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Evaluation of the effect and feasibility of pelleting Sickie bush/ Mupangara(*Dischrostachys Cinerea*) pods and leaves on the growth performance of weaned Mashonagoats in Ward 10, Shamva District of Mashonaland Central, Zimbabwe

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OF THE BACHELOR OF SCIENCE HONOURS DEGREE IN ANIMAL HEALTH,
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The undersigned certified that they have supervised and recommended to Bindura University of Science Education for the acceptance of the dissertation entitled **“Evaluation of the effect and feasibility of pelleting Sickle bush / Mupangara (*Dischrostachys Cinerea*) pods and leaves on the growth performance of weaned Mashona goats in Ward 10, Mashonaland Central Province, Shamva District, Zimbabwe,”** submitted in partial fulfilment of a Bachelor of Science Honours in Animal Health Production and Extension Degree.

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Declaration

I hereby declare that the project entitled” **Evaluation of the effect and feasibility of pelleting Sickie bush / Mupangara (*Dischrostachys Cinerea*) pods and leaves on the growth performance of weaned Mashona goats in Ward 10, Mashonaland Central, Shamva District, Zimbabwe**”, submitted to Bindura University of Science Education, Faculty of Agriculture and Environmental Science is my original work done under the guidance, supervision of TNC Mangwiro and Shamva Veterinary Services team. This piece of work is hereby submitted in partial fulfilment of the requirements of the award of a **Bachelor of Science Honours Degree in Animal Health Production and Extension**. Results attained in this thesis or any other extract thereof have not been submitted to any academic Institution or University for the award of any diploma or degree.

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Dedication

This piece of work is dedicated to my family and all those who worked tirelessly in assisting and encouraging me in this academic journey.

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My special thanks go to the Almighty for granting me the gift of life and strength during my academic journey. I would like to thank my family for unwavering support and endurance during my academic studying period. Immense gratitude goes to my supervisor Mr TNC Mangwirofor his great assistance, patience and academic guidance throughout my research period.

ABSTRACT

Feed scarcity and poor- quality forage remain major constraints to goat productivity in semi-arid regions of Zimbabwe. *Dischrostachys Cinerea* which is abundant browse species has a potential of becoming goat supplementary feed. However, its utilisation may be limited by presence of anti- nutritional factors such as tannins, tree height and by high fibre content. This study evaluated the effect and feasibility of pelleting *D. Cinerea* pods and leaves as supplementary feed for goats especially during the dry season period. Goats used in the experimental study were selected using purposive sampling as goats with specific characteristics such as age of 7 months were required. In terms of experimental design, a completely randomised design was used in which weaned growing goats were allocated to four dietary treatments. The treatments comprised of pods only, leaves only, pelleted mixture of pods and leaves (1:1) and a control diet of chopped thatch grass and maize stover at a ratio of 1:1, all these components were by weight. The feeding trial lasted for 99 days. Parameters measured included feed intake, average daily gain (ADG), feed conversion ratio (FCR) and economic feasibility of pelleting *D. Cinerea*. Goats fed on pelleted diet of *D. Cinerea* showed significantly higher average daily feed intake (29.7 kg) compared to those of pods only (21.45 kg), leaves only (27.12 kg), control (17.48 kg) and had the lowest feed refusal rate (mean 0.00) as compared to other diets. The control group lagged behind all the groups. The pelleted treatment resulted in the improvement of weight gain and feed conversion efficiency (Pods only ADG 0.05 kg/day, leaves only ADG 0.07 kg/day, Pellets ADG 0.09 kg/day, Control ADG 0.02 kg/day) and this was relative to the control group. The findings of the study suggest that pelleting enhances feed intake and growth performance and at the same time improves practicality of using *Dischrostachys Cinerea* as a supplementary feed. *D. Cinerea* has a potential of becoming a cost – effective and sustainable feed resource for smallholder goat production systems mostly done in the communal areas of Zimbabwe. Further research is recommended to evaluate long- term performance and economic viability of using *D. Cinerea* pellets under field conditions. Moreover, the research studies should investigate the shelf life and storage stability of pellets particularly moulds growth on pellets and nutrient deterioration during storage.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Small ruminants particularly goats, play an essential role in the livelihood of small holder farmers in Zimbabwe. They are a source of income, milk, meat, hides and enhancement of social security. Within African society, sheep

and goats comprise a greater proportion of the total wealth of the poor families than other richer families (Peacock, 1984). Over half of the population of goats are in arid zones prone to drought and feed scarcity (FAO, 1992). Therefore, productivity is constrained by seasonal feed shortage, poor nutrition and reliance on natural pastures of low nutritive value during the dry season. Despite this, browse species such as *Dischrostachys Cinerea* (Mupangara) are widely available in semi – arid areas of Zimbabwe and they have been shown to contain high crude protein of 16 -22 % and minerals, making them suitable for use as supplementary feed (Mudau et al, 2021). Feeding trials once done on goats have demonstrated that *D. Cinerea* pods improve growth and nitrogen utilisation (Mlambo et al., 2004; Maphosa et al 2009). However, direct utilisation of *D. Cinerea* is sometimes limited by its hardness, bulkiness and tannin contents which reduce palatability and digestibility (Marius et al., 2018). Processing techniques such as pelleting can be harnessed to improve intake and digestibility (Cooke et al., 2024).

