

**DIFFERENTIAL EFFECTS OF CASTOR (*Ricinus communis*) VARIETIES ON
PRODUCTIVITY OF ERI SILKWORM (*Samia cynthia ricini*)
SILK IN THIKA, KENYA.**

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DECLARATION AND APPROVAL

Declaration by the Student

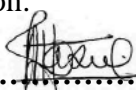
This thesis is my original work and has not been presented for a degree in any other University or for any other award.

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Approval by the Supervisors

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

This dissertation is entirely devoted to my mentors, Dr. Charles Warui and Purity Gacheri, whose unwavering support and guidance enabled me to finish this thesis.



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ABSTRACT

Eri silkworms (*Samia cynthia ricini*) produce a protein fiber known as silk which is determined on the foods they ingest. Five castor (*Ricinus communis*) varieties namely M2, M3, M4, M12 and S11 were investigated to determine their differential effects on growth, development and cocoon productivity of eri silkworms. M4 variety recorded the highest preference followed by M3, M2, M12 and S11. Differences in growth rate and development of eri silkworms were registered where least larval duration was recorded in M2 and S11 (26 days each), M12 (27 days), M3(28.75 days) and M4 (28.25 days). Significant difference on larval survival was portrayed where M2 and M4 had the highest growth (100%), S11 (99.5%), M12 (98.5%) and M3 (73.5%). Effective rate of rearing (ERR) revealed significant difference where M2 recorded the highest (98.5%) followed by M12 (91.5%), S11 (91%) M4 (84%) and M3 (61.5%). The maximum hatchability (95.6%) was registered by S11 followed by M12, M4, M2 and M3 (93.2%, 90.4%, 88.9% and 86.5%) respectively. M4 recorded significantly higher fecundity (380 eggs/female) followed by M3, M12, S11 and M2 (343,339.89, 327.38, 283.88) eggs/female respectively. Variation on mature larval weight was highest in M3 (4.78g) followed by S11 (4.70g), M4 (4.64g) M12 (4.58g) and M2 (4.27g). Eri silkworms fed on castor variety M3 recorded the highest cocoon weight (2.73g/cocoon) followed by M4, M12, S11 and M2 (2.62, 2.63, 2.57 and 2.35) g/cocoon respectively). M3 showed the highest shell weight (0.33g/shell) followed by M4, M12, S11 and M2 (0.32, 0.31, 0.30 and 0.27) g/shell respectively. M3 registered (12.11%) shell ratio followed by M4, S11, M2 and M12 (11.87, 11.77, 11.53 and 11.50) % respectively. The study found that certain castor cultivars, specifically M3 and M4, were the most promising in terms of cocoon characteristics and therefore recommended for further future research on growth development and cocoon productivity of eri silkworms in Thika, Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

DFLs	:Disease Free Layings
ERR	:Effective Rate Of Rearing
KALRO	:Kenya Agricultural And Livestock Research Organisation
KEPHIS	:Kenya Plant Health Inspectorate Service
Lakh	:A Hundred Thousand
MT	: Metaric Tonnes
NACOSTI	NationalCommission For Science Technology And Innovation
NSRC	:National Sericulture Research Center
Rs	: Rupees



CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Silk farming exists as an agricultural based business that involves the raising of silk producing insects which are arthropods (Ahmed, 2015). The study of (Chowdhury, 2006) explained silk being a protein fiber secreted by arthropods. (Edison *et al.*, 2016) explained the suitability of eri rearing to most developing countries urging the hardiness and disease resistance of eri silkworms as an advantage over mulberry silkworm especially given the typical rearing conditions in rural households which are not highly sanitary, capital requirement is minimal, labor intensive and the equipment required can be constructed locally. According to (Shubhangi, 2015) the technicality involved in sericulture and labor requirements can easily be handled at household level providing occupation to a recommendable section of the population.

There are various products that are produced in the textile industry out of this protein fiber which includes fishing lines, garments, jackets, insulation coil for electric and telephone wire, sieve for flour mill and tyres of racing cars (Rajasri and Lakshmi, 2015). The leftover foliage can be used as manure and also the branches obtained after pruning can be utilized as fuel (Manjunath, 2014). (Hajare *et al.*, 2007) testified how silkworm farming would influence positively the development of ecosystem and in return great financial earnings. The activities involved in the raising of the worms, growing of food plants reeling and weaving of the protein fiber would provide occupation for many people hence curbing the problem of employment. Silkworm farming is environmentally friendly best suited to all community members becoming an effective tool in eradication of poverty (Rajesh and Elangovan, 2010). The implementation of the industry in Kenya, would contribute to the decrease of unemployment which has remained a great a

challenge to the economy of the country (UNDP, 2013). Silkworm farming can also have a great impact in the eradication of movement of individuals from rural to urban areas in search of occupation to earn living. (Venu and Munirajappa, 2013) explains the suitability of the industry in the socio-economic rural set up promoting the standard of living of the less advantaged and also the farmers living in dry areas. A research done by (NSRC, 2016) reassures the development of the venture in the countryside on condition that the Kenyan authority would offer incentives to advance the cultural performance as well as structural procedures such as improved techniques and intensive research.

Silkworm is a larva that produces silk fitting in the phylum Arthropoda, class insecta, order Lepidoptera and super family Bombycoidea. Lepidoptera consist of 8 families and only Bombycoidea and Saturniidae super families produce the protein fiber (NSRC, 2016). The non-mulberry silkworm (*Samia cynthia ricini*) and mulberry silkworm (*Bombyx mori*) are known to be the main domesticated silkworms in Kenya. Eri silkworm was introduced in Kenya by Tosheka Ltd (a social enterprise textile company) and KALRO to evaluate their practicability as far as their commercial aspect was concerned. Apart from eri silkworms and mulberry silkworms other uninhabited silkworms witnessed in Kenya represent three lepidoptera families: saturniidae, lasiocampidae and thaumetopocidae. There are 58 species spread across these three families: Saturniidae (19), Lasiocampidae (33) and Thaumetopoeidae (6) (NSRC reports, 2016). Examples of some species that presently are not widely reared include *Anaphe pada*, having *Bridelia micrantha* as primary food (Euphorbiaceae), *Argema mimosae* having *Sclerocarya birrea* (Anacardiaceae) as primary plant and *Gonometa* sp having *Acacia* sp (Fabaceae) as primary plant (NSRC reports, 2016).

A study done by (Bindroo *et al.*, 2007) notifies the many generations of eri silkworm due to the fact that it's multivoltine and polyphagous insect. The insect depends on various

kinds plants for food although castor is the primary plant. The other alternative plants include *Kesseru* and *Tapioca* (Thangavelu *et al.*, 1983). The study done by (Jayaraj, 2004) explains how oil making is not affected when castor leaves are harvested for eri silkworm feeding. The maximization of superiority of castor foliage influences the efficiency and effectiveness of silk production.

An experiment done by (Singh and Das, 2006) showed how nutritional value of host foliage influences worm progression, improvement and shell efficiency. Different castor varieties show varying morphological features and nutritional standards of the foliage. The nourishment of eri worms with varying castor cultivars portrayed pronounced deviation, (Petil *et al.*, 1998). (Joshi, 1992), explained the commencement of commercialization, domestication and indoor rearing of eri silkworms. In India several studies have also been carried out on effects of host plants on progression and raising performance of eri worms such as (Prasanna and Bhargavi, 2017) who found that among the five castor varieties evaluated DCH-519 portrayed the best results in regard to worms mass, larval period, silk ratio, effective rate of rearing, case weight, hatchability, as well as fecundity. (Kedir *et al.*, 2014) investigated the differences in raising performance of eri larvae after being nourished with different castor varieties and recorded varied results on larval and cocoon parameters where eri silkworms nourished with Abaro castor recorded the highest weight of the cocoon, shell, pupa as well as the ratio of the shell.

1.2 Problem Statement

The eri larvae (*Samia cynthia ricini*) exists as multivoltine and polyphagous creature and nourishes on various food crops castor being the favorite host plant, (Singh and Das, 2006). The silkworms secrete fiber which is a protein substance secreted by arthropods, (Chowdhury, 2006). The study done by (Hajare *et al.*, 2007), explains how the protein fiber creation can potentially bring forth substantial impact to the budget of various

nations. Such financial benefits are visible in Ethiopia, India, Japan and Arabia which are among top countries with successful eri silkworm raising, (Kedir *et al.*, 2014).

A study carried out in Ethiopia which is among the largest eri silkworm rearing center, established that different castor foliage have different effects on the advancement and progression of the eri worms. The study also showed that this in turn leads to varying silk production (Kedir *et al.*, 2014). In Kenya castor is grown by individual farmers, private institutions and government organizations such as KALRO. This is most preference in Rift valley, coastal area, Central regions and parts of Eastern Kenya. (NSRC, 2016), shows that most castor grown in Kenya is for oil production rather than raising of eri larvae. Consequently there has not been any test to determine the viability of the various cultivars for raising the eri worms. As much as there is no organized cultivation of castor in Kenya, a few eri farmers use wild castor leaves available in the bushes, along the river banks and around their homestead. This does not put in consideration the type, quality and variety of the castor leaves (NSRC, 2016). Thus, the study's objective was to ascertain the advancement, progression, and cocoon productivity that eri worms (*Samia cynthia ricini*, Boisduval) Lepidoptera: Saturniidae) exhibited as they were fed on different castor varieties in Thika, Central Kenya. The study also sought to identify the best castor variety that is appropriate for eri worm cultivation in order to maximize the proper advancement, progression, and high yield in cocoon productivity.

1.3 Purpose of the study

The purpose of this study was to elucidate the significance of investigating the differential effects of various castor (*Ricinus communis*) varieties on the productivity of Eri silkworm (*Samia Cynthia ricini*) silk in Thika, Kenya. This research aims to achieve a comprehensive understanding of how different castor varieties can impact the productivity of Eri silkworm silk, thereby contributing to the sericulture industry in

Thika, Kenya. By examining these effects, we hope to provide valuable insights and recommendations that can enhance sericulture practices, increase silk production, and potentially strengthen the economic prospects of this industry in the region.

1.4 Objectives of the study

1.4.0 Main Objectives

To determine differential effects of castor (*Ricinus communis*) varieties on productivity of eri silkworm (*Samia cynthia ricini*, Boisduval; Lepidoptera: Saturniidae) silk at Thika, Kenya.

1.4.1 Specific Objectives

1. To determine preference of eri silkworms to different varieties of castor grown in Kenya.
2. To compare eri silkworms growth and development when fed on different castor leaf varieties.
3. To identify the castor type associated with the highest cocoon yield weight in Kenya.

1.5 Hypotheses

1. The number of worms that preferred each of the five types used did not significantly differ from one another.
2. There was significant difference in the growth and development of Eri silkworms when fed on different castor leaf varieties.
3. Castor varieties M3 and M4 were associated with the highest cocoon yield weight in Kenya.

1.6 Justification of the study

This study intended to investigate and understand the relationship between different varieties of castor plants and the productivity of Eri silkworm silk in a specific region, Thika, Kenya. Silk production can be a significant economic activity in many regions, contributing to the livelihoods of local communities. In Thika, Kenya, sericulture (silk production) may represent an important industry. Investigating factors that can enhance silk productivity, such as the choice of castor varieties, was essential for improving the economic prospects of the region. Castor plants are commonly used as a source of food for silkworms in sericulture. Different castor varieties may have varying nutritional profiles and growth characteristics. Understanding which castor varieties are most suitable for Eri silkworms can lead to more efficient and sustainable agricultural practices. Different regions may have unique environmental conditions, and certain castor varieties may be better suited to Thika's specific climate and soil. Identifying which varieties perform best in this particular region can help sericulturists make informed decisions about crop selection. The choice of castor varieties can also have ecological implications. Some varieties may require fewer inputs like pesticides or fertilizers, which can contribute to more environmentally friendly and sustainable sericulture practices. It's possible that there is limited existing research on the specific relationship between castor varieties and Eri silkworm productivity in the context of Thika, Kenya. This study aimed to fill that gap and provide valuable local insights. Ultimately, the research's findings can be used to enhance the sericulture industry in Thika. By identifying the most productive castor varieties, local sericulturists can optimize their practices, increase silk production, and potentially expand their market reach. This study can contribute to the broader scientific knowledge of sericulture and agriculture. It adds to the understanding of how different crop varieties can impact the

growth and productivity of a particular insect species, which has implications not only for silk production but also for the broader field of agricultural research. This study is justified by its potential to improve the economic prospects of Thika, enhance agricultural practices, and contribute to scientific knowledge, all of which can benefit the local sericulture.

1.7 Scope of the study

The study was conducted exclusively within the geographical boundaries of Thika, Kenya. It focused on the specific conditions and environmental factors present in this region, as they relate to the cultivation of castor plants and the rearing of Eri silkworms. The findings and conclusions of this study should be understood within the context of Thika which may not be directly applicable to other regions with differing climates, soil types, or agricultural practices. The study analyzes the impact of a selected set of castor (*Ricinus communis*) varieties on the productivity of Eri silkworms. The study's scope was limited to these specific castor varieties, and the effects of other castor varieties are not considered in this research. The research was primarily concerned with the Eri silkworm species, *Samia cynthia ricini*. Other silkworm species are beyond the scope of this study. The study was conducted under controlled laboratory conditions, allowing for precise data collection and comparison. Field conditions, which might introduce additional variables such as natural predators, were not part of the research scope. The study covers a defined time frame for data collection, typically from the start of the experiment to the completion of the experiments. Longer-term effects and seasonal variations were not comprehensively addressed within this time frame.

