positions in a plant viz., top, middle, and bottom were collected in paper bags at 90 days after sowing and composite leaf samples were prepared, shade dried for three days and then dried in a hot air oven at 70°C until constant weight was obtained. For chemical analysis, the dried leaf samples were ground into a fine powder and preserved in butter paper bags. Each sample had four replications. The leaf nutritional parameters such as Nitrogen, phosphorus, Potassium, Calcium, Magnesium and Sulphur use standard procedures (Jackson (1973).

REARING OF ERI SILKWORM

Disease-free layings (Dfls) of eri silkworm were obtained from Eri P2 Basic Seed Farm, Central Sericulture Germplasm and Research Institute, Hosur, and reared following the standard rearing method (Dayashankar, 1982) by feeding different castor genotypes.

Disinfection of rearing room

The rearing appliances were disinfected with 5 per cent bleaching powder solution and the rearing room with 2 per cent chlorine dioxide solution under an air tight condition. The foot mat at the entrance was soaked with 5 per cent bleaching powder solution to prevent possible infection.

Incubation of eggs

The optimum environmental conditions of 25±1 ºC temperature and 75±5 per cent relative humidity were maintained for uniform development of an embryo and complete darkness was provided for 48 hours before hatching in order to obtain synchronized and uniform emergence of larvae.

Rearing of young age Eri worms

The first and second instar larvae were fed twice with tender leaves and the third instars with semi-tender castor leave thrice a day. Temperature and humidity were maintained using paraffin paper and a wet foam pad. Direct handling of young age worms was avoided to prevent infection.

Late age silkworm rearing

The environmental and nutritional conditions required for late age rearing differed from those of young age. Temperature and relative humidity ideal for late age rearing were 24-26°C and 70-80 per cent respectively.

The following growth attributes [Larval weight (g), Cocoon weight (g), Shell weight (g), and Silk gland weight (g)], economic parameters [Shell ratio (%), Effective rate of rearing (%), Mortality (%), Silk productivity (%) and Fibroin and Sericin (%)] were observed.

All the data recorded with respect to experiments of eri silkworm reared on various castor genotypes were tabulated and analysed statistically (one way CRD) for the test of significance using Fisher's method of "Analysis of variance" (Gomez and Gomez, 1984). The level of significance of 'F-test' was expressed at 5 per cent.

Economic parameters calculated

i. Shell ratio (%)

$$\text{Shell ratio (\%)} = \frac{\text{Weight of cocoon shell without pupa}}{\text{Weight of cocoon with live pupa}} \times 100$$

ii. Silk productivity (cg/day)

Silk productivity was suggested by Joshi and Mishra (1982). It was calculated by using the following formula,

$$\text{Silk productivity (g/day)} = \frac{\text{Shell weight (g)}}{\text{V instar larval duration (days)}}$$

iii. Effective Rate of Rearing (ERR %)

$$\text{Effective Rate of Rearing (ERR \%)} = \frac{\text{Number of cocoons harvested}}{\text{Number of larvae brushed}} \times 100$$

iv. Fibroin and Sericin (%)

The cocoon shell was treated with 2% KOH at 70-80oC for five minutes, constantly stirring till the cocoon became fluffy, and then washed thoroughly in tap water, later treated with diluted acetic acid (1g/liter) to neutralize the alkali. After treatment, another thorough wash was given with water and dried at 90-100 °C in a hot air oven. The weight of fibroin obtained after the dissolution of sericin was recorded. The fibroin and sericin contents in cocoon shell were calculated as per the procedure suggested by Singh and Benchamin, 2002.