This study, therefore, seeks to evaluate the effect and feasibility of pelleting *Dischrostachys Cinerea* pods and leaves on the performance of weaned Mashona goats in ward 10, Shamva District of Mash Central, Zimbabwe.

This study contributes in addressing myriad problems such as feed supply shortage, poor goat growth rate, inadequacy of nutrients and feed in improved quantity and quality at critical periods of natural feed shortages.

1.2 Background of the study

Shamva District (Mash Central) experiences a unimodal rainfall regime that stretches from November to April as a wet season.

Average rainfall ranges between 700- 1000 mm per year under normal seasons and the area is classified under region II. The area has sandy to sandy- loamy soils derived from granite. Agro- ecological characteristics of Shamva District favour mixed crop and livestock production systems. Crops such as tobacco, maize are grown and in livestock production there is goat and cattle production. The landscape encompasses woodland and shrub- savanna communities that include browse species such as *Dischrostachys Cinerea* (Muoni, 2024).

Farmers mostly rely on goat production as their major contributing factor to household income generation, financial security, meat production and this is in particular among the resource – poor farmers (Peacock, 1984). Besides being engaged into agriculture and livestock production some households in Shamva District are into artisanal mining and tourism related activities for income generation activities associated with the Umpfurudzi Safari. Some households have gained employment opportunities and informal trading there. However, these sources of income are seasonal and unreliable and this reinforces the continued importance of goat production as a livelihood strategy for most communal households.

Goats have become high value animals in Shamva District due to their adaptability to harsh environmental conditions, low input requirement and their ability to utilise a wide range of feed resources under marginal conditions. However, the level of income generation is severely compromised by weight gain of goats particularly in the dry season period (April – October). Goats also play a pivotal role in sustaining the livelihood of the communal farmers.

There is an average herd size of 6 goats per household and there is also a strong demand for goat meat, live animals for rearing purposes or for accomplishment of traditional ceremonial events such as “Kusungira”. However, the strong demand for goats is affected by the occurrence of the dry season from April to October that compromises the nutritive value of natural pastures declining both in quality and quantity. This often leads to reduced growth of goats and high mortality of weaned kids (Monau et al., 2020). Natural pastures such as *Hyparrhenia* spp (thatch grass) together with crop residues such as maize stover constitute major feed resources during the dry period. However, available feeds during this period are often characterised by low crude protein level, high fibre levels and this results in reduced digestibility and poor animal performance (Van Soest 1994).

In ward 10 browse species such as *D. Cinerea* that are rich in crude protein are found in abundance even during the dry season period. These browse species found in their abundance

levels have therefore become important supplementary feed resources in the semi arid regions (Mudau et al 2021). However, consumption of these browse species by animals like goats is affected by tree height, bulkiness and hardness of pods. Mudau et al (2021) highlights that browse plants commonly found in Southern Africa contain relatively high crude protein that ranges approximately 12 – 25 % and this makes them valuable protein supplements for ruminants in dry season period. *D. Cinerea* which is a widely distributed tree is said to be readily consumed by goats (Maphosa et al ., 2009). Studies which have been done in Zimbabwe show that its pods contain around 15 - 19 % crude protein and are readily eaten by goats (Mlambo et al., 2004; Maphosa et al., 2009.). Researches carried out on *D. Cinerea* show that leaves contained 16 – 19 % Crude Protein, which is well above the minimum of 7 % needed to maintain rumen microbial activity (Mudau et al (2021). Foliage is noted to contain 15 -18 % Crude Protein. Goats that were fed with supplemented *D Cinerea* showed a certain level of improvement on growth performance and better body condition (Smith et al., 2005). However, utilisation challenge remains on seed hardness and reduced palatability when fed unprocessed (Tjelele, Ward & Dziba., 2012).

Processing techniques such as grinding and pelleting have higher chances of mitigating these issues by reducing feed bulkiness, making feed more uniform and convenient (Mthiyane et al., 2019; Cooke et al., 2024). Researches that were done before were basing on ground meals and this one was basing on pelleting ground meals, this has been noted as a research gap. The intention of pelleting the feed is to reduce feed wastage and to improve feed intake. Therefore, evaluating the effect and feasibility of pelleting *D. Cinerea pods* and leaves as supplementary feed for goats may contribute towards developing affordable and sustainable feeding strategies for smallholder farmers residing in ward 10 and similar environments.