1.8 Study limitations and delimitations

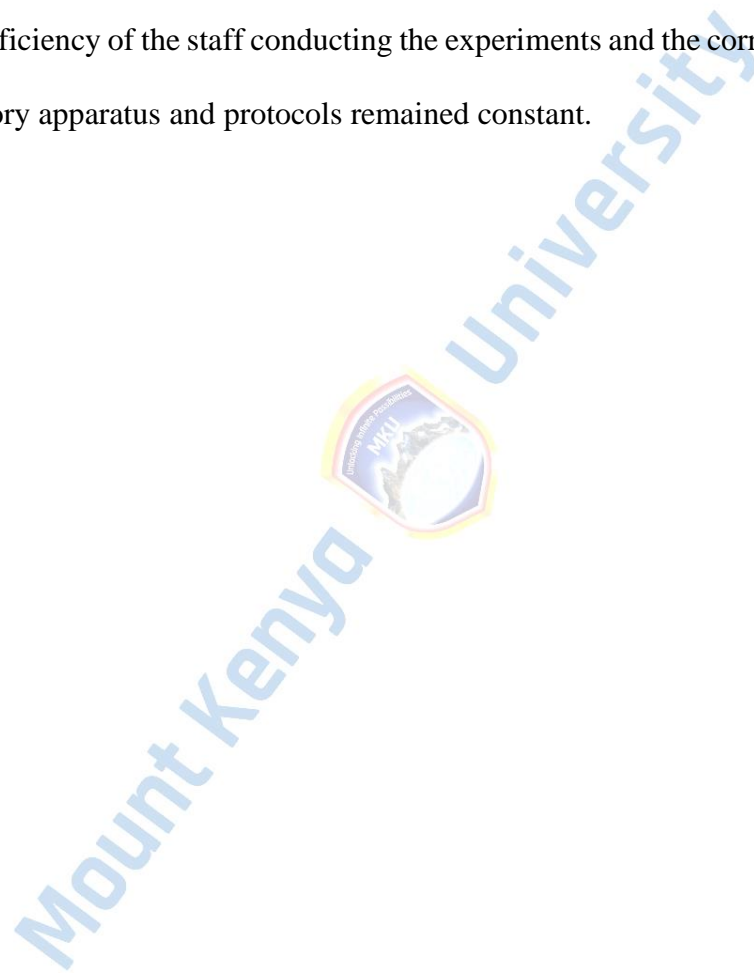
The local climate and seasonal variations in Thika, Kenya, may have an impact on the results. Weather conditions affected both the growth of castor plants and the development of Eri silkworms, which introduce variability into the study. The availability of specific Eri silkworm strains for experimentation would be limited. This limitation could affect the generalizability of findings to other Eri silkworm populations. Limited resources, such as funding, laboratory equipment, and time, would affect the scale and depth of the research. This could impact the number of castor varieties tested and the duration of the study. The implementation of the experimental conditions, would have introduce variability. The study was delimited to Thika, Kenya, and the findings may not be directly applicable to other regions with different environmental conditions or agricultural practices. The study focused on a specific set of castor (*Ricinus communis*) varieties. Varieties beyond this selection were not considered in this research. The research was limited to the Eri silkworm species (*Samia cynthia ricini*). Other silkworm species were not included in the study. The study covered a specific time frame for data collection. Seasonal changes or longer-term effects might not be fully addressed within this time frame. The research operated under controlled laboratory conditions. Field conditions, which might present additional variables, were not part of the study.

1.9 Assumptions of the study`

The study made the following assumptions;

- Thika, Kenya, had generally uniform environmental circumstances, including a constant soil composition, climate, and other environmental elements.
- Eri silkworm strains had a minimum amount of genetic diversity and a constant genetic makeup.

- The eri silkworms' feeding procedures and rearing environment, which included exposure to light, humidity, and temperature, were uniform and standardized.
- The study would not significantly alter Thika's cultural or agricultural traditions, nor the pressures of pests and diseases on Eri silkworms and castor plants.
- The chosen kinds of castor (*Ricinus communis*) were thought to have similar traits and nutritional values.
- The proficiency of the staff conducting the experiments and the correctness of the laboratory apparatus and protocols remained constant.



CHAPTER TWO

LITERATURE REVIEW

Ericulture is a distinct type of sericulture that involves plants used in agriculture, horticulture, and forestry. The polyphagous Eri silkworm, *Samia cynthia ricini* consumes more than thirty different kinds of host plants. Not all food plants are created equal for eri silkworms raising, and it exhibits various behaviors based on the type of food plant used. It has been discovered that certain species are more suited for commercial sericulture, including castor (*Ricinus communis*), borkessaru (*Ailanthus excelsa*), cassava (*Manihot utilissima* and *Manihot esculenta*), and payam (*Evodia flaxinifolia*) (Ravi Kumara, 2023). In Kenya, the sericulture sector is growing in popularity, particularly in arid areas where it employs a sizable portion of the population. Researchers and sericulturists who study the growth, development, and fiber production of eri worms have long been drawn to the worms' economic and financial entomology. The majority of research focuses on the interaction between plants and insects, according to (Lorhit, 2000). Well-being, progress, and the presence of silk's qualitative and quantitative characteristics have all been impacted by the primary crop's biochemical characteristics and evaluation (Pallavi and Shantappa, 2018). The following summarizes the literature on the effects of different castor varieties on the productivity of eri silkworms in producing silk

2.1 Empirical literature

2.1.1 Impact of Castor Varieties upon the Performance of Eri Worms

Study done by (Neupane *et al.*, 1990) showed 6 generations of *Samiacynthia ricini* per annum on castor (*Ricinus communis*) in the research laboratory. During March-September raising the lifespan stayed for 38-50 days, 114-126 days throughout November-April and 49-61 days for the period of September-November. The average

mass of fully developed worms, sheaths, chrysalises and shells were 5.25, 3.76, 3.08 and 0.610 grams, respectively. The period of during July-August had related results which were achieved after utilizing cassava for nourishment, but the results indicated lesser masses of the worms, cases, chrysalises and shells.

A study on eri silkworm growth and economic traits as influenced by the exchange of castor with other food sources showed that eri worm raised entirely on castor demonstrated dominancy on seed, cases and larval traits followed by the larvae raised on castor up to the fourth instar and finally Tapioca leaves up to the fifth instar (Govindan *et al.*, 1992).

In an experiment done by (Kumar *et al.*, 1993) explained how the foliage of kesseru followed castor in relations to case reaping as well as other commercial characters. The experiment of (Hazarika, 1996) on the preference of local and high yielding selection of castor for eri worm showed minimal consumption of Powdery and Red petiole with low moisture and C: N ratio. On Red petiole quantity of food consumed was positively related to the weight of matured worms. According to (Sannappa, 1997), eri worms presented inconsistency in performance regarding the worms, case, and grainage characters after utilizing the various castor cultivars for feeding, dominance on Aruna and 8- RC varieties, PCS-121 and SL-1 achieved the minimum.

(Basaiah *et al.*, 1997) in their experiment noted extremely low sericin content on RC-8 (32.58 mg/g shell) whereas Aruna (31.06 mg/g shell) and was maximum on tapioca (63.45 mg/g shell).

The experiment done by (Sarmah *et al.*, 2015) regarding the behavior of eri worms nourished using dissimilar castor varieties at Karnataka conditions and revealed that among the twenty four varieties RG-323 portrayed considerably maximum mass of the chrysalises, shell, case, shell fraction, worms as well as egg laying ensue SKI-80. Further

more, RG-34, RG-201, RG-363 RG-356, RG-828, RG-501, RG-359 and RG-202 showed better progression and advancement, case produce as well as better egg production compared to Aruna, a popular selection in Karnataka, while, RG-135 showed minimal economic characteristics as well as low rate of egg production. In order to increase economic characteristics RG323 was highly recommended. Impact of castor varieties as far as raising dissimilar eri worms is concerned have also been considered by (Jayaramaiah and Sannapa, 1998) where in their discovery the worms nourished on RC-8 took considerably extensive larval duration, moulting and feeding followed closely by larvae nourished on Aruna variety. Nevertheless, Aruna portrayed the highest survivability, mean larval mass and effective rate of rearing. Amongst the strains White zebra showed extensive larval duration, feeding and moulting while the whole fresh and dry weight of the worms and ERR was greater in White-plain. (Sharma *et al.*, 1996) investigated the influence among the three different food plants that is, kesseru, castor as well as Borpat on definite lifetime factors of eri worms *Philasamia ricini* Hutt. and noted castor nourishing had higher rate of egg laying and longer adult life of eri larvae. For the duration of spring and autumn weight of the shell and its ratio also improved. Nourishment during summer on Borpat raised both shell mass and fraction. The foodstuffs had no variation in respect of the worms weight, maturation period, pupation, incubation time, growth index, and egg hatchability of eri worms.

A study done by (Sannappa, 1997) similarly observed difference in chrysalises period amongst castor varieties. The chrysalises period was shorter (thirteen days) in both RC-8 and Aruna compared to extensive period of sixteen days on PCS-121 and SL-1 varieties. Greater developed worm mass (72.89 g/10 worms), was shown by white semi zebra nourished on foliage of native (non- bloomy green petiolated) variety of castor whereas white - pure strain fed on native type registered minimal worms period (23.01

days), greater case mass(3.12g), chrysalis mass(2.69g), shell mass (0.326g), ERR (94.2%) as well as fecundity (360.7 eggs/laying). Combination of blue plain and aruna gave more shell ratio (11.20%), whereas, white- plain and local had more rate of moth emergence and egg hatching (97.72%)), though the above factors existed as minimal compared to plain white and Aruna.

(Neelu *et al.*, 2000) did an experiment on the volumetric attributes of eri silkworms on different food plants where castor portrayed the shortest larval duration of 26 days. The experiment done by (Jayaramaiah and Sannappa, 2000a) revealed that eri larvae nurtured on RC-8 and Aruna castor cultivars recorded maximum weight of larvae ERR and larval survival which were lesser on castor variety PCS-121. (Patil *et al.*, 2000) testified that the castor selections RG-323 showed the utmost mass of the worms, case, chrysalises, shell, shell fraction and egg laying rate above compared to other castor varieties. Minimal economic characters were portrayed by RG-135. The total larval and pupa period as well as emergence of moth egg hatching were not affected by the castor varieties.

The study done by (Govindan *et al.*, 2002b) showed that worms nourished on plants of DCH- 177 castor variety nurtured as per endorsed practices resulted to considerably greater fully developed worm mass (8.53 g), worm existence (97.58%), case mass (2.99 g), shell mass (0376 g), fraction of the shell(12.76%), ERR (94.75%),protein fiber output (5.499 cg/day), chrysalises mass (2.61 g), degree at which chrysalis forms (98.50%), egg hatching (98.67%) and egg laying rate (353.77 egg/laying) with minimum larval period (24.08 days) and chrysalis period (12.00 days).

(Jayaramaiah and Sannappa, 2002) did an evaluation of twelve castor genotypes, among them, Aruna and RC-8 resulted to an yield of ERR 91.05 and 92.67 per cent, case harvest of 58.15 and 60.15 kg per 100 DFLs as well as protein fiber alteration level of 1.832 and 1.801 per cent. The case harvest (9.048 kg per 100 DFLs), protein fiber output

(6.544 cg/day), protein fiber index (1.357), sericin content (28.99%), oviposition index (1.144), multiplicative control (4.41%) and fibroin substance (68.49%) showed greatness on Aruna variety ensue RC-8 (9.102 kg, 6.579 cg, 1.441, 68.32%, 28.20%, -14.20% and 1.142, respectively). Nevertheless, Local variety gave higher rate of leaf cocoon conversion (12.30%).

The study done by (Govindan *et al.*, 2002b) showed that eri worms raised on Local green non powdery vegetation resulted to a minimum larval period of (21.33 days) and longer period of 22.44 days for DCH-32 crossbreed. Nevertheless, DCH-177 hybrid showed greater fully developed larval mass (86.42 g/ 10), case harvest (84.74 kg/ 100 DFLs), ERR (96.75%) with fewer worms death (2.43%). These factors were lesser in regard to Local green powdery selection (67.45 g, 88.50%, 59.94 kg and 9.020%, respectively) with an exception of local pink powdery variety shell harvest which was less (6.63 kg). (Sarmah *et al.*, 2002) announced similar comments where in the assessment of certain castor varieties for eri chawki silkworm performance the native red (non- powdery) variety of castor showed the greatest performance amongst ten designated varieties of castor regarding to main commercial behaviors putting into consideration bioassay of eri worms. Other factors were also considered which includes, maximum worm mass, shell mass, protein fiber fraction, ERR, and egg laying, percentage of emergence of young ones.

(Pandey, 2003) recorded greater case ratio (16.88%), adult development (82.25%), ERR (88.95%), egg laying (413 egg/laying) as well as hatching of eggs (86.50%) in his experiment of feeding juicy, nutritious and excellence leaves of castor (red non- bloomy) with fundamental favorable abiotic settings for the period of raising eri worms.