$$\text{Fibroin (\%)} = \frac{\text{Weight of fibroin (g)}}{\text{Weight of cocoon shell (g)}} \times 100$$

$$\text{Sericin (\%)} = 100 - \text{Fibroin (\%)}$$

RESULTS AND DISCUSSION

Primary nutrients of castor genotypes

A marked difference was observed in the nitrogen content present in the leaves of selected castor genotypes. In the present analysis, a higher level of nitrogen was recorded in GCH 4 (4.031 %) (Table 1) as against 3.982 g reported by Chandrasekhar *et al.* (2013) and the next best was in DCH 519 (3.947 %) followed by Local variety (3.230 %) and GCH 7 (2.903 %) with negligible variations between them. However, TMV 5 recorded the least nitrogen content. Nitrogen content in foliage is known to influence the quality of foliage, especially its protein content (Shankar, 1997). Similarly, Chandrappa *et al.* (2006) noticed variations in the macronutrient status of leaves among different castor genotypes and this could be attributable to the inherent characteristic feature of castor cultivars. The role of nitrogen in improving silkworm economic parameters was as certain by Shifa *et al.* (2016) as evident in the present findings.

The estimation of leaf phosphorus content indicated that it was maximum in GCH 4 (0.273 %) and minimum in TMV 5 (0.136 %) which was on par with GCH 7 (0.152 %) (Table1). Further, EL-Shaarawy et al. (1975) recorded higher phosphorus content with the bloomy red variety of castor than with the bloomy green variety confirming that phosphorus content varied with varieties of castor. The higher phosphorus content in leaves was reported to enhance the levels of total sugars and is accountable for improving the growth and development of silkworm larvae (Ray *et al*., 1973). In the present study, DCH 519 recorded the phosphorus content of 0.237 per cent and it corroborates with the findings of Rath *et al*. (2017) who reported that the phosphorus content of 0.255 per cent in the same genotype.

Potassium content varied significantly in all the genotypes with a higher level of 2.732 per cent in DCH 519 castor genotype, followed by GCH 4 (2.512 %) and local variety (2.001%). However, potassium content was less in TMV 5 genotype (1.527 %) (Table 1). In a physiological study by Shankar *et al.* (1999), it was found that the silkworms fed on leaves with higher content of potassium were responsible for an increase in the body weight of silkworms and subsequently augments the cocoon production. In a similar study, Chandrasekhar (2007) observed that potassium content varied among the genotypes with significantly higher was recorded in the local genotype (4.002%) and lower in 48-1 genotype (1.946%).

Secondary nutrients of castor genotypes

The present experiment revealed that GCH 4 recorded maximum calcium content (3.762 %) followed by DCH 519 (3.248 %) (Table 1). The results are in concurrence with the findings of Kaleemurrahaman and Gowri (1982) and Govindan (2002) that a marked variation in the calcium content in different castor genotypes was studied. The nutritional value of host plants either alone or in combination played a significant role in the larval growth and silk productivity (Pandey, 2003). Similarly, Chandrashekhar *et al*. (2013) reported the calcium content was higher in the local genotype (6.716 %) and lower in GCH-4 (3.010 %).

Variation was found in the leaves of different castor genotypes in respect of magnesium content. The genotype GCH 4 registered a maximum magnesium content of 2.117 per cent followed by DCH-519 followed by local variety (1.813 %) (Table 1). Genotype, TMV 5 recorded the least magnesium content of 1.523 per cent. The present study is in conformity with the findings of Manjunath and Sannappa (2014) who recorded significant variation in the magnesium content in all the castor ecotypes included for the study, with the highest being in KJ000406 accession (2.414 %). The presence of magnesium content could be one of the attributes for the suitability of castor genotypes as food for eri worms.

The genotype GCH 4 registered a maximum sulphur content of 0.643 per cent which was found on par with genotype DCH 519 (0.619 %) and genotype TMV 5 registered the lowest sulphur content of 0.299 per cent (Table 1). The results conform with the observations of Govindan (2002), Chandrappa *et al.* (2006), Chandrashekar *et al.* (2013), Manjunath and Sannappa (2014), Shifa *et al.* (2016) and Rath *et al*. (2017).