1.3 Statement of the problem

Nutritional deficiencies in the dry season limit goat production in Shamva District. This often leads to poor growth rates, high mortality rates of weaned kids and weight loss (FAO, 1992). Despite, the fact that *Dischrostachys Cinerea* is found in abundance and is rich in crude protein, its use as supplementary feeding remains limited and less accessed by goats due to its bulkiness and seed hardness (Marius et al., 2018). The alternative is to try to find a way of making the local feed source available to animals through pelleting. In Shamva District, farmers have a knowledge gap on practical feed processing technologies that could convert this underutilized browse into an effective supplement. With the harnessing of interventions such as pelleting, the productivity of Mashona goats can improve household income and food

security. Goat herd size of 6 per household is not improving. Seasonal drought affects productivity.

1.4 Justification of the study

Nutritional constraints, feed shortage and compromised Mashona goat growth has led to the need to improve goat productivity and weight gain. Income generation by smallholder farmers in Shamva District has negatively been affected by poor growth rates and low animal live weights and this has led to reduction in market value of goats and overall productivity. Previous studies have shown that feeding goats with pods and leaves in form of ground meal made the feed to become uniform and convenient (Mthiyane 2019). There is no study that supports that pelleting of *D. Cinerea* pods and leaves was once done, therefore this research seeks to support, improve feed uniformity and convenience through pelleting. In this regard, pelleting is being treated as a new innovative approach to make the once used bushmeal in form of meal by attempting to pellet it to improve efficient utilisation and storage life after producing it particularly for communal farmers in ward 10. The intention is to improve further feed intake, efficiency and growth performance and the study will demonstrate practically the pelleting process.

This completed study tries to provide answers and evidence for the feasibility of commercialized goat production, harvesting and pelleting *D. Cinerea* as supplemental goat feed (commercialising the natural feed). This will in turn support improved food security and boost livelihoods of rural farmers.

1.5 Study Objectives

1.5.1 Main objective

To determine the feasibility of pelleting *D. Cinerea* as protein supplement for goats.

1.5.2 Specific objectives

1. To assess the effect of pelleted *D. Cinerea* diets on the average daily gain (ADG) and growth performance of weaned Mashona goats.
2. To evaluate the feed conversion ratio of goats fed pelleted *D. Cinerea* diets against other diets.

1.6 Hypotheses

H₀: Pelleting *D. Cinerea* pods and leaves has no significant effect on the growth performance, feed intake or feed efficiency of weaned Mashona goats.

H₁: Pelleting *D. Cinerea* pods and leaves improves growth performance, feed intake and feed efficiency of weaned Mashona goats and is economically feasible.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Scholarly review literature relevant to the utilisation and pelleting of *Dischrostachys Cinerea* (*D. Cinerea*) pods – leaf mixtures in goat feeding systems are highlighted in this chapter. This chapter examines current knowledge on the browse – based feed in small ruminants, nutritional attributes of *D. Cinerea*, its limitations, pellet formulation technologies and the growth response of goats to browse supplements. The review identifies gaps in previously carried out studies and clarifies how the present research responds to these gaps, particularly to production of Mashona goats in the semi-arid smallholder systems.

2.2 Importance of Browsers in Smallholder Goat Nutrition

In Zimbabwe's smallholder areas browse trees and shrubs are vital in the dry season as feed resource for goats, where natural pastures decline in quality and quantity (Gwaze et al., 2020). Several studies report the ability of indigenous goat breeds to efficiently utilise high fibre browse materials due to their selective feeding behaviour and rumen adaptability (Sebolai et al., 2019). However, the palatability, availability and anti- nutritional factors vary widely among browse species.

Across Southern Africa researches done consistently show that browse supplementation improves feed utilisation, daily weight gain and survival of weaners during periods of feed scarcity (Mlambo & Mapiye, 2015; Sibanda et al., 2021). These findings demonstrate the potential of browse – based strategies, however, little work and lack of practical focus on *D. Cinerea* pod- leaf mixtures processed into pellets and feed to indigenous Mashona goats has been noted.

Gap: Limited research exists on converting *D. Cinerea* pods – leaf mixtures into pellets to enhance intake, reduce sorting and improve performance of indigenous breeds particularly Mashona goats.

2.3 Nutrient Composition of *D. Cinerea* pods and leaves

In Zimbabwe's semi-arid districts particularly Shamva, pods and leaves of *D. Cinerea* constitutes an abundant yet under- utilised feed resource. Studies carried out report that pods contain moderate crude protein (CP) levels that range from 12 -18 %, while leaves range

from 16 -22 % CP. These ranges make the pods and leaves to be suitable for maintenance and moderate growth in goats (Mupangwa et al., 2020; Mlambo et al., 2021).