The study done by (Govindan *et al.*, 2003a) reported noteworthy dissimilarities amongst castor varieties in respect to case, egg as well as shell harvest, greater being in DCH-177

(84.74, 11.59 kg/100 DFLs as well as 354.77 egg / laying). Nourishing on foliage of crossbreed DCH-177 gave maximum case mass (30.75g/10), silk output 6.499 cg/day), egg laying (354.76 egg/ laying) chrysalis mass (25.99g/10), percentage of chrysalis development (99.00%), fibroin (70.38%), hatching (99.67%) fewer sericin emission (29.49%) as well as chrysalis period (13.67 days). Nevertheless, the above characters existed to be lesser as far as local green powdery variety was concerned apart from case mass, protein fiber yield as well as fibroin which remained minimum for Native pink dusty variety (Ramakrishna *et al.*, 2003).

Experiment of (Mahobia *et al.*, 2005) showed case harvest for eri worms ranging in between 50.79 to 64.45 kg averaging at 57.02 kg / hundred DFLs being considerably extraordinary and revealed worthiness of raising eri worms in Chhattisgarh.

(Sannappa *et al.*, 2007) observed noticeable deviation in worms growing as well as enlargement, grainage and case factors after nourishing eri worms on vegetation of diverse varieties of castor grown in rainy regions. Extensive entire worms period as well as extreme developed larval heaviness were noted in worms nurtured on Aruna (23.20 days and 67.98 g/10) and RC-8 (23.20 days and 64.53 g/10) castor varieties, greater shell mass (0.438 and 0.434 g) as well as egg laying rate (347.67 and 344.00 eggs/laying) were as well noted. Larvae nourished on RC-8 genotype portrayed minimal cocoon mass (2.328 g), chrysalis mass (1.993 g) and also hatchability of eggs (99.92%). whereas the case fraction was greater in cases made by worms nourished by Aruna cultivar (15.82%). The study of (Sannappa *et al.*, 2007) testified how eri worm's silk making has been influenced by the quantity of feedstuff delivered during the feeding of the worms, the proportion of food given as well as the amount of foliage the worms utilises. The effect is portrayed by the developmental level as well as duration, mass of the body, strength of protein fiber emission, moth appearance, copulation as well as rate of regeneration.

(Kedir *et al.*, 2014) observed that amongst the castor cultivars served to eri-silkworm, Abaro nourished larvae presented fully developed worms mass(8.27 g), ERR (74.78%), existence level (77.08%), case mass (3.44 g), chrysalis mass (2.96 g), protein fiber fraction (14.59%), potency (383.00 eggs/female), emergence of young ones (89.17%) as well as shorter worms period of development (585.17h).

(Lakshmi *et al.*, 2014) did an experiment to investigate the promising castor variety for eri silkworm rearing and found that among the seven castor cultivars evaluated PCH-111 variety recorded the highest leaf consumption during IV to V and higher nutrition consumption Harith (1125.5g), PCH 222 (1231.0g) as well as GCH-4 (1159.5g) in course of the worms growing season.

(Rajasri and lakshmi, 2015) evaluated different castor genotypes to identify the variety that is most suitable for rearing eri silkworm larvae and reported the castor genotypes PCH-111, PCS-262 and GCH-4 as favorable for larvae nurturing and cocoon traits of eri worm. PCH-111 portrayed maximum records of mature larvae weight (1.85g), cocoon mass (2.02g), pupal heaviness (1.62g), shell mass(0.45g), silk fraction (22.27%) and shorter larval period of 19 days.

Based on the rearing and grainage parameters of four eri silkworm breeds (White-Plain, Blue-Plain, White Zebra, and White Semi-Zebra), studies were done by (Naik *et al.*, 2003) to identify the best castor cultivar between Aruna and Local cultivars for feeding the worms. The highest mature larval weight (72.88 g/10 larvae) was recorded by the Eri silkworm breed White semi-Zebra, which was fed local castor leaves (with non-bloomy green petioles). The White-Plain breed raised locally had the shortest larval duration (923.2 days), highest effective rearing rate (93.2%), and the lightest cocoon weight (3.02 g), shell weight (0.326 g), pupal weight (2.69 g), as well as the highest fecundity (361.7 eggs per laying). While the moth emergence (i.e. egg hatching) percentage was higher

with the Local x White-Plain (99.31%) and Local x White Semi-Zebra breeds (99.31%), the combination Aruna x Blue-Plain (11.20%) had the highest shell ratio.

A study done by (Neupane *et al.*, 1990) reported case mass of 0.18 to 0.55 when the worms were nourished on castor varieties. (Kumar *et al.*, 1993) showed greater shell fraction ranging from 12.65 per cent to 16.44 per cent on diverse castor cultivars. The raising of the worms is largely influenced by kind of hosts and castor variety available. Various degree of case mass of 3.47g, 2.64 g, 3.10 g, 2.51 g, 2.60 g, 2.12 g, and 2.99 g portrayed by various varieties of castor were recorded by (Kumar *et al.*, 1993).

(Sannappa *et al.*, 1999) observed that various castor varieties which includes PCS-121, SL-1, Aruna, DCS-72, local, as well as RC-8 recorded case mass of 1.79 g, 2.13 g, 1.89g, 2.24 g, 1.86g and 1.82 g, respectively. Case mass obtained from worms nurtured on various castor types for instance, SL-1, Local, Aruna, DCS-72, PCS-121 and RC-8, measuring 0.22 g, 0.24 g, 0.34 g, 0.23 g, 0.25 g, 0.34 g, and respectively was noted by (Sannappa and Jayaramaiah, 1999a). According to (Teotia *et al.*, 2003) 7,200 commercial farmers can produce 271.6 MT eri cocoon shells yielding eight to nine kg for every 100 DFLs in the states of Assam, Nagaland and Meghalaya.

(Chandrashekhar, 2007) noted that castor varieties had a great impact on case mass maximum being in DCS-85 (28.78 g) closely followed by Local (28.63 g), DCH- 177 (27.65 g) and Kranti (26.59 g). The genotypes DCS-9 (25.85 g), 48-1 (25.61g), DCH-32 (24.77g) and GCH-4 (24.50 g) were found next in the rank. The researcher observed statistical variations amongst the castor varieties with respect to cocoon production per worms. Highest cocoon yield was recorded in DCS-85 (250.5 g/100worms) together with Local (246.4 g). However, cocoon yield was lowest with GCH-4 (200.1 g). Significantly higher cocoon yield was registered on DCS-85 genotype (75.14 kg/100DFLs) followed by Local (73.92 kg), DCH-177 (69.21 kg), Kranti (68.53 kg), DCS-9 (64.85 kg), 48-1

(63.99 kg) and DCH-32 (61.17 kg). However, cocoon yield was less with GCH-4 (60.02 kg). (Pallavi and Sannappa, 2018) investigated the commercial traits of eri silkworm eco-races reared on castor cultivars i.e Local pink and DCH-177. The local pink portrayed the highest larval weight, weight of cocoon, cocoon yield, shell weight and silk productivity.

(Swathiga *et al.*, 2019) did an experiment and found that when eri silkworms were raised on leaves with varying genotypes of castor, the larval weight varied significantly among the eco races. When eco races of eri silkworms were raised on the leaves of GCH 4, the resultant mature larval weight was higher (8.55 g), followed by DCH 519 (8.39 g) and the local castor variety (8.24 g). The lowest weight was observed in TMV 5 (7.78 g), on the contrary TMV 5 had the longest larval duration (26.14 days), followed by GCH 7 (26.07) and local variety (26.0 days). The lowest larval duration was recorded on GCH 4 (25.60 days), followed by DCH 519 (25.79 days). Between castor genotypes, cocoon weight varied significantly, GCH 4 had the highest weight (3.44 g), while DCH 519 had the next-best weight (3.34 g). There was a significant variation in shell weight between the castor genotypes; GCH 4 had the highest shell weight (0.46 g), followed by DCH 519 (0.42 g), local (0.38 g), and GCH 7 (0.36 g). When eco races of eri silkworm were raised on the leaves of GCH 4 (13.49%), it was found that the shell ratio was significantly higher. This was followed by DCH 519 (12.45 %), Local (11.81 %), and GCH 7 (11.40 %). TMV 5 (10.83 %) had the lowest shell ratio. ERR was highly impacted by the castor genotypes; in GCH 4, the maximum was 91.57%, which was comparable to 90.72 % in DCH 519 and 90.42 % in local variety.

According to (Dereje *et al.*, 2022) the silkworms' growth and development, and ultimately the economic characteristics of the cocoons, are significantly influenced by the quality of their diet. Ten genotypes of castors (*Ricinus communis* L.) were assessed

in the experiment and it was found that, the rearing performance of eri-silkworms fed on leaves of the 200390 genotype showed a shorter larval period (22 days), a higher effective rearing rate (94.54%), and a shorter life cycle (58 days). On the other hand, the Abaro genotype produced larvae with a higher recorded weight (6.16 g). Nonetheless, it was discovered that Eri-silkworms fed on leaves of genotype 219645 had higher cocoon weight (3.26 g), pupal weight (2.46 g), shell weight (0.45 g), and silk ratio (13.8 g). Thus, genotype 219645 demonstrated comparatively better results in silkworm rearing.

(According to Vaishali *et al.*, 2019) on the rearing performance of *Samia ricini* (Donovan), on a variety of hosts, including castor, tapioca, arduso, banyan tree, and Indian almond, the latter had the lowest larval duration (22.57 days), disease incidence (8.50%), incubation period (8.06 days), and duration of life cycle (54.43 days), while the castor showed the highest larval weight (7.65g), larval survivability (94.0%), effective rate of rearing (89.40%), cocoon weight (3.49g), cocoon shell weight (0.42g), shell ratio (11.90%), moth emergence (92.81%), fecundity (348.17 eggs/female), hatching percentage (99.59%), and female and male longevity (9.02 and 7.01 days, respectively.)

2.2 Theoretical literature

A possible explanation for the varying impacts of different castor varieties on the productivity of eri silkworms is the nutritional makeup of the leaves. For the growth and development of eri silkworms, castor leaves are an excellent source of protein, essential amino acids, and other nutrients. The observed variations in eri silkworm productivity may be explained by variations in the nutritional composition of different castor varieties. The castor leaves' physical attributes could also be relevant. For instance, the leaves of some castor varieties may be thicker or larger than those of others. This may have an impact on the ease with which eri silkworms can consume the leaves as well as the leaves' nutritional value. Ultimately other factors might also be involved in the different ways

that different castor varieties affect the productivity of eri silkworms. One such factor could be the presence of secondary metabolites in castor leaves. In order to feed the eri silkworm to put forth its best growth and development in order to realize higher cocoon and egg production, several studies have been conducted to determine the nutritional status of various castor genotypes. (Chandrashekhar *et al.*, 2013) conducted an experiment regarding the biochemical components of leaves, there were notable differences between the genotypes of castor. Leaf moisture content was higher with DCS-85 (71.15%) and lower with 48-1 (63.45%), while the highest concentrations of chlorophyll 'a', 'b', and total chlorophyll were found in 48-1 (2.965, 1.156, and 4.115 mg/g). Conversely, the major foliar nutrient status of castor genotypes, namely nitrogen, phosphorus, and potassium, were higher with Local (5.529, 0.396, and 4.002%), while these were lower with GCH-4 (2.156%), DCH-177 (0.125%), and 48-1 (1.946%), respectively. Crude protein and total carbohydrates were higher with Local genotype (34.56 and 53.61%) and lower with GCH-4 (13.48 and 32.96%). In a similar vein, secondary nutrients such as calcium and sulfur were found to be higher in individuals with the Local genotype (6.716 and 0.491%), whereas DCH-177 (2.111%) showed higher levels of magnesium. But while DCH-177 recorded higher sulfur levels (0.109%), GCH-4 recorded lower levels of calcium (3.010%) and magnesium (1.375%).

According to (Sarmah, 2011) in the analysis, GCH 4 (4.031%) had the highest nitrogen level with DCH 519 (3.947%) coming in second, Local variety (3.230%), and GCH 7 (2.903%) trailing behind. According to the estimate, the amount of leaf phosphorus content was on par with GCH 7 (0.152 %), peaking in GCH 4 (0.273 %) and falling in TMV 5 (0.136 %). All of the genotypes showed substantial variation in potassium content, with the DCH 519 castor genotype having the highest level at 2.732 percent. This was followed by GCH 4 (2.512%) and local variety (2.001%). Nonetheless, the

TMV 5 genotype had a lower potassium content (1.527%). There was variation in the magnesium content of the leaves between the various genotypes of castor. The genotype GCH 4 recorded the highest magnesium content at 2.117 percent, which was followed by DCH-519 and local variety at 1.813%. The TMV 5 genotype had the lowest magnesium content, measuring 1.523%. At 0.643 percent, the genotype GCH 4 recorded the highest sulphur content, comparable to that of genotype DCH 519 (0.619 percent), while genotype TMV 5 recorded the lowest sulphur content at 0.299 percent. (Kedir *et al.*, 2016) found that the diets that silkworms eat have a significant impact on their ability to reproduce, grow, and yield. They stated that minerals are among the vital biochemical components of leaves and may have a significant impact on silkworm productivity. The study found that Abaro was the genotype of castor that was found to be better than the others when it came to the indicators of silkworm rearing performance, which included 8.17 g of mature larval weight, 3.344 g of cocoon weight, 2.860 g of pupal weight, 0.484 g of shell weight, and 14.487 % silk ratio, 74.68% effective rate of rearing (ERR), 76.079 % survival rate, 382.00 eggs as fecundity, and 88.17% worth of egg hatchability. Among the foliar minerals, it was discovered to contain 4.125% nitrogen, 2.30% PPM phosphorus, 6874.5 PPM potassium, 102.033 PPM calcium, and 13.467 PPM magnesium. Furthermore, there was a strong positive correlation found between the mineral constituents of castor genotypes and the rearing performance of eri silkworms, specifically with regard to the nitrogen and phosphorus contents and the drainage, cocoon, and larval parameters of the worms. The study recommended that when castor leaves are used as feed sources, the amounts of nitrogen and phosphorus in the leaves should determine the gains on key eri silkworm parameters.