Growth attributes of eri silkworm fed with castor genotypes

The growth response of eri silkworm fed with castor genotypes showed significant variation. Among the five castor genotypes, the eri silkworm fed with GCH 4 showed better growth attributes (larval weight (9.61 g), cocoon weight (3.79 g), shell weight (0.56 g), and silk gland weight (1.86 g)) followed by DCH 519 (9.55 g, 3.70 g, 0.53 g and 1.83 g) and local variety (9.50 g, 3.63 g, 0.50 g, and 1.81 g) respectively and least was observed in TMV 5 genotype (9.38 g, 3.48 g, 0.43 g, and 1.76 g) (Table 2). The present study strengthens the findings of Mandali and Narayanamma (2015), that the genotypes vary in the composition of foliar nutrients, which in turn contribute for differences in larval and cocoon parameters of eri silkworm fed with various castor genotypes. Similarly, Prasanna and Bhargavi (2017) and Sarmah *et al.* (2002) revealed the growth attributes were better in DCH 519 genotype. It was also stated that the variations in mature larval weight were evident when eri worms were fed with leaves of different castor genotypes. The difference perceived among the genotypes might be attributed to the fact that these genotypes vary in the composition of foliar nutrients, which in turn contribute to differences in growth attributes. (Fig 1)

Economic parameters of eri silkworm fed with castor genotypes

The economic parameters of eri silkworm fed with castor genotypes showed significant variation. A significantly higher shell ratio was obtained when silkworm was reared on the leaves of GCH 4 (14.77 %) followed by DCH 519 (14.32 %) and Local variety (13.58 %) and the outcome is in agreement with the results obtained by Narayanamma et al. (2013) and Dayashankar (1982) with a shell ratio of 13.3 per cent due to worms fed on GCH 4 genotype. The castor genotypes significantly influenced ERR, with a maximum being 91.57 % in GCH 4, which was on par with DCH 519 (90.72 %) and Local variety (90.42 %). The difference in ERR was observed among the castor genotypes and similar kinds of results were reported earlier (Jayaramaiah and Sannappa, 2000 and Sarmah *et al.*, 2002). The changes in environmental conditions alter the physiology of worms and hence they become susceptible to either environment or diseases. The mortality was high in TMV 5 (11.35 %) followed by GCH 7 (10.53 %).

Silk productivity was maximum in GCH 4 (8.34 cg/day) and lowest in TMV 5 (7.88 cg/day) which was on par with GCH 7 (8.00 cg/day). The present results are in agreement with the findings of Manjunath *et al.* (2019) who reported variations in silk productivity due to castor accessions. Significantly higher fibroin and lower sericin contents were obtained when eri silkworm reared on the leaves of GCH 4 (87.79 % and 12.21 %) followed by DCH 519 (87.70 % and 12.30 %) respectively (Fig.9). Similarly, Manjunath *et al.* (2019) reported that eri silkworm fed on leaves of castor genotype (accession number KJ000406) was found to be superior with respect to fibroin and sericin contents.