It is argued that *D. Cinerea*, also contains tannins, which limit protein digestibility and reduce nutrient utilisation when fed in high amounts (Mlambo & Mapiye, 2015). However, recent scholarly studies argue that processing techniques such as pelleting, grinding, and adding binding agents can reduce the negative impact of tannins while at the same time improving nutrient availability (Ncube et al., 2022).

Gap: Suggestions have been given but practical evaluation of how pelleting modifies nutrient availability, intake behaviour and growth responses in weaned indigenous goats have not yet been done despite known nutritional potential of *D. Cinerea*.

2.4 Anti nutritional Factors and Strategies for Mitigation

Browse species with Tannin that include *D. Cinerea* complex with proteins reduce their digestibility (Mlambo et al., 2019). Studies recently done demonstrate that pelleting reduces tannin activity by binding them within pellet matrices or through heat generated Millard reactions (Muchadeyi et al., 2021). During pelleting addition of molasses or other binders has also shown to improve palatability, energy density while promoting higher dry matter intake (Ncube et al., 2022; Sibanda et al., 2021).

Gap: No empirical evidence specifically exists assessing how pelleting *D. Cinerea* pods- leaf mixtures improves growth outcomes and alters tannin effect in Mashona goats.

2.5 Goat Growth Performance on Browse- based Diets

Carried out studies in Zimbabwe and other countries like Botswana show that goat kids supplemented with browse meals or pods achieve higher daily weight gain than unsupplemented controls (Mwenya et al., 2020). Most studies evaluated browse meals, hay or fresh leaves rather than pellets. Researches that were done show that feed pelleting increases intake, reduces feed wastage and improves growth performance (Ncube et al., 2022)

Gap: No specific studies have yet quantified how *D. Cinerea* pellets specifically influence Average daily gain, feed conversion, or weaned goat survivability in communal Zimbabwean conditions.

2.6 Feasibility of using *D. Cinerea* as Goat feed source

Feasibility encompasses availability, cost effectiveness, processing practicality and farmer acceptance of use of the local supplementary feed. *D. Cinerea* is abundant and regarded as invasive; harvesting pods and leaves has dual benefits- feed provision and environmental control (Musvoto et al., 2020). Pellet production may be cost effective for farmers where local cooperatives or small feed mills exists (Nhongo et al., 2023). Studies show that smallholder farmers easily adopt beneficial ideas such as those that reduce bulkiness, storage and improve intake (Sibanda et al.,2021).

Gap: No feasibility study assessment specific to ward 10 of Shamva District exists in regard to farmer's access to raw material, cost of pelleting, equipment availability and practical adoption.

2.7 Synthesis of literature and knowledge Gaps

Reviewed literature confirms that Pelleting enhances feed intake and performance in browse specie diets. Browse resource is vital for dry season goat feeding and indigenous goats respond positively to browse supplementation .*D. Cinerea* has adequate crude protein and energy to support growth. Processing improves utilisation limitation caused by presence of Tannins

Major gaps however, remain regarding:

1. Effect of pelleting *D. Cinerea* pods and leaves on nutrient digestibility and growth performance of Mashona goats.
2. Feasibility and practicality of producing *D. Cinerea* pellets in Zimbabwean communal context
3. Scientific evaluation of pod – leaf combination in pellet form with weaned Mashona goats

This study covers these gaps by evaluating intake, growth performance, feed conversion ratio and feasibility of using *D. Cinerea* pellets in Ward 10, Shamva District of Zimbabwe.

2.8 Summary

Practical attention towards pelleting *D. Cinerea* as supplementary for indigenous Mashona goats has not yet been given. The current study examines both the biological performance and feasibility of pelleting *D. Cinerea*, providing evidence needed to support adoption of sustainable locally available feed.

CHAPTER 3

METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Madziva Ward 10, located in Mash Central Province, Shamva District, Zimbabwe. The distance from Harare to Shamva is approximately 150km. The area is located on the North- East part of Shamva District centre. When using Global Positioning System (GPS) Madziva area lies at north of Latitude (-17.029361) and East of longitude (31.50868). Altitude is 1091m. The area falls under Agro – Ecological Region IIb, receiving annual rainfall of 700 -1000 mm, with seasonal rainfall occurring between November to March. Madziva area generally experiences warm climatic conditions year round, characterised by distinct wet and dry seasons. Mean annual temperatures range between 18 - 28 °C and Maximum daily temperatures can reach up to 38 °C in the hottest months of October to December.