Different castor accessions' leaf biochemical compositions had an impact on the eri silkworm's ERR. The nitrogen and crude protein content of the foliage had a major

impact on the weight of the larvae and cocoons. Overall, it was discovered that the Ac03 and Ac04 castor genotypes performed better when it came to agronomical and yield-related features as well as silkworm rearing (Sarmah, 2011).

(Mahesh *et al*, 2022) did an experiment to determine which cultivar of castor (*Ricinus communis*) would be best suited for commercial chawki, or the rearing of young silkworms, in order to produce eri silkworms (*Samia ricini* D). A standard package of procedures was followed to determine which of the five commercially available cultivars of castor—NBR-1, Kalpi-6, DCH-519, ICH-66, and DCS was the most economically viable in terms of yield parameters and plant growth. The cultivars were sown in the field. In terms of plant height, number of leaves per plant and leaf yield at different days after sowing, the results showed that all five cultivars had differing degrees of growth and yield parameters. Two cultivars (Kalpi-6 and NBR-1) showed the highest growth and yield parameters of all the cultivars. Additionally, NBR-1 and Kalpi-6 were chosen as cultivars for biochemical constituent analysis. NBR-1 exhibited higher levels of moisture retention (82.65%), protein content (20.60%), carbohydrate content (17.12%), and other leaf quality parameters that are critical for eri young silkworms (chawki). The eri-silkworms fed on NBR-1 and Kalpi-6 castor cultivars showed greater larval weight and more homogeneity, respectively, of the two cultivars of castor. According to the results, the NBR-1 cultivar was suitable for raising young silkworms and for growth, yield, and biochemical constituents. As a result, NBR-1 was suggested for commercial eri chawki rearing due to its superior ability to improve eri chawki rearing performance and its higher leaf yield obtained at various points throughout the year. A study conducted by (Micheal *et al*., 2021) examined the effects of various host plants on the eri silkworm, *Samia cynthia ricini*. The results showed that the castor YTP 1 variety had high levels of moisture content, protein, and total carbohydrates (70.83%, 24.92%, and 39.35%%,

respectively), which were linked to its superior economic traits, which included a 3.85 g cocoon yield and a 17.43% silk percentage.

The effects of eight different castor genotypes on eri silkworms (*Samia cynthia ricini* B.) Abarro, Acc 106584, Acc 203241, Acc 208624, Ar sel, Bako, GK sel, and local genotype were evaluated by (Kedir et al., 2016). When it comes to silkworm rearing performance metrics, the castor genotype known as Abaro showed the best results. Along with 74.68% effective rate of rearing (ERR), 76.079 % survival rate, 382.00 eggs as fecundity, and 88.17% hatchability of eggs, these included 8.17 g of matured larvae weight, 3.344 g of cocoon weight, 2.860 g of pupal weight, 0.484 g of shell weight, and 14.487 % silk ratio. According to (Dasari Prasanna, 2013) there were noticeable differences in the length of time that larvae spend in each treatment, in all five instars, and over the course of three seasons. The silkworms fed the local castor variety and DCH-519 had shorter larval durations (21.51 days and 22.17 days), while the silkworms fed the DCS-9, 48-1, and DCH-177 castor genotypes had longer larval durations (24.19, 23.08, and 22.96 days). The winter season recorded a longer larval duration of 27.49 days, while the summer season recorded a shorter larval duration of 19.82 days. Over the course of three seasons, significant differences in mature larval weight were observed with five different castor genotypes. When fed local and DCH-519 castor varieties, larvae reached 69.67 and 69.18 gms/10 larvae of mature larval weight; lower weight (65.61, 66.02, and 67.57 gms/10 larvae) was observed with DCS-9, 48-1, and DCH-177 castor genotypes. During the winter, the mature larval weight was high (74.77gms/10 larvae), while during the summer, it was low (60.55gms/10 larvae).

With the five distinct castor genotypes, notable variations in mature larval weight were noted over the course of three seasons. Larvae fed local and DCH-519 castor varieties reached mature larval weights of 69.67 and 69.18 gm. /10; larvae genotypes DCS-9, 48-

1, and DCH-177 showed lower weights of 65.61, 66.02, and 67.57 gm./10. The mature larval weight was low (60.55gms/10 larvae) in the summer and high (74.77gms/10 larvae) in the winter. During the winter, cocoons could weigh up to 2.52 gm. /each in the summer and rainy seasons; they could weigh up to 2.41 gm. /each. The weight of each shell was 0.35 grams, 0.36 grams, and 0.32 grams in the summer, winter, and rainy seasons. The shell ratio was found to be lower (14.10%) in the summer and higher (14.67%) in the rainy season. Castor genotypes were observed to cause significant variation in eri worms over the course of three seasons. ERR values for local, DCS-9, 48-1, DCH-177, DCH-519, and other castor genotypes were 93.5 percent, 89.5 percent, 89.5 percent, 85.2 percent, and 92.06%, respectively. When DCH-519 and local worm food were provided, ERR was 92.27%, 91.17%, and 87.80% in the summer, winter, and rainy seasons, respectively. Significant differences in grainage parameters were observed across all genotypes of castor during the course of three seasons. DCS-9, 48-1, and DCH-177 were not as good as the worms fed DCH-519 and local castor. When provided with local, DCS-9, 48-1, DCH-177, and DCH-519 castor genotypes, larvae passed 13.89, 14.67, 14.44, 14.11, and 14.00 days during the pupa stage. Winter observed a longer pupa period (19.40 days), while summer observed a shorter pupa period (10.80 days). Over the course of three seasons, pupa weight varied significantly across all genotypes. Local and DCH-519 produced pups that weighed 2.26 and 2.15 grams each, respectively, while DCS-9 produced pups that weighed 1.86 grams each. Due to their longer growth period, pupae gained greater weight (2.16 gm. /each) during the winter and less weight (1.92 gm. /each) during the summer. Moth emergence was found to be higher (97.28%) in the winter than in the summer and rainy seasons (97.21% and 96.37%), with the highest (98.04%) occurring with DCH-519 and the lowest (96.00%) with local castor. The worms fed with different genotypes of castor showed significant differences in average fecundity

and hatchability. Average fecundity was higher (365.53 and 356.78 eggs), maximum hatchability was higher (99.17% and 99.14%), and lower (340.56 eggs) with DCS-9. Season had little effect as the rainy season produced 350.73 eggs (98.96%), which was comparable to the summer season's 350.07 eggs (98.89%) (Dasari Prasanna, 2013).

2.3 Conceptual literature

2.3.1 Effects of defoliation on castor seed production

Castor is quite economical when grown both for ericulture and seed production. The utility of ericulture is the high performance of castor leaves being converted into silk and the remaining foliage helping to form castor seed for additional revenue.

The economic characteristics and growth of eri worms on castor and three other foods were studied by (Govindan et al., 1992). Castor showed superiority in the worms' larval, cocoon, and seed technological behaviors when compared to tapioca (*Manihot utilissima*), gulancha (*Plumeria alba*), and barkesseru (*Ailanthus excels*).

According to (Misra,2001), Castor for eri cocoon production generated a net profit of Rs.5, 406 per ha compared to Rs.2, 345 with sole production of castor seed. The return per rupee invested was also found to be highly encouraging over sole castor seed production (Rs.1.16). Aruna variety gave higher leaf biomass which afforded viable revenue on partitioning it for cocoon as well as bean production. While the unpartitioned leaf biomass fetched a net profit of 16 per cent from exclusive bean for oil industry, the partitioned leaf role additionally accommodated eri silkworm for cocoon yield on integrated 34 per cent net profit. The castor leaf available in the country from the total area under castor (8.0 lakh ha)(a hundred thousand hectares) for rearing of eri silkworm without affecting the seed yield was estimated to be 1,38,310 MT creating an opportunity to produce 41,43,900 kg of eri cocoon shell yield with an income potential of Rs.8,288 lakhs (Sannappa *et al.*, 2002).

According to (Govindan *et al.*, 2002a) a significant statistical variation on seed yield was recorded among the castor genotypes. SHB-649 genotype recorded 742 kg/ha ensue JHB-876 634kg whereas SKI-217 genotype documented minimal harvest of 314kg. The twin advantages of castor crop viz., leaves for rearing eri silkworm and seeds for industrial use, suggested that 25 per cent of leaf harvest on castor seems to be economically viable. GCH (castor variety) documented maximum germ harvest with better progress as well as produce aspects, whereas utmost foliage biomass existed on indigenous inflamed no powdery (282.33 g/ houseplant/yard) ensue indigenous green variety (236.89 gm.) (Sarmah *et al.*, 2002).

Findings of (Govindan *et al.*, 2002c) revealed that germ harvest in castor had diverse variation in regard to the dissimilar periods of propagating. Considerably greater germ harvest existed in 5th July propagation (506.68kg/hac), which was lesser in 30th July dispersal (508.12 kg/hac). The germ produce acquired after yielding castor vegetation intended for feeding eri worms, stood at maximum in DCH-177 crossbreed under commended set of practices in Bangalore (531.61kg/hac), whereas minimal was witnessed for indigenous pink selection at Chitradurga site (367.69kg) (Govindan *et al.*, 2002d).

Statistical differences were shown when different varieties were combined through which DCS-9 variety gave the highest germ harvest (594.1 0kg) ensue GCH-4 (590.44kg) as well as DCH-177 (586.85kg) with 5th July seeding alongside DCH-177 (591.55kg) and DCS-9 (570.95kg) (Sannappa *et al.*, 2002).

(Govindan *et al.*, 2002c) noted variation of castor genotypes in seed yield, DCS-9 variety portrayed the highest yield 594.10kg followed by GCH (590.44kg) and DCH-177 (586.95kg) with July sowing. In August sowing DCH-177 gave (590.55kg) and DCS-9 with (571.95kg). The hybrid castor, DCR-177 under recommended practice of

cultivation at Bangalore (Rs. 14,704) recorded a higher total cost of castor production and eri silkworm rearing alone at Chintamani (Rs. 14,604), Malavalli (Rs.14,344), Magadi (Rs. 14,208) and Chitradurga (Rs. 14,112) locations. The combined revenue from bean production and cocoon shell yield was found to be higher with DCH-177 crossbreed with endorsed agricultural practices at Bangalore (Rs.31, 282). However, benefit-cost ratio was found to be more with DCH-177 crossbreed under recommended cultivation practices (1.127) under Bangalore condition (Govindan *et al.*, 2002d).

It is a proven possibility that 400-600 DFL's per ha can be raised in 2-4 nurturing seasons with returns of 9200/ha of castor cultivation (Krishna Rao, 2003). He observed that reaping castor leaves up to 25 to 40 per cent did not have any effect on seed production with the possibility of raising 401-601 DFLs per hac in 2-4 raising periods. Therefore enabling the agriculturalist yielding up four raising yearly giving attractive earnings (Rs. 9,200 per ha) castor farming during rainy seasons.

(Raghavaiah, 2003) noted endurance of castor plant on defoliation of up to 25-30 percent with no negative impact on seed production paving the way for double gains of agriculturalists in arid and semi-arid areas of tropical lands. (Pandey, 2003) reported that the fixed cost of eri rearing amounted for Rs. 10,255, while the variable costs @ Rs. 481 per crop would amount to Rs. 1444. Hence, net additional income from ericulture in the first year was Rs. 3001, which increased to Rs.13, 256 from second year onwards. This income is in addition to Rs. 21,000 per acre from traditional crops of castor.

(Chandrappa, 2003) urged that castor genotype 11-226 can be raised both for seed production and ericulture (@ 25% defoliation) from which greater unsophisticated profit (Rs. 38,379/ha) and after deductions revenue of (Rs. 27,179/ha) and B: C fraction (2.496:1) were realized with DCS-85 variety (Rs. 39,362, Rs. 27,806 and 2.320:1 respectively).

(Raghavaiah, 2003) noted no adverse effect on castor seed yield under rain fed conditions with defoliation of up to 25-30% which indicated dual gains for higher revenue and hence higher standard of living for eri rearing farmers in dry lands and semi-arid tropical regions. According to (Jadhar et al., 2004) the yield of castor seed was highest 1780kg/ha compared to 255kg/ha, under rain fed conditions. Jayaraj (2004), reported that detachment of around 26-40% of castor leaves to be used for feeding eri silkworm have no effect to oil germ production.

(Jadhar *et al.*, 2004) observed that the average harvest of castor seed was 265 kg/hac, which raised returns of (Rs. 4080) under rainy seasons, whereas beneath wetted conditions the harvest per hectare gave 1780 kg fetching Rs.25, 000. The investigation also noted that rearing of eri silkworm on one hectare of castor provides an additional income of Rs. 7,200-12,420 through sale of cocoons. With judicious plucking of castor leaves (25% leaf is about 500 g/plant) two to three rearing of eri silkworm per year as well as harvest of oil seed can be taken up simultaneously. Besides, tasar rearers could be encouraged to take up castor plantation in and around their tasar plantation as intercrop during the gestation period. Thus, ericulture enjoys big potential in Orissa state and can be popularized among rural masses as a subsidiary.