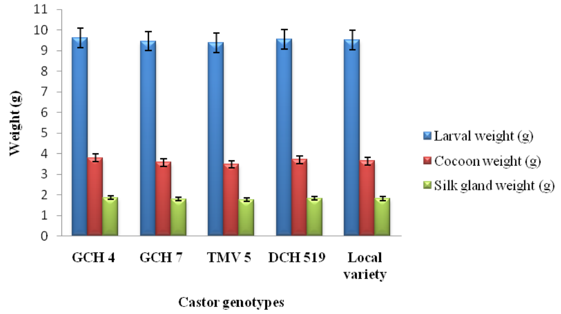

Figure 1. Growth attributes of eri silkworm fed with castor genotypes

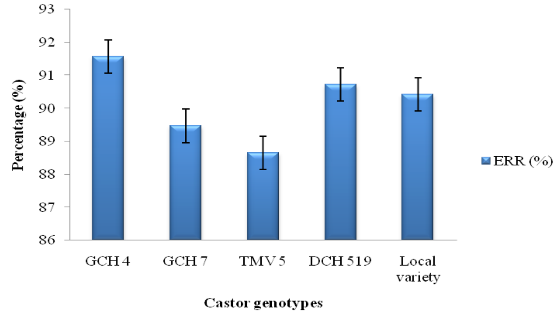

Figure 2. Effective rate of eri silkworm fed with castor genotypes

Table 1. Primary and secondary nutrient composition of Castor genotypes

Castor genotypes	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Calcium (%)	Magnesium (%)	Sulphur (%)
GCH 4	4.031a	0.273a	2.512b	3.762a	2.117a	0.643a
GCH 7	2.903d	0.152d	1.876de	3.110cd	1.695d	0.411c
TMV 5	2.534e	0.136d	1.527e	3.009d	1.523e	0.299d
DCH 519	3.947b	0.237b	2.732a	3.248b	1.970b	0.619ab
Local variety	3.230c	0.199c	2.001c	3.119c	1.813c	0.523b
SEd	0.040	0.015	0.104	0.078	0.018	0.012
CD (0.05%)	0.081	0.033	0.222	0.167	0.038	0.025

Each value is the mean of four replications

Means followed by similar letter(s) are not significantly different by DMRT (P = 0.05)

Table 2. Growth attributes of Eri silkworm fed with castor genotypes

Castor genotypes	Larval weight (g)	Cocoon weight (g)	Shell weight (g)	Silk gland weight (g)
GCH 4	9.61	3.79	0.56	1.86
GCH 7	9.46	3.56	0.46	1.79
TMV 5	9.38	3.48	0.43	1.76
DCH 519	9.55	3.70	0.53	1.83
Local variety	9.50	3.63	0.50	1.81
SEd	0.061	0.115	0.020	0.234
CD (0.05%)	0.124	0.246	0.041	0.451

Each value is the mean of four replications

Means followed by similar letter(s) are not significantly different by DMRT (P = 0.05)

Table 3. Economic parameters of Eri silkworm fed with castor genotypes

Castor genotypes	Shell ratio (%)	ERR (%)	Mortality (%)	Silk Productivity (cg/day)	Fibroin (%)	Sericin (%)
GCH 4	14.77	91.57	8.43	8.34	87.79	12.21
GCH 7	12.92	89.47	10.53	8.00	87.54	12.46
TMV 5	12.01	88.65	11.35	7.88	87.41	12.59
DCH 519	14.32	90.72	9.28	8.26	87.70	12.30
Local variety	13.58	90.42	9.58	8.17	87.61	12.39
SEd	0.455	3.032	1.201	0.924	1.835	0.534
CD (0.05%)	0.965	6.071	2.312	1.743	3.723	0.989

Each value is the mean of four replications

Means followed by similar letter(s) are not significantly different by DMRT (P = 0.05)

CONCLUSION

With respect to nutritional composition, growth attributes, and economic parameters of eri silkworm, genotype GCH 4 was the most promising followed by DCH 519 genotype which is suitable for rearing in non-traditional states like Tamil Nadu. Concluded that, the rearing of eri silkworm provides additional income to the farmers and employment opportunities to the entrepreneurs.

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All authors are ready to afford all financial or non-financial interests that are directly or indirectly related to the work submitted for publication.

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Authors should ensure that they have written and submit only entirely original works, and if they have used the work and/or words of others, that this has been appropriately cited. Plagiarism in all its forms constitutes unethical publishing behavior and is unacceptable

Consent for publication

The authors give consent for the publication of identifiable details, text, tables, and figures to be published in the above journal.

Competing Interests

The authors declare that they have no competing interests" in this article.

Data availability

All data generated or analyzed during this study are included in this manuscript article and some of the datasets generated during and/or analyzed during the current study are not publicly available.

Authors Contributions

Swathiga Ganesan contributed to the conceptualization, investigation and writing original draft and all other authors contribute to review, editing and preparation of the final draft.

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