Agro- ecological characteristics of Shamva District favour mixed crop and livestock production system. Crops such as maize, tobacco are immensely grown for livelihood sustainability. In livestock production there is goat and cattle production. Tourism is also practiced and farmers benefit by selling crop produce such as vegetables and animals like goats to tourists and lodges but this is practiced to a lesser extent. Gold mining also plays a pivotal role by acting as a prominent activity during periods of agricultural uncertainty. Despite the fact that it causes environmental degradation, it remains another source of income generation in Shamva particularly in areas like Chakonda.

The landscape encompasses shrub- savanna and woodlands communities. Vegetation is predominantly Miombo woodland that consists mainly of *Brachystegia* species *Jubernadia globiflora*, *Acacia karoo* and *Dischrostachys Cinerea*. The soils found comprise of sandy to sandy loamy soils that favour *D. Cinerea* growth in abundance. Smallholder farmers in Madziva practice mixed farming that encompass crop – livestock farming systems, where indigenous goat, cattle and poultry dominate. Livestock in the area are mostly reared under extensive production system, supplemented with crop residues such as maize stover and available browse species during the dry season. Goats are housed in wooden housing at night for security and health management reasons. Water for livestock is drawn from community

boreholes, wells and seasonal rivers. There is very minimal treatment and, deworming of livestock.

The map below shows Zimbabwe map, Mashonaland Central Province, Shamva District from which Madziva area ward 10 lies within

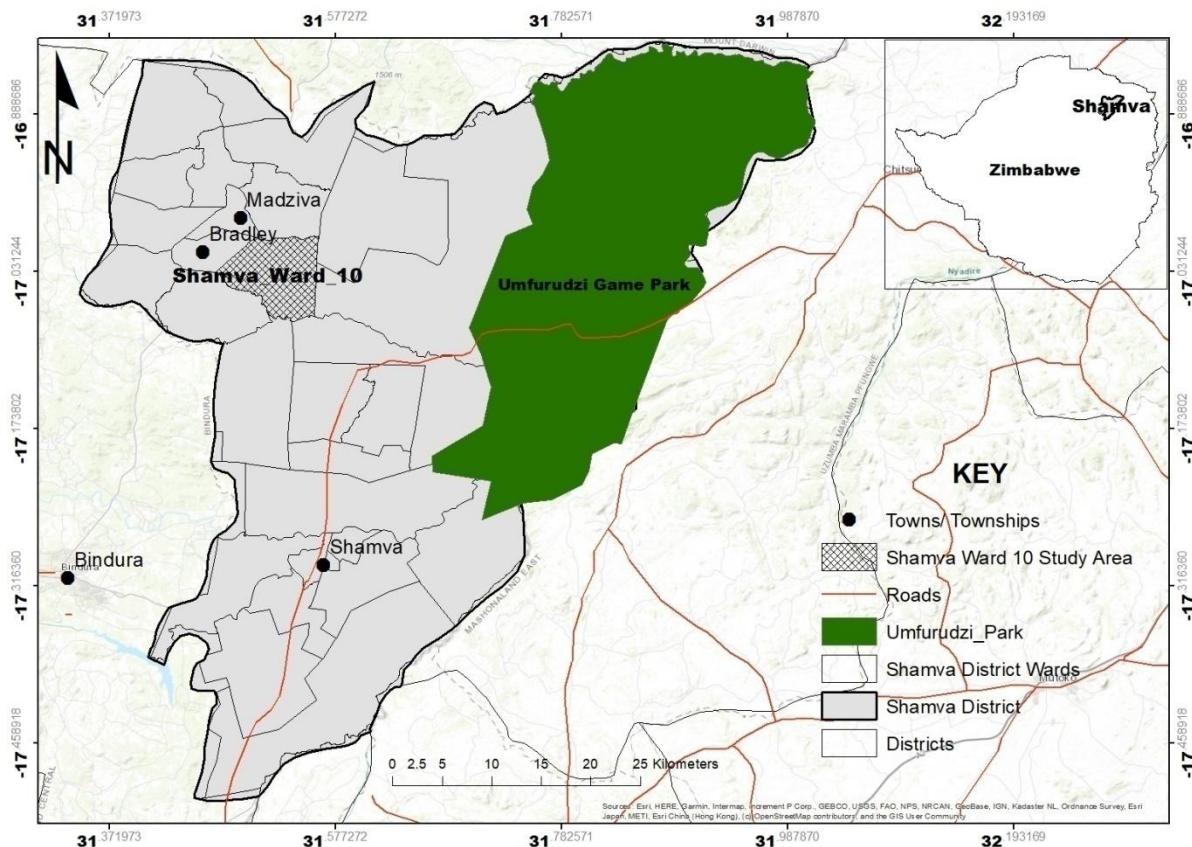


Figure 3.1 Study Area Map

3.2 Experimental Treatments

Four treatments based on diet constituted the experimental factors and were randomly assigned within each block where T stands for Treatment. This design was appropriate in making sure that the objective to measure cause and effect relationship between feed type and animal performance was met properly. The dietary treatments were grouped as below:

1. T1 (Block A): *D. Cinerea* pods

Mature pods were collected from the trees of the surrounding environment and these were sun dried for 7 days to reduce moisture content and prevent spoilage. Drying was also done to minimise mould growth, improve storability and to maintain feed quality. The dried pods

were subsequently offered to goats as dietary treatment at 300g per goat per day without being crushed.