(Hazarika, 2005) noted direct relationship of quality of silk upon rearing technology, season, silk breeds and quality of food. (Dutta and Khonikor, 2005) in their experiment on food plant substitution during rearing of eri worms noted recommendable performance on castor in all seasons in comparisons to combinations with other food plants.

According to (Chandrashekhar, 2007) castor varieties grown in rainy situations varied significantly as per leaf yield (@ 50% defoliation at 90 days after sowing. Higher leaf yield of 2.049 kg/5 plants and 9837 kg/ha was recorded in DCS-85 genotype closely

followed by 48-1 (1.880 and 9026 kg). However, Local genotype recorded significantly lowest yield of 1.511 and 7252 kg, respectively. He further observed significant variation among the castor genotypes with respect to seed yield when plants were defoliated to the extent of 50% at 90 days after sowing. Seed yield was higher with DCS-85 (0.393 kg/5 plants and 1885 kg/ha) followed by 48-1 (0.275 and 1322 kg), DCH-32 (0.247 and 1187 kg), DCS-9 (0.243 and 1167 kg) and DCH-177 (0.233 and 1119 kg). Seed yield was significantly lowest in Local castor genotype (0.213 and 1023 kg).

(Kedir, 2011), in his study evaluated the significance of castor cultivars source of food for eri worms and witnessed that varieties exhibited considerably extensive deviation in their qualitative and quantitative traits. (Sarmah, 2011) studied existence of dissimilar castor selections grown in agro-climatic environments of Northeastern India. He further clarified that besides NRB-1 which is a non-bloomy red variety of castor other varieties with greater production of oil include, DCH-177, Aruna, GCH-5, GCH-4, DCH-519 as well as CO1 have also been used for rearing eri silkworms in India. He further recommended application of fertilizer and regular weeding to enhance foliage growth and harvesting in castor plant. (Chandrappa *et al.*, 2012) conducted a study using ten castor varieties to find out the financial side of castor germ together with eri shell creation. According to the study the hybrid castor JI-226 defoliated at 25 percent documented greater profit (Rs.38, 378/hac) after deductions of (Rs.27, 089) and B: C ratio 2.396.0 for germ and eri farming followed by DCS-85 variety (Rs.35.362/ha, Rs26, 806 and Rupees 2.320.1 respectively).

(Pranabjyoti *et al.*, 2013) noted great variation in the performance of raising eri worms based upon locally available castor plant varieties viz red powdery, red non powdery, green powdery and non-green powdery. He recommended red powdery to be

the most suitable for larval weight, shell weight, shell ratio and pupa weight by increasing its productivity and reducing production cost.

(Kedir *et al.*, 2014) also reported great variation after nourishing eri worms on different castor varieties. The study showed that amongst the varieties Acc203241, Acc208624, Ar Sel, Bako, GKsel Abaro, local check and Acc.106584, Abaro showed good performance as far as raising eri worms is concerned. According to (Sarkar *et al.*, 2015) castor was found to be the most suited plant host for eri silkworm rearing in larvae growth, development and cocoon productivity. (Mandali and Narayanamma, 2015) also reported that defoliation of castor leaves up to 30% can be used for rearing eri silkworm larvae without much loss of seed yield adding more remuneration to the farmers.

(Prasana and Gybhargavi, 2017), in their studies noted castor being an important crop in dry lands, they did an experiment with five castor varieties, DCS-9, 48-1, DHC-519 and DCH-177 to evaluate the most beneficial to the performance of eri silkworms. They revealed that DCH-519 was the most beneficial to the eri rearing farmers as its yield was higher compared to the other varieties. According to (Babita *et al.*, 2018) castor emerged the best food for eri silkworms compared to other food plants with respect to all the parameters that is, larval growth, development and cocoon productivity.

In terms of seed and leaf biomass yield, two genotypes of castor, accession numbers Ac03 and Ac04, were chosen as the superior varieties. The eri silkworms' shell weight, shell ratio, and effective rearing rate (ERR) improved when they were fed the leaves of accession numbers Ac03 and Ac04. There was a noteworthy inverse correlation found between the weight of larvae and the nitrogen content of leaves, and an inverse correlation found between the crude protein and sugar contents. Accession numbers Ac03 and Ac04 were determined to be superior in terms of rearing performance, yield-attributing traits, and agronomy (Sarmah, 2011).

It has been demonstrated that eri culture benefits castor farmers and provides them with profitable work, since seed yield is unaffected by a 30% defoliation. Seeds of high oil yielding castor hybrids varieties, such as DCS-9, 48-1, DCH-519, and DCH-177 were tested in addition to local varieties. By feeding them leaves from five different castor genotypes separately during three seasons of tray rearing over the course of two consecutive years, the performance of eri silkworms that is, their larval traits, cocoon traits, and grainage traits were investigated. Temperature and humidity had a significant impact on the economic cocoon parameters as well as rearing performance. The rearing performance of eri silkworms was found to be season-specific, with maximum yields observed in the winter and rainy season compared to the summer. In terms of shell ratio over the course of three seasons, local and DCH-519 castor genotypes were found to be superior. This study indicated that farmers who grow castor can convert to DCH-519 hybrid castor cultivation for eri culture, as it produces higher yields than the local variety and offers farmers twice the benefits in terms of castor oil and silk yield (Prasanna Dasari *et al.*, 2013).

According to (Narayanamma and Padmasri, 2022) the raising of eri silk worms, is important for ensuring the security of rural livelihoods, particularly for the weaker and marginalized groups. As the principal host plant of the eri silk worm *Samia cynthia ricini* Boisduval, castor (*Ricinus communis* L.) can be used to rear the worm without reducing the amount of seeds produced. Eight castor genotypes, namely Haritha, Kranthi, Kiran, DPC-9, PCH-111, PCH-222, GCH-4, and DCH-177, were investigated at the Regional Agricultural Research Station, Palem, during the 2011–12, 2012–13, and 2013–14 kharif and rabi seasons in order to determine the impact of defoliation on seed yield and additional income. Interestingly, there was 30% of defoliated plants and no variation in seed yield from the non-defoliated samples. The batches that were raised on PCH-111

leaves produced the highest possible shell yield of 15.1 kg/ha, which was significantly higher than that of GCH-4 (14.8 kg/ha) and PCH-222 (14.6 kg/ha). Significantly higher gross returns and net profit were achieved with PCH-111 (Rs. 55,582 and 37,452), GCH-4 (Rs. 55,144 and 37,036), and PCH-222 (Rs. 54,820 and 36,635) when the 30% defoliated leaf was used for rearing. Almost all genotypes produced an extra income of Rs. 4,000/ha on average, on top of the regular seed yield when the silk worms were raised, (Narayanamma and Padmasri, 2022).

A two-year field study was conducted in 2005–07 by (Lakshamma *et al.*, 2009) to ascertain the yield loss in castor (DCS 9) at various growth stages due to varying degrees of defoliation. Four defoliation levels i.e. 25%, 50%, 75%, and 100% were applied at the primary, secondary, and tertiary spike initiation stages in addition to control. There were three replications of the experiment carried out in RBD. The percentage of defoliation that was impacted was closer to the recommended levels than it was exactly. Depending on the stage of defoliation, the number of leaves removed varied, at 25%, it could be 3, to 6, at 50%, it could be 5, to 11, at 75%, it could be 7, to 17, and at 100%, it could be 10, to 25. In reality, the defoliation at various stages of defoliation was 23–32% for 25%, 50–55% for 50%, and 58–71% for 75%. The percentage of defoliation increased but the seed yield significantly decreased. With 25, 50, 75, and 100% defoliation respectively, the reduction in seed yield ranged from 10 to 20%, 20 to 23%, 24 to 36%, and 26 to 55%. Defoliation at the primary stage reduced yield by 21% on average, and at the secondary stage, it reduced yield by 33%. Defoliation in the tertiary stage reduced yield by 26%. It was discovered that the most sensitive stage of defoliation that decreased overall seed yield was at the initiation of the secondary spike.

2.3.2 Biology and culture of eri silkworm

Ordered position

Eri silkworm (*Samia cynthia ricini*) Boisduval fits the family Saturniidae in order Lepidoptera, class Insecta and stands measured phyletically an ancient group having the features mark of an eye spot with reliable persistency (Lorhit, 2000).

Biology and life-cycle:

According to (Lorhit, 2000) eri silkworm has four stages in their life cycle- egg, larva, pupa or chrysalis engaged inside a shell and moth or full-grown. Whole development period takes around 44 days during summertime and around 85 days wintertime.

Hatching of eggs takes place during morning periods after nine - ten days summertime where as fourteen - fifteen days wintertime at ordinary atmospheric temperature (Sarmah 1992). Tiny larva stay very close to each other with very minimal movement. The larva feed unceasingly and continues developing and only stop when they are shedding off their skin during the larval growth. To complete the larvae period, it under goes five different instars in which it moults and sheds off their skins four times. The worms are raised for their silk making being an emission of a couple large silk gland which corresponds resembles the insects salivary glands. Each gland is a elongated tube-shaped structure folded in nature. The silk gland occupies almost the whole body of the mature worm since its the longest organ of the body. The mature appropriate place on the moutage for the formation of cocoon. The spinning starts by forming the base of the shell ensue by the sides and lastly the upper part is formed. At this time the movement of the head is irregular. Completion of the case takes place three to five days where the worm gets totally surrounded in the thick layers of the protein fiber. The cases of eri are lengthened, spineless, open mouthed, flossy peduncleless and exhibit different colours based upon the race, that is, brick red and creamy white. The montage used by the larvae

and the host plant will determine the size and shape of the cocoons. For example the wild eri cocoon are longer in size, with tapered ends, open mouthed and tight with strong peduncles. (Lorhit, 2000). The worm transforms into pupa inside the cocoon. The chrysalides is brown in colour and exists as edacious type. The chrysalis buildup into a moth having the limbs of an adult for instance antennae, compound eyes, wings, genitalias and limbs which are observable. The weight of the female chrysalises is more compared to the male. Before the emergence of the adult, the pupae changes its colour into black and the posterior part of the abdomen have a harp movement. (Lorhit, 2000). The colours of eri adults are brown or black bounded by scales that appear to be white in colour. Comparing their sizes, male moths are smaller than the females. Two pairs of wings, which in their in the outlying part have coloured buff with white strippes. Wings shielded by scales of different colour as well as form. There is visibility of prominent veins from both sides. According to (Lorhit, 2000) the forewings of both sexes which are elongated are thinner compared to hind wings and are simmlar in colour pattern and structure. Antimedial line which is bright chocolate tracks through the centre and has a white margin sides. The black coloured post median line has on either side a single grey dull grey border. The top most apex of the black spotted wing has a plero stigma with a tinge which is white in colour. The wings also has slanted lines which are white in colour.



Figure 1. Newly hatched silkworms



Figure 2. Young eri silkworms



Figure 3. Mature eri silkworms



Figure 2. Cocoons of eri silkworms



Figure 5. Eri cut cocoons with double pupa of eri silkworms



Figure 6. Eri silk moth

Rearing techniques :

Surface tray rearing technique was used whereby twenty four hours before hatching the eggs were kept on a piece of paper in the rearing tray. On hatching, the young ones were covered with a tender leaves after which they crawled slowly on to the underneath of the foliage and stayed close together in clusters. Great caution was adhered to ensuring the compatibility of the age of the leaves with the age of the larvae where the larval population concentration was greatly regulated. The freshness of the leaves was ensured through covering with wet cloth and ensuring that they were loosely heaped (Lorhit, 2000). Two methods were used to feed larvae in which the tray method involved spreading the leaves over the larvae. The other method involved hanging the leaves vertically which facilitated complete intake of the foliage and also allowed the dropping of the litters directly on the tray beneath ensuring that the leaves were not soiled hence this method ensured cleanliness and the economy of the leaves. From the first to the third instar the larvae were fed four times a day and from the fourth to the fifth instar they were fed five times a day at regular intervals. Healthy progression of the worms was ensured through the maintainance of hygienic conditions during the rearing duration by ensuring that rearing beds were cleaned regularly. All seasons requierd normal room conditions in the entire raising period. After the worms attained maturity they were put on to the mountages for the spinning of the cases to take place which took 3-4 days to be complete and then 5-8 days just before the harvesting from the mountages took place, (Lorhit, 2000). Different varieties of castor plants exhibit variability in agronomic traits, including growth rate, leaf morphology, and chemical composition. These differences may have direct or indirect effects on the feeding behavior and performance of Eri silkworms. Studies have indicated that Eri silkworms exhibit preferences for specific castor varieties based on the chemical composition of leaves. Certain varieties might

possess higher nutritional content, potentially leading to better growth, silk quality, and cocoon productivity. Research might highlight variations in the silk quality and quantity produced by Eri silkworms fed with different castor varieties. Factors such as cocoon weight, silk yield, and other silk parameters might vary across different feeding regimes. Higher productivity in terms of silk yield and quality could have significant economic benefits for silk producers influencing their choice of castor varieties for cultivation. Some studies may also delve into the environmental impact of using different castor varieties in Eri silkworm rearing. This could include aspects such as water consumption, soil health, and sustainability of cultivation practices (Lorhit, 2000).



CHAPTER THREE

MATERIALS AND METHODS

3.0 Introduction

The investigation into the differential effects of various castor (*Ricinus communis*) varieties on the productivity of Eri silkworm (*Samia cynthia ricini*) silk in the agricultural landscape of Thika, Kenya, required a comprehensive approach integrating entomological, and analytical methodologies. This section outlined the materials utilized, the experimental setup, and the methodologies employed to assess the impact of castor plant variations on Eri silkworm productivity. This study involved the selection of diverse castor varieties prevalent within the Thika region. The process encompassed a thorough survey of local farms and agricultural databases to identify and procure distinct castor varieties exhibiting variability in leaf morphology. The selected varieties were carefully chosen to represent a spectrum of traits that could potentially influence the feeding behavior and performance of Eri silkworms. The experimental setup involved controlled environments for rearing and maintaining Eri silkworms. Specialized rearing units equipped with appropriate temperature and humidity controls were employed to ensure optimal conditions for the silkworms' growth and development. Silkworm larvae were fed exclusively with leaves from each specific castor variety under investigation, thereby facilitating the evaluation of the direct impact of different plant materials on silkworm productivity. To evaluate the productivity of Eri silkworm silk, multiple parameters were systematically measured and recorded. This included but was not limited to larval parameters, cocoon weight and silk yield. Statistical analyses, such as ANOVA and regression models, were applied to interpret the collected data, discern patterns, and establish correlations between the castor varieties and the observed productivity metrics.

3.1 Study design

This study design aimed to systematically evaluate the effects of different castor varieties on Eri silkworm silk productivity in Thika, Kenya, controlled experiments and rigorous data collection methods were employed to enable reliable conclusions.

The sampling design that was utilised was adopted from earlier work by (Kedir *et al.*, 2014). Five varieties of castor plant were used as treatments. These varieties were M2, M3, M4, M12 and S11. which were replicated 4 times each. Leaves from each variety were weighed separately and an equal amount were used to feed Eri silkworms in each treatment in the rearing room. The experiment was a Completely Randomized Design (CRD) which enabled systematic investigation of the study while minimizing biases and allowing for robust statistical analysis of the results.

3.2 Study location

The investigation took place in the research laboratory at National Sericulture Research Center, Thika, located at latitude 0 degrees 46' 59.95" N and longitude 37 degrees 07' 60" E longitude about 225° SW Maragua Central. The altitude of the area is 1531 m above oceanic level and obtains bi-modal rainwater ranging between 1300-1700mm per year. The two rain seasons occur between March-May and October-November. The soils are fertile red loams. The main cash crop is coffee while maize is the major food crop which is inter-cropped with beans, cassava, yams, bananas, sweet potatoes and Irish potatoes. Passion fruits, avocados, paw paw and mangoes are also grown in this area. Vegetables such as kale, cabbage carrots, onions, tomatoes and arrowroots are also grown here.

3.3 Study population/target organism

The study population or target organism in the research focused on two key organisms:

Eri Silkworm (*Samia cynthia ricini*): The primary focus and target organism of this study are the Eri silkworms. *Samia cynthia ricini* is a domesticated silkworm species known for its ability to produce silk while feeding on a variety of plant materials. These silkworms play a crucial role in silk production and are chosen for their adaptability to various environmental conditions.

Castor Plant Varieties (*Ricinus communis*): The different varieties of the castor plant, *Ricinus communis*, constitute another critical component of the study population. These plants serve as the primary food source for the Eri silkworms under investigation. The study assesses the impact of various castor varieties on the productivity, growth, and silk quantity of the Eri silkworms.

The interaction between these two organisms forms the core of the study. The research aimed to explore how different varieties of the castor plant influence the feeding behavior, growth, cocoon production, and silk quantity of the Eri silkworms in the specific geographical context of Thika, Kenya. The study population comprised these interconnected components, emphasizing the relationship between the plant variations and the productivity of the silkworms reared on them.

3.4 Sample size determination

Sample size determination was crucial for the study's reliability and validity. It ensured that the study was adequately powered to detect meaningful differences between the castor varieties in their effects on Eri silkworm silk productivity in Thika, Kenya. Determining the sample size for a study involved considerations of statistical power, variability, and effect size. The following approach was used to determine the sample size:

- **Effect Size Estimation:** The effect size referred to the magnitude of the difference in productivity of Eri silkworm silk attributed to different castor varieties.
- **Variability and Variance:** the variability within the data was determined in terms of larva parameters, cocoon weight and silk yield which were used to measure productivity. This involved assessing the standard deviation or variance within these parameters across different castor varieties.
- **Significance Level:** The significance level (0.05) for the study set the threshold for considering results as statistically significant.
- **Statistical Test and Analysis Approach:** The statistical test used to compare the productivity of Eri silkworm silk among different castor varieties was ANOVA (Analysis of Variance) which compared means across multiple groups.
- **Sample Size Calculation:** Genstat was the statistical software used to calculate the required sample size. The formulas for sample size estimation in ANOVA considered factors like number of groups and variability within groups..
- **Practical Considerations** such as feasibility in rearing and managing Eri silkworms, availability of resources, and time constraints when determining the final sample size.

3.5 Sampling procedure

Designing an effective sampling procedure for this study involved a strategic approach to selecting representative castor plant varieties and managing the Eri silkworm population which included the following:

- **Selection of Castor Varieties:** Diverse range of castor plant varieties found in the Thika region were identified in terms of leaf morphology.
- **Randomized Sampling:** This approach was employed to select representative samples from each identified castor variety. This method ensured that the chosen plants were fair representation of the overall population of each variety and minimized bias in selection.
- **Uniform Rearing Conditions for Eri Silkworms:** Controlled environments for rearing Eri silkworms were established which ensured consistent temperature, humidity, and feeding conditions. Separate batches of silkworms for each castor variety under investigation were designated.
- **Feeding Regimen:** Each treatment of Eri silkworms was provided with leaves from their respective castor variety. Monitor and control of the quantity and quality of leaves was provided to ensure consistency in the silkworms' diet across different groups. The larvae in the first two instars were maintained in small separate trays each up to the 3rd instar after which they were transferred to bigger trays for proper growth and observation.
- **Data Collection:** Data was recorded on various parameters related to silkworm growth and productivity, including larva parameters, cocoon weight and silk yield. For data collection 10 worms were selected randomly from each replication thus each treatment held 40 worms giving the entire sample population of 200 worms which were 20% of the entire population. This ensured adequate representation of each castor variety in the study. This was also applied to cocoon sampling.

- **Replication and Sample Size Consideration:**

The target population were 1000 worms which were divided into five treatments each comprising of 200 worms replicated 4 times. Treatment details were as follows;

Treatment-1 Eri silkworms to be fed on leaves of castor variety M 2.

Treatment-2 Eri silkworms to be fed on leaves of castor variety M 3.

Treatment-3 Eri silkworms to be fed on leaves of castor variety M 4.

Treatment-4 Eri silkworms to be fed on leaves of castor variety M 12.

Treatment-5 Eri silkworms to be fed on leaves of castor variety S 11.

Similar designs have been used in the past to study eri worms population density (Terefe *et al.*, 2017).

3.6 Inclusion and Exclusion

Establishing clear inclusion and exclusion criteria helps maintain the study's focus, ensures the validity of results, and enhances the overall reliability of findings by ensuring consistency and relevance in the data collected and analyzed.

3.6.1 Inclusion Criteria:

- **Castor Varieties:** Included various castor (*Ricinus communis*) varieties available in the Thika region, representing a range of morphological, growth, and chemical composition differences.
- **Eri Silkworms:** Included *Samia cynthia ricini* silkworms for the study, ensuring their health and suitability for experimental conditions.
- **Experimental Conditions:** Included controlled environmental conditions for rearing Eri silkworms.
- **Data Parameters:** Include parameters relevant to the productivity of Eri silkworm silk, such as cocoon weight, silk yield, and larva parameters.

- **Ethical Compliance:** Include adherence to ethical guidelines concerning the treatment and care of live organisms throughout the study.

3.6.2 Exclusion Criteria:

- **Non-representative Castor Varieties:** Exclude castor varieties that are not native to the Thika region.
- **Contaminated or Unhealthy Silkworms:** Exclude Eri silkworm batches exhibiting signs of disease, contamination, or abnormal growth that could affect the integrity of the study.
- **Insufficient Data Quality:** Exclude data sets with inaccuracies, inconsistencies, or insufficient information that could compromise the reliability of analysis.
- **Ethical Violations:** Exclude any experimental data or practices that do not comply with ethical guidelines or involve mistreatment of organisms.
- **Outliers and Anomalies:** Exclude extreme outliers or data points significantly deviating from the expected range without reasonable cause or explanation.

3.7 Experimental and laboratory techniques

In this investigation various experimental and laboratory techniques were crucial for evaluating the impact of different castor varieties on Eri silkworm silk productivity.

Rearing and Maintenance of Eri Silkworms employed the following techniques:

Rearing Units: controlled environments equipped with regulated temperature, humidity, and light cycles for optimal silkworm growth and development was used. Temperatures ranging between (25-27)⁰C and relative humidity(70-80) percent were maintained for uniform development of the worms.

Feeding Trials: Feeding trials were conducted where Eri silkworms were exclusively fed with leaves from specific castor varieties under investigation. Cleaning and sterilization of the room and equipments where the silkworm nurturing took place was done in advance. The hands were cleaned with a detergent and rinsed with clean water to prevent larval contamination during the operation. For each replication, newly hatched worms were fed with whole tender leaves of a specific castor variety until they molt to 2nd instar. The 3rd and 4th instar were fed with semi – mature leaves of the same variety and the 5th instar worms were fed on mature leaves. Feeding was done every morning at 8.30 am and in the evening at 4.00pm. The food quantity was increased with increase in the age of the larva which ensured proper growth and development. The worms ceased from feeding during the peeling of the skin. Immediately after molting, the worms were sprinkled with some lime powder to protect the delicate skin from damage, desiccations and infection. Feeding after molting resumed after 95% of the worms were out of molt. Weighing the leaves before feeding ensured that each treatment received same quantity of leaves. Perforated paraffin paper was used to cover the food fed to the worms to prevent fast drying of the leaves hence ensuring freshness of the leaves for longer periods. Bed cleaning was done to avoid multiplication of pathogenic micro-organisms that can affect the health of the worms. In the 1st instar the bed cleaning was done once prior to 1st molting. Bed cleaning in the 2nd instar was done after the second feeding and before settling of worms for 2nd molt. The 3rd and 4th instar bed cleaning was done after the third feeding, at the middle stage and before settling down for the next molting. In the 5th instar, bed cleaning was done after the first feeding which was done on daily basis until the worms were ready for spinning. Bed thickness was reduced just before molting to give adequate spacing and to ensure quick drying of leftover leaves. Lime powder was applied over the worms settling for molt to reduce humidity and quicken the drying up

of leftover leaves. Mature worms were transferred to montages made of newspapers for spinning of cocoons. The cocoons were reaped and analyzed after the 10th day of spinning .

3.8 Quality control

Quality control measures were ensured which provided reliable insights into how different castor varieties affected Eri silkworm productivity in Thika, Kenya. The experiment was well-designed, which included appropriate sample sizes and replications which minimized biases for reliable results. Standardized procedures were used for rearing Eri silkworms which ensured consistency across the different batches. Implementation of rigorous data collection methods for measuring productivity parameters such as silk yield, cocoon weight and growth rates of silkworms were ensured. Appropriate statistical tools were employed to analyze the data and determine significant differences between the effects of various castor varieties on Eri silkworm productivity. The study was subjected to peer review to validate the methodology, data analysis, and conclusions drawn, which ensured that the research met scientific standards. Documentation of all procedures, data, and outcomes allowed transparency, reproducibility and future reference by other researchers. Checks were implemented at various stages which ensured that the research adheres to ethical guidelines, avoids biases, and maintains scientific integrity.

3.9 Data management

Effective management of data in this study was crucial for accurate analysis and interpretation. The data collection plan was as follows:

3.9.1 Experiment 1. To determine preference of silkworms to different varieties of castor grown in Kenya.

The primary objective was to determine the preferential inclinations of Eri silkworms towards different varieties of castor grown in Kenya. By elucidating these preferences, the potential correlations between silkworm behavior and castor varieties were unveiled. Olfactory technique was used to determine the most preferred variety by eri silkworms whereby leaves of the five varieties were arranged at a radius of 10 cm for the silkworms in 1st, 2nd and 3rd instars and 20 cm for 4th and 5th instars. One hundred and twenty newly hatched silkworms were placed at the center of the leaves on a bench in the laboratory where they were allowed to move to the castor leaf of their preference. This method was repeated for every first feeding after moulting in each instar.

3.9.2 Experiment 2. Determination of the differences in growth and development of Eri silkworms after feeding on different varieties of castor foliage

The intricate interplay between Eri silkworms (*Samia cynthia ricini*) and the foliage of diverse castor (*Ricinus communis*) varieties holds fundamental importance in separating the complexities influencing silk productivity. This investigation aimed to discern and evaluate the discernible differences in the growth and developmental patterns exhibited by Eri silkworms subsequent to being fed different varieties of castor foliage. The following parameters were assessed:

3.9.2.1 Larval duration

The time taken by the larva from hatching to maturity were recorded and expressed in terms of days.

3.9.2.2 Mature larval body weight

After maturity the larvae from each treatment were weighed individually and their weight recorded in grams and then the mean data from each treatment calculated.

3.9.2.3 Effective rate of rearing (ERR)

The ERR was calculated from the number of worms brushed and number of cocoon yield as suggested by Singh and Benchamin (2002)

$$\text{ERR \%} = \text{Number of worms spinning cocoon/Number of worms brushed} \times 100$$

3.9.2.4 Larval survival

Larval survival was calculated from the no. of worms that survived and number of brushed worms

$$\text{Larval survival} = \text{Number of survived worms/Number of worms brushed} \times 100$$

3.9.2.5 Fecundity

Ten pairs of newly emerged moths from each treatment were coupled. After five hours of coupling, the female moth were allowed to lay eggs for three days after which the eggs from each female were counted and recorded.