2. T2 (Block B): *D. Cinerea* leaves

The *D. Cinerea* leaves were collected air dried to reduce moisture content. Drying was aimed at enhancing storability and preserving nutritional integrity of the feed prior to its use. The dried leaves were then fed to goats at 300g per goat per day without being crushed.

3. T3 (Block C): Pelleted mixture of dry *D. Cinerea* pods + dry leaves

D. Cinerea mature pods and leaves were harvested from the study area. Leaves were air dried and pods were sun dried for seven (7) days to reduce moisture content and prevent mould development during storage. The dried material was milled and passed through a 3 mm hammer mill to produce fine and uniform meal. The leaves and pods were then mixed in a 1:1 ratio and processed into pellets using a pellet machine fitted with 4 mm die. The intention of pelleting was to reduce bulkiness, selective feeding and minimised feed wastage. Processing was also aimed at enhancing nutrient utilisation and palatability of feed.

4. T4 (Block D): Control diet (standard browse diet)

A standard browse diet was used and this was obtained from the natural veld grazing. It consisted of thatch grass (*Hyparrhenia* spp) and crops residues of maize stover. Maize stover comprised of dried maize leaves, stalks and husks. Chopped thatch grass and maize stover were mixed at a ratio of 1:1 by weight. Feed was generally coarse, bulky and fibrous in texture. The diet often has low nutrient content (maize stover 3- 6 % crude protein, thatch grass 3 – 7 % crude protein) during the dry season. This kind of feed is associated with reduced digestibility and lower animal performance. No *D. Cinerea* supplementary was offered

Five goats were randomly assigned to each treatment, giving a total number of 20 female weaned Mashona goats with the age of 7months. Prior to the commencement of experiment, goats were acclimatised to experimental conditions for 14 days. . During the experimental period, all test animals were housed in well ventilated pens with adequate space to allow free movement and minimise stress. . Experimental animals were individually housed in separate pen to facilitate precise monitoring of feed intake, refusals and growth performance. The pens were positioned next to each other to allow visual and limited social interaction among goats.

This was done to reduce stress and behavioural disturbances associated with isolation. On daily basis goats were allocated to different dietary treatments and were fed once at 0800 hours. Throughout the experimental period, clean drinking water from the borehole was provided at ad libitum level. Feed refusals were collected before fresh feed was offered.

Routine health management practices were observed throughout the study period. Goats were first dewormed and animal inspections were regularly done to check for signs of disease or distress. All test animals were managed under similar environmental and management conditions to minimise experimental variation not related to dietary treatments.

3.3 Preparation of Experimental Diets

3.3.1 Collection of Feed Materials

Dischrostachys Cinerea leaves and pods were harvested from ward 10 natural rangelands. Healthy green leaves and only mature pods were collected. All foreign materials such as stones and soil were removed manually.

3.3.2 Drying process

The pods were sun dried and the leaves were air dried. The pods were placed on raised wrecks for approximately 7 days. The purpose of raised wrecks was to reduce soil contamination and microbial contamination of the collected feed. Complete drying was only considered when material was brittle and easy to grind.

3.3.3 Grinding

The dried leaves as well as the pods were ground separately. A hammer mill known as Akon with China Model XH 220 was used in grinding the dried pods and the leaves. A 3mm sieve was used to obtain a uniform particle size suitable for pelleting and feeding

3.3.4 Formulation of Pelleted Diet

The pellets for treatment 3 were formulated by mixing the ground pods and leaves at a ratio of 1:1 on dry matter basis by weight, such that before pelleting 1kg of pod meal was combined with 1 kg of leaf meal.

The mixture was thoroughly blended to ensure uniform distribution of nutrients. Molasses (5 %) was then used as a binder to the mixed material to improve pellet cohesion, reduce feed dustiness and enhance palatability. 1part molasses was mixed to 3 parts of water and 1.25 litres of mixture to every 10 kg of the mixed dry feed matter and this was done to achieve

adequate conditioning moisture required for pellet formation without excessively wetting the trial material. 10 % of warm water per every total weight of dry mater was used and this was done to ensure a smooth, low viscosity liquid mixture suitable for pelleting. Warm water was also used to improve mixing efficiency and pellet quality. The selected formulation levels were basing on common feed pelleting practices in animal feed processing literature (Thomas et al., 2012).