3.9.2.6 Hatchability

After 10-11 days of egg's incubation at 25 degrees centigrade they were allowed to hatch and the hatchability calculated as follows;

$$\text{Hatchability} = \text{No. of eggs hatched/Total number of eggs} \times 100$$

3.9.3 Experiment 3. Determination of the castor type which results in the production of cocoons with the highest mass.

The search to identify the optimal castor (*Ricinus communis*) variety that facilitates the production of cocoons with the highest mass stands as a pivotal endeavor within the landscape of Eri silkworm (*Samia cynthia ricini*) sericulture. This objective was dedicated to sorting out and evaluating the differential effects of various castor types on

the mass yield of cocoons, situated within Thika region. Cocoon mass (with chrysalis) and cocoon shell mass (without chrysalis) were noted independently and shell fraction calculated in % as suggested by (Dhiramani *et al.*, 2017).

Shell ratio%= mass of the cocoon shell/weight of whole cocoon x100.

3.10 Data analysis and presentation

In analyzing and presenting data regarding the effects of different castor varieties on Eri silkworm productivity in Thika, Kenya, several steps were followed for effective analysis and presentation. Descriptive analysis was used to summarize and describe key variables such as silk yield and silkworm growth rates. This included measures like mean and standard deviation. Comparative analysis was conducted between different castor varieties. ANOVA was used to identify significant differences in silk productivity and growth rates. Correlation analysis explored correlations between castor plant characteristics and Eri silkworm productivity metrics. This analysis helped in understanding potential relationships between these factors.

3.11 Ethical considerations

Addressing ethical considerations in this study ensured that the research was conducted with integrity and a commitment to minimizing any potential negative impacts while maximizing the benefits of the study's outcomes. Ethical treatment of the Eri silkworms involved in the study was ensured by following appropriate guidelines for worms care, handling, and housing to minimize stress and discomfort during experimentation. It was ensured that the cultivation of different castor varieties did not pose any threat to the local ecosystem or indigenous plant species in Thika, Kenya. Ethical standards of scientific conduct were adhered to by avoiding fabrication, falsification, or plagiarism in the

collection, analysis, and reporting of data. Transparency in reporting research findings was ensured by sharing results and methodologies for peer review and future scientific advancement. Regulatory Compliance was ensured by adhering to local, national, and international regulations and ethical guidelines governing research involving animals and plants.



CHAPTER FOUR

RESEARCH FINDINGS, ANALYSIS AND PRESENTATION

The sericulture industry, characterized by its intricate relationship between silkworms and their food sources, remains a pivotal sector in Thika, Kenya where the cultivation of Eri silkworms and the growth of castor plants intersect. This presentation explores deeper into the findings and participates in an interpretive discussion of the various effects on the productivity of Eri silkworm (*Samia cynthia ricini*) silk that have been observed among different varieties of castor (*Ricinus communis*). The following summarizes the results of the study conducted to determine how different castor varieties affected the growth, development, and cocoon productivity of eri silkworms:

4.1 Determination of the preference level of eri silkworm towards different castor varieties grown in Kenya.

There was no significance difference in the number of worms that preferred each of the five varieties used ($F_{4,20}=0.917$, $P=0.473$). However, variety M4 was the most preferred (mean= 29.4 ± 6.651) followed by M3 and M2 (25.6 ± 2.863 , 20.0 ± 3.899 , respectively). M12 and S11 recorded the least preference each (18.0 ± 5.109). Probably, the difference might be due to the variations in palatability of the leaves owing to many characteristics. Various larval stages portrayed varied preferences. Newly hatched eri silkworms highly preferred M4 where they hardly preferred S11 and M12. During the late stages, the variation was not significant probably due to uniform environmental Conditions with consistent temperature, light, and food sources, in which the larvae were raised. (Table 1). Comparable results were recorded by (Lorhit, 2000) in his experiment on nutritional efficiency of *Samia cynthia ricini* reared on different castor varieties.

Table 1. Differential preference of castor variety by eri silkworms

Castor variety					
Larval instar	M2	M3	M4	M12	S11
I	33	31	53	0	0
II	25	31	33	20	10
III	15	23	15	29	32
IV	13	17	25	26	32
V	14	23	20	15	16
Mean \pm SE	20.0 \pm 3.899	25.0 \pm 2.863	29 \pm 6.261	18.0 \pm 5.109	18 \pm 5.109
F _{4,20}	0.917				
P=	0.473				

Preference of castor varieties by eri silkworms at 0.05 significant level

4.2 Differences in growth and development of eri silkworms after feeding on different varieties of castor leaves.

The results on the determination of eri silkworms' growth and development in terms of larval duration, larval survival, and effective rate of rearing, mature larval body weight, fecundity and hatchability are presented and explained below,

4.2.1 Larval duration

Significant differences ($F_{4, 15}=64.25$, $P<0.001$) in larval duration were recorded in eri silkworms provided with different castor varieties. The least larval duration was observed in M2 and S11 which took 26 days followed by M12 and M4 (27.00 and 28.25 days, respectively). M3 took the longest period of 28.75 days (Table 2). The observed variation might be due to the differences in the nutrient composition of the leaves of the castor varieties. Comparable observations (26.60 – 29.15 days) were recorded by (Swathiga *et al.*, 2019) on rearing performance of c2 breed of eri silkworm, *Samia cynthia ricini*, (Family: Saturniidae, order: Lepidoptera) feeding with different castor genotypes.

4.2.2 Larval survival

Significant differences ($F_{4, 15}=38.92$, $P<0.001$) in larval survival were recorded on castor varieties. M2 and M4 showed equivalent larval survival of 100 %. S11 followed closely with 99.5 % followed by M12 with 98.5%. M3 had the least survivability of 73.5 % compared to the rest of the varieties. (Table 2). Comparable results in larval survival has also been reported by (Sannappa *et al.*, 2007) while studying the influence of some castor genotypes on larval and cocoon traits of eri silkworms.

4.2.3 Effective rate of rearing

The percentage of the number of cocoons harvested in relation to the number of larvae brushed (ERR) was significantly different ($F_{4, 15}=9.435$, $P<0.001$) for eri silkworms fed on different castor varieties. Eri silkworms fed on M2 recorded the highest ERR (98.5 %) followed by M12 and S 11. (91.5 and 91.0 respectively. M4 had 84.0 %. M3 recorded the least ERR value (61.5%) (Table 2). The variations recorded in ERR was due to the fact that variety M3 deviated greatly from others. (Dasari Prasanna *et al.*, 2013) reported variations in ERR during the study on evaluation of castor varieties based on the performance of eri silkworm *Samia cynthia ricini*.

4.2.4 Mature larval body weight

Significant differences on the weight of mature larva were recorded ($F_{4, 15}=2.881$, $P<0.001$) among varieties. M3 recorded the highest mean weight (4.78 g,) followed closely by S11, M4 and M12 (4.70, 4.64, and 4.58 g, respectively). M2 recorded the least weight (4.27 g). The variation might be attributed to the differences in the composition of foliar nutrients of those varieties. The results are in conformity with those of (Patil *et al.*, 2000) during their study on the performance of eri silkworms on different castor varieties.

4.2.5 Fecundity

A significant difference ($F_{4, 15}=4.179$, $P=0.005$) in fecundity was recorded when they were fed on different castor varieties. Silkworms fed on M4 expressed the highest mean fecundity (380 eggs) followed by M3, M12, and S11 (343.00, 339.89 and 327.38 eggs respectively). M2 recorded the least fecundity (283.88 eggs) among the varieties (Table 2). Closely related values (275 to 360) had been reported earlier (Swathiga *et al.*, 2019) on rearing performance of c2 breed of eri silkworm, *Samia cynthia ricini*, (Family: Saturniidae, order: Lepidoptera) feeding with different castor genotypes.

4.2.6 Hatchability

There was no significant difference ($F_{4, 15}=1.616$ $P=0.221$) in hatching percentage of eri silkworms fed on different varieties of castor. The highest hatching percentage was recorded in S11 (95.6 %) followed by M12 (93.2 %), M4 (89.47 %) and M2 (88.9 %). M3 recorded the lowest hatchability (86.50) (Table 2). Deviation in the hatchability of eri silkworms was also recorded by (Govindan *et al.*, 2002a) studying on the Influence of castor genotypes on economic traits of eri silkworms.

Table 2: Effect of Castor varieties on eri silkworm's larval and egg parameters

Castor variety (Mean ± S.E.)						F _{4,15}	P-Value
Parameter	M2	M3	M4	S11	M12		
Larval duration (days)	26 ±00.00	28.75± 0.25	28.25±0.25	26.00±0.00	27.00±0.00	64.25*	<0.001*
Survival Rate (%)	100±0.00	73.50±4.03	100±0.00	99.50±0.50	98.50±0.96	38.92*	<0.001*
ERR (%)	98.5±0.96	61.5±2.87	84.0±4.40	91.0±4.20	91.5±7.85	9.435*	<0.001*
Larval weight (g)	4.27±0.04	4.78±0.05	4.64±0.04	4.70±0.04	4.58±0.04	2.881	<0.001
Fecundity	283.88±15.96	343.00±15.96	380.00±17.07	327.38±15.96	339.89±15.96	4.179*	0.018*
Hatching%	88.92±5.46	86.50±5.46	89.47±5.83	95.6±5.46	93.22±5.46	1.616	0.221

Data are Mean ± S.E. of 4 replications; * Significant (P < 0.05)

4.3 Cocoon production

According to the results, eri silkworms fed on various castor varieties portrayed various results. There was significant difference in the cocoon weight of eri silkworms fed on different varieties of castor leaves (F_{4, 15}=5.568, p=0.0059). The larvae fed on castor variety M3 recorded the highest cocoon weight (2.73 g) followed by M12, M4, S11 and M2 (2.63, 2.62, 2.57 and 2.35 g, respectively). The results revealed statistical significant with regard to shell weight (F_{4, 15}=3.07, P= 0.001). M3 portrayed the highest mean shell weight (0.33) g, followed by M4, M12, S11 and M2 (0.32, 0.31, 0.30 and 0.27 g, respectively). Significant difference was noted between the means of the castor varieties when shell percentage was put into consideration (F_{4, 15}=7.17, P>0.001. The experimental

results showed that variety, M3 had the highest shell percentage (12.11) followed by M4, S11, M2, and M12 (11.87, 11.77, 11.53, and 11.50 respectively) (Table 3). These results are in agreement with (Swathiga *et al.*, 2019) investigating on rearing performance of c2 breed of eri silkworm, *Samia cynthia ricini*, (Family: Saturniidae, order: Lepidoptera) feeding with different castor genotypes.

Table 3: Cocoon parameters of eri silkworms reared on different castor varieties

Data are Mean \pm S.E. of 4 replications; * Significant (P < 0.05)

Castor variety (Mean \pm S.E.)						F _{4,15}	P-Value
Parameter	M2	M3	M4	S11	M12		
Cocoon weight (g)	2.35 \pm 0.034	2.73 \pm 0.035	2.62 \pm 0.035	2.57 \pm 0.035	2.63 \pm 0.035	5.568	0.005 *
Shell weight (g)	0.27 \pm 0.015	0.33 \pm 0.021	0.32 \pm 0.022	0.30 \pm 0.026	0.31 \pm 0.018	3.07	0.001*
Shell %	11.53 \pm 0.128	12.11 \pm 0.223	11.87 \pm 0.11	11.77 \pm 0.272	11.50 \pm 0.13	7.17	0.001*

4.4 Correlation analysis

Correlation analysis revealed varied results between larval and cocoon parameters. The correlation coefficient between cocoon weight and larva duration was -0.0392, which indicated a very weak negative correlation between the two variables. The p-value was 0.8768 which was greater than 0.05, and f-value 0.001545 which suggested no statistically significant correlation. The correlation coefficient between cocoon weight and survival was 0.3535, which showed a moderate positive correlation between the two variables. The p-value was 0.1211 and the f-value was 1.972, which indicated no statistically significant relationship between the two variables. The correlation

coefficient between cocoon weight and ERR was 0.0198, ($p=0.949$, $f=0.000395$) which demonstrated a very weak positive correlation between the two variables which was not statistically significant. Based on the results, there was a moderate positive correlation between cocoon weight and larva weight ($r = 0.451$), but it was not statistically significant ($p\text{-value} = 0.657$, $f=3.095$). The correlation coefficient between cocoon weight and hatchability was 0.0798 ($p\text{-value} = 0.629$, $f\text{-value}=0.248$) which showed a very weak positive correlation between the two variables which was not statistically significant. The correlation between cocoon weight and fecundity was moderately positive (0.5319, $p=0.0202$, $f=6.579$) which was statistically significant. The correlation coefficient between cocoon weight and shell ratio was -0.430($p=0.033$, $f=3.270$) which showed a significant negative relationship between the two variables. The correlation coefficient between cocoon weight and shell weight was 0.73 ($p\text{-value} =0.000354$, $f\text{-value}= 10.19$) which demonstrated a strong positive correlation which was statistically significant. The correlation coefficient between shell percentage and shell weight 0.03887 ($p\text{-value} =0.497$, $f\text{-value} =0.2976$) indicated a weak negative correlation that was not statistically significant at conventional significance level of 0.05. The correlation coefficient between shell weight and larva duration was -0.01918, which demonstrated a very weak negative correlation between the two variables. The $p\text{-value} = 0.9256$, $f\text{-value}= 0.0001071$, which suggested no statistically significant correlation between shell weight and larva duration. The correlation coefficient between shell percentage and larva duration was 0.20709 ($p\text{-value} = 0.427$, $f\text{-value} = 0.8238$) which demonstrated a very weak positive correlation between the two variables which was not statistically significant. The correlation coefficient between shell weight and larva weight was 0.5802, ($p\text{-value} = 0.00751$, $f\text{ value}= value 10.81$) which indicated a statistically significant, moderate positive correlation between the two variables. There was a

significant weak positive correlation between shell weight and fecundity ($r=0.0909$, $p=0.0099$, $f=4.115$). The correlation coefficient between shell weight and survival was 0.146 (p value= 0.6166 , f value= 0.02749) indicating a weak positive correlation which was not significant. The correlation coefficient between shell weight and hatchability was -0.217 , p -value = 0.4692 f -value = 1.409) which indicated non-significant weak negative correlation between the two variables. The correlation between shell weight and ERR gave a value of -0.259 (p -value= 0.00277 . f -value = 5.783). This indicated a significant moderate negative correlation between the two variables. The correlation coefficient between shell percentage and larva weight was -0.534 (p -value = 0.165 f -value = 4.079), which demonstrated a non-significant moderate negative correlation between the two variables. Correlation coefficient between shell percentage and ERR was -0.318 (p value= 0.375 , f value = 1.201) which showed a weak negative correlation between the two variables which was not statistically significant at the 0.05 significance level. The correlation coefficient between shell percentage and survival was 0.023 , (p -value = 0.8614 , f -value = 0.0324) which indicated no significant correlation between the two variables. Correlation coefficient between shell percentage and fecundity was found to be -0.19 (p -value = 0.46 f -value= 1.63) which indicated a weak negative correlation that was not statistically significant. There was a weak negative correlation coefficient between shell percentage and hatchability $r= -0.485$, $p= 0.166$, $f =0.885$) which was not statistically significant at the 5% level of significance since it was greater than the conventional threshold of 0.05. The findings are consistent with those of Subramanian et al., (2013) who studied the rearing of the eri silkworm (*Samia cynthia ricini*) under various seasonal and host plant circumstances and discovered a variety of findings about the relationship between cocoon characteristics and larval growth, (Table 4).

Table 4: Correlation between larval and cocoon characteristics of eri silkworm

Parameter	Cocoon weight			Shell weight			Shell percentage		
	r	P	F4,15	r	P	F4,15	r	P	F4,15
Cocoon weight									
Shell weight	0.73	0.00035*	10.19						
Shell %	-0.430	0.033*	3.270	-0.388	0.497	0.2976	-	-	-
Larval duration	-0.039	0.9699	0.001545	-0.019	0.9256	0.0001	0.207	0.4271	0.8238
Survival rate	0.353	0.1798	1.972	0.146	0.6166	0.0275	0.023	0.8614	0.0324
ERR	0.019	0.985	0.000395	-0.259	0.37	5.783	-0.318	0.375	1.201
Larvawgt	0.451	0.657	3.095	0.5802	0.00754*	10.81	-0.534	0.165	4.079
Fecundity	0.5319	0.0202*	6.579	0.0909	0.0099*	4.115	-0.19	0.46	1.63
Hatchability	0.0798	0.629	0.248	-0.217	0.4692	1.409	-0.485	0.166	0.885

r = Correlation tested at F 4, 15 degree of freedom; * Significant (P < 0.05).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

The culmination of rigorous investigation into the diverse effects of castor (*Ricinus communis*) varieties on Eri silkworm (*Samia cynthia ricini*) silk productivity in Thika, Kenya, leads to this pivotal juncture where the amalgamation of findings, conclusive insights, and actionable recommendations emerge. This section aims to distill key observations, draw conclusive inferences, and propose recommendations that bear significance for the sericulture landscape of Thika.

5.1 Summary

Rearing eri silkworms involves feeding them with castor leaves as a primary food source which promotes a sustainable and eco-friendly practice. It reduces dependency on other resources and aligns with natural feeding habits, making it an environmentally conscious approach to silk production. Castor varieties used in this context often include local castor plant species like *Ricinus communis*. The leaves of these plants serve as an essential nutritional component for Eri silkworms, supporting their growth and development through various life stages. This practice of utilizing castor varieties in Eri silkworm rearing is fundamental to successful silk production in many areas. Eri silkworms are unique compared to other silk-producing insects and since they feed primarily on castor leaves, the choice and cultivation of these castor varieties is very crucial in their rearing process. The study from the present investigation has portrayed varied results in the rearing performance of eri silkworms when the leaves of the different castor varieties were used as a source of food where larval parameters and cocoon characters were attentively studied. The previous researchers e.g. (Kedir Shifa *et al.*, 2014) have also studied the rearing of eri silkworms by using leaves of different types of

castor plants and various results have been recorded which include varied larval duration, larval weight, shell weight and shell ratio. Overall, the choice of castor varieties plays a pivotal role in the successful rearing of eri silkworms and the production of high-quality silk. It's a symbiotic relationship between the chosen plants and the silkworms that requires careful attention and expertise from farmers to ensure optimal results.

5.2 Conclusion

The number of worms that preferred each of the five types that were employed did not significantly differ from one another, according to the study. This offers insightful information about the behavior and feeding preferences of eri silkworms. Furthermore, these results show that silkworm tastes may not be significantly influenced by the particular type of food offered, which has practical consequences for management techniques. The growth and development of Eri silkworms fed on several species of castor leaves showed a considerable variation, according to the study. These results highlighted how crucial it is to take leaf variety selection into account when designing silk production procedures. A better understanding of the ways in which different varieties of castor leaves affect the development of silkworms can lead to improved farming methods and optimized silk output. This research advances our comprehension of the complex interplay between variations in host plants and the biology of Eri silkworms, providing significant perspectives for scholars studying sericulture as well as silk producers.

Among the castor types examined in Kenya, M3 and M4 showed the highest cocoon yield weights. These results are highly significant for the region's sericulture sector since they offer important information about choosing high-yielding castor types for silk production. For silk producers looking to maximize crop selection choices, the study provides useful assistance by identifying M3 and M4 as higher performers in terms of

cocoon yield. Moreover, the possible financial advantages linked to higher cocoon yields from these cultivars may enhance the standard of living for rural farmers involved in sericulture. Overall, this study highlights the significance of crop selection in improving the sustainability and efficiency of silk production, as well as prospects for further innovation and expansion in Kenya's sericulture industry.

5.3 Recommendations

It is highly recommended that in future worms be reared in the laboratory condition during the early stages, before dispatching them to farmers which has several advantages which include,

- **Controlled Environment:** Laboratory conditions provide a controlled and optimized environment for the critical early stages of silkworm development. This controlled environment can ensure stable temperature, humidity, and food supply, reducing the risk of mortality and disease during these vulnerable stages.
- **Enhanced Survival Rates:** By rearing eri silkworms in a laboratory, survival rates can be significantly improved. The controlled conditions minimize exposure to predators and adverse weather conditions, which can be especially beneficial during the early, fragile instars.
- **Quality Control:** Laboratory rearing allows for close monitoring of silkworm health and growth during the early stages. Any issues or diseases can be detected early, and corrective measures can be taken to ensure the production of healthy silkworms.
- **Consistency in Quality:** Consistency in silkworm quality is essential for silk production. Laboratory rearing helps maintain a consistent quality of young silkworms, leading to uniform cocoon production and silk quality.

Farmers need to select specific varieties of castor plants, often local to their region, for feeding eri silkworms which should be chosen based on factors such as leaf size, nutritional content, and adaptability to local climate and soil conditions.

Farmers also need to cultivate these castor varieties which ensure a consistent and adequate supply of leaves. Requiring them to manage plantations or gardens of these castor plants near the silk production facilities to ensure a readily available food source for the silkworms. Eri silkworms go through various instars or stages of growth, and their feeding needs change accordingly. Therefore farmers need to attentively monitor the growth stages and adjust the quantity and frequency of castor leaf feeding to support optimal growth. Kenyan authority need to offer incentives to advance the venture for the expansion of textile industries leading to creation of employment and curbing rural urban migration which have several advantages:

- **Job Creation:** Promoting eri silk production can stimulate the growth of the textile industry. As more silk is produced, it can be used in textile manufacturing, leading to the creation of jobs in the production, processing, and marketing of silk-based products.
- **Rural Development:** Eri silkworm rearing is often a rural-based industry. By supporting eri silk production, the Kenyan government can promote rural development by providing income-generating opportunities to rural communities, thus reducing rural poverty and migration to urban areas in search of employment.
- **Value Addition:** The expansion of the textile industry through eri silk production can add value to locally produced silk. This can lead to higher profits for farmers and other stakeholders in the value chain. Incentives could

be provided for value addition activities such as silk spinning, weaving, and dyeing.

- **Export Potential:** Eri silk has export potential, especially in international markets that value eco-friendly and sustainable textiles. Kenyan authorities can offer incentives for businesses to explore international markets, leading to foreign exchange earnings for the country.
- **Skill Development:** Supporting the eri silk industry can also involve training programs for farmers and entrepreneurs. Skill development initiatives can enhance the expertise of individuals involved in sericulture and textile production. More research is highly recommended to support the current findings considering the following factors;
- The differences in nutritive value of the various castor varieties in Kenya since castor leaves provide essential nutrients required for the growth and development of eri silkworms which include proteins, carbohydrates, vitamins, and minerals which are necessary for the larvae to thrive and spin quality silk cocoons.
- The specific role of these available nutrients in castor leaves as far as eri silkworm rearing is concerned since the quality of silk produced by eri silkworms is directly influenced by their diet. Nutrient-rich castor leaves contribute to the formation of strong and lustrous silk fibers, impacting the commercial value of the silk produced.
- A research to ensure that farmers typically cultivate specific varieties of castor plants suited for the region's climate and soil conditions, ensuring an adequate and consistent food supply for the silkworms.
- The pests and diseases that affect the castor leaves and their management.
- The availability of an alternative crop for eri silkworm rearing in Kenya.

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APPENDICES

Appendix I: Certificate of Ethical Clearance from MKU


Mount Kenya University

REF: MKU/ERC/1800
TO: MARY WANGUI KAMAU

Date: 04 May 2021

REG: MSAE/2015/32240

Dear Sir/Madam,

RE: DIFFERENTIAL EFFECTS OF CASTOR (*Ricinus communis*) VARIETIES ON PRODUCTIVITY OF ERI SILKWORM (*Samia cynthia ricini*, Boisduval; Lepidoptera: Saturniidae) SILK IN THIKA, KENYA.

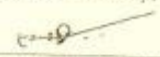
This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **873**. The approval period is **04/05/2021 - 03/05/2022**.

This approval is subject to compliance with the following requirements;

- i. Only approved documents including informed consents, study instruments, MTA will be used
- ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
- iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
- iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
- v. Clearance for export of biological specimens must be obtained from relevant institutions
- vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
- vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) <https://oris.nacosti.go.ke> and also obtain other clearances needed.

Yours sincerely,


The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Dr. Peter G. Kirira
Chairman, Mount Kenya University IERC

Main Campus, General Kago Road, P.O. Box 342-01000 Thika, Tel: +254 67 2820 000,
Call: +254 720 790 796, 0709 153 000

Appendix II: Introduction Letter from MKU



DIRECTORATE OF GRADUATE STUDIES

MSAE/2015/32240

3rd August, 2021

*The Director, Research Coordination Division
National Commission for Science, Technology & Innovation
Utalii House, 8th & 9th Floor
P.O Box 30623- 00100
NAIROBI*

Dear Sir/Madam,

RE: MARY WANGUI KAMAU - REGISTRATION NO. MSAE/2015/32240


The purpose of this letter is to introduce the above named student who is pursuing **Master of Science in Applied Entomology** in the Department of **Biological Sciences** in the School of Pure and Applied.

The title of her research is *"Inferential Effects of Castor (Ricinus Communis) Varieties on Productivity of Eri Silkworm (Samia Cynthia Ricin, Boisduval: Lepidoptera: Saturniidae) Silk in Thika, Kenya."*

She has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data for her research between **August and October, 2021**.

Any assistance accorded to her will be highly appreciated.

Thank you.



Dr. Samuel M. Karenga, Ph.D
Director, Graduate Studies
Enc.

Appendix III: Research Authorization from NACOSTI



REPUBLIC OF KENYA

Ref No: 741944



**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION**

Date of Issue: 12/August/2021

RESEARCH LICENSE



This is to Certify that Miss. MARY WANGUI KAMAU of Mount Kenya University, has been licensed to conduct research in Kiambu on the topic: DIFFERENTIAL EFFECTS OF CASTOR(*Ricinus communis*) VARIETIES ON PRODUCTIVITY OF ERI SILKWORM (*Samia cyathia ricini*, Boisduval; Lepidoptera: Saturniidae) SILK IN THIKA, KENYA, for the period ending 31/12/August/2022.

License No: NACOSTI/P/21/12303

Applicant Identification Number
741944

Walter Ombaka
Director General
**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION**

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THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

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E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
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Appendix IV: Similarity Index

DIFFERENTIAL EFFECTS OF CASTOR(*Ricinus communis*) VARIETIES ON PRODUCTIVITY OF ERI SILKWORM (*Samia cynthia ricini*, Boisduval; Lepidoptera: Saturniidae) SILK IN THIKA, KENYA

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

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