Selection of these formulation ratios were done as an intention of optimising pellet quality, binding efficiency and processing characteristics. The purpose of diluting molasses with warm water at 1:3 ratio was to reduce the viscosity of molasses and to ensure uniformity distribution within the feed mixture. Inclusion of 5 % molasses was meant to improve binding and palatability. The addition of approximately 1.25 litres of solution per 10 kg feed mixture (ground pod +ground leaves) provided adequate conditioning moisture allowing effective pellet formation. Use of warm water equivalent to 10 % of the dry matter weight was used to improve mixing efficiency, reduce viscosity as well as to facilitate smooth pelleting without excessively increasing feed moisture content that can affect pelleting and pellet quality.

The mixture was thoroughly mixed until slightly damp and not soaked to allow efficiency in the pelleting process.

3.3.5 Pelleting Process

A pelleting machine from South Africa with model P – 160 having 4mm die was used in coming up with pellets of 4mm diameter size and a length of 6mm. The mash was compressed by the machine under pressure to produce cylindrical pellets. The final pelleting process was then completed by spreading the pellets on clean surfaces and these were air dried for 48 hours to reduce moisture and improve hardness. The purpose of reducing moisture was to reduce incidences of feed moulding and spoilage.

3.3.6 Feed Storage

The prepared feeds of pods only, leaves only, the pellets and control diet (dry thatch grass and maize stover) were then stored in polypropylene bags. The bags were also placed on raised platforms in a dry, well ventilated room to prevent fungal growth and contamination. On a similar way, the control diet components namely dry thatch grass and maize stover were stored under dry hygienic conditions to maintain feed quality and reduce feed spoilage prior to feeding.

3.4 Experimental Animals and Management

20 female Mashona goats aged 7 months were sourced locally in ward 10. They were screened for diseases by the veterinarian. Upon arrival, goats were ear tagged for ease of identification, vaccination against Pulpy kidney disease and Pasteurella was done using Multivax P Plus at 2mls per goat. Goats were dewormed using Albendazole (dose 2.5 mls / 10 kg live mass). Triatix dipping chemical was used for controlling external parasites such as mange mites. Vaccinating and deworming goats before onset of experiment were done to avoid confounding factors in the experiment such death of animals before experimental results were achieved and also to ensure that weight gain reflects feed effects not disease effects. Goats underwent a 14 day adaptation period to housing and general handling prior to feeding trial. Individual housing of 4m² was facilitated to ensure accurate individual feed intake measurement. The spacing allowed enough animal free movement, feeding space and resting area. Clean water and mineral licks were provided adlibitum. The target population consisted of growing weaned goats suitable for fattening. A purposive sampling method was used in selecting healthy goats of the same breed and in this scenario it was the Mashona goats.

3.5 Ethical Consideration

All procedures that were done followed the animal welfare guidelines that are recommended by the Division of Veterinary Field Services. Goats were handled in a humanely manner and were monitored daily for health and comfort

3.6 Research Design and Experimental layout

The design employed a quantitative experimental design as the aim was to measure and compares the effects of different forms of *Dishrostachys Cinerea* (pods only, leaves only, pellets and control). The design enabled the researcher to objectively evaluate how each treatment influenced variables such as feed intake, growth performance and feed conversion efficiency. The quantitative methods were appropriate as the study involved measurable variables such as body changes and feed consumptions and refusals that needed to be recorded numerically.

A Randomised complete Block Design (RCBD) was employed. Weight range was used as a blocking factor and this was due to the fact that goats had slight variations in initial body weights (Fisher, R. A, 1935). The weight ranged from 11 kg to 16 kg. Blocking the

experiment reduced the experimental error and ensured that weight differences did not bias treatment effects on weight gain

The Mashona goats were first weighed to determine the initial body weight of each goat. Basing on the obtained weights, goats were grouped into five (5) blocks with each containing four (4) goats of similar weight range. Within each block the four treatments were randomly assigned.

Table 3.1 Experimental layout for RCBD (20 Goats)

Block	Goat Number	Weight Range (kg)	T1 Pods	T2 Leaves	T3 Pellets	T4 Control
Block 1	G 1 – G 4	11 - 12kg	1 goat	1 goat	1 goat	1 goat
Block 2	G 5 _ G8	12 – 13kg	1 goat	1 goat	1 goat	1 goat
Block 3	G9 - G 12	13 - 14kg	1 goat	1 goat	1 goat	1 goat
Block 4	G13 – G 16	14 - 15kg	1 goat	1 goat	1 goat	1 goat
Block 5	G17 – G20	15 - 16kg	1 goat	1 goat	1 goat	1 goat

3.7 Experimental procedure

Each goat was fed at 8:00 Hours, once a day and received predetermined amount of feed ((300 g per goat, per day of feed). Feed was offered daily on fixed rates of 300g .Feed refusals were collected and weighed to determine actual feed intake. Body weight was measured on fortnightly bases. The feeding trial lasted for 14 weeks

3.8Data Collection Procedures

The following parameters were measured:

3.8.1 Weight Measurement

Live weights of goats were measured using a Chinese digital scale (model CS300, 300kg capacity, ± 0.1 kg accuracy) at initial onset of the experiment and then fortnightly in the morning before animal feeding. The same digital weighing scale was also used for weighing feed.

Average Daily Gain (ADG) was calculated as: $ADG = \frac{\text{Final weight} - \text{Initial weight}}{\text{Days}}$

Number of days

3.8.2 Feed intake Measurement

Feed offered as well as refusals were recorded daily. Feed intake is shown as:

Feed intake = Feed offered – feed refusal

3.9 Health Monitoring

Animal behaviour, coat condition, temperature, appetite and faecal consistency were closely monitored on a daily basis.

3.10 Quality Control Procedures

To ensure validity and accuracy of measurement, weighing scale (CS 300, 300kg capacity $\pm$ 0.1 accuracy) was calibrated before data collection. Calibration is the known process of checking and adjusting a weighing scale to ensure measurement accuracy and this is regarded mandatory (ISO, 2017). Recalibration was done on weekly basis to maintain precision as well as to minimise instrumental drift associated with repeated use such as daily use on weighing feed rations and fortnightly use on weighing goat weight. Randomization was employed and this was meant to ensure minimised bias within blocks. Each weighing was replicated twice and averaged. Samples of feed for nutrient analysis were collected daily, stored in air tight bags. (AOCS, 2007). Pretesting of data collection sheet was done to ensure consistency.

3.11 Data analysis

Data on weight gain, Average Daily Gain (ADG) and Dry Matter Intake (DMI) were analysed using **Analysis of variance of (ANOVA)** for RCBD in **SPSS Version 23**

The statistical model used was:

$$Y_{ij} = \mu + T_i + B_j$$

where

Y_{ij} = observed response (weight gain)

μ = overall mean

T_i = effect of i- th treatment

B_j = effect of the j- th block

ϵ_{ij} = Random error Significance means were separated using the Least Significant Difference (LSD) at **P < 0.05**

CHAPTER 4

RESULTS

4.1 Feed intake

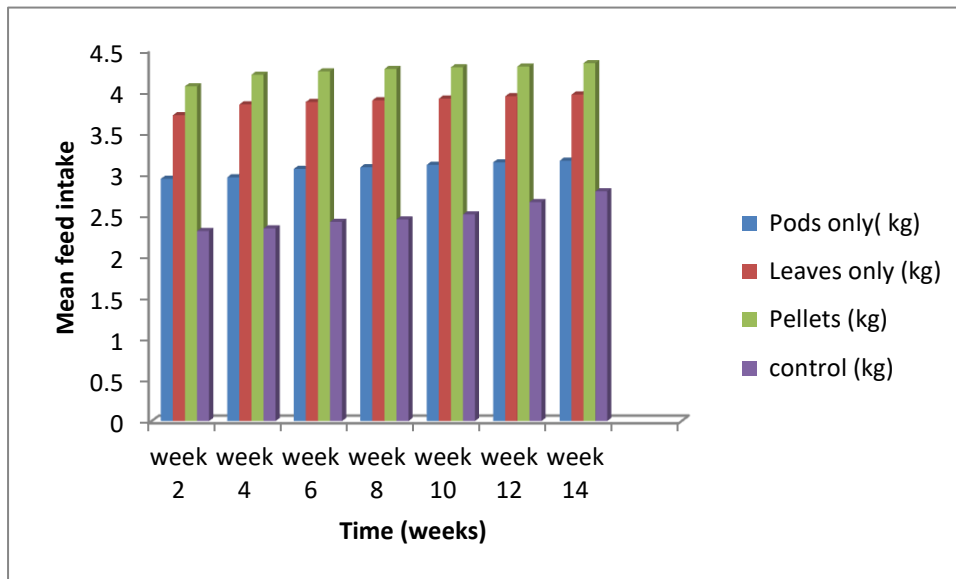


Figure 4.1 Mean feed intakes for treatments

The same amount of feed (300g per goat per day) was offered to trial animals. The duration of feeding lasted for 14 weeks (99 days). There were significant differences in terms of feed intake on the different treatments that were present. *D. Cinerea* pellets had the highest feed intake (mean = 29.7 kg) by week 14. At the same calculated period the following sequential orders were noted: leaves (27.12 kg), pods(21.45 kg) and control lagged behind (17.48 kg).

4.2 Growth Performance

4.2.1 Effect of *D. Cinerea* on Goat weight and Average Daily Gain (ADG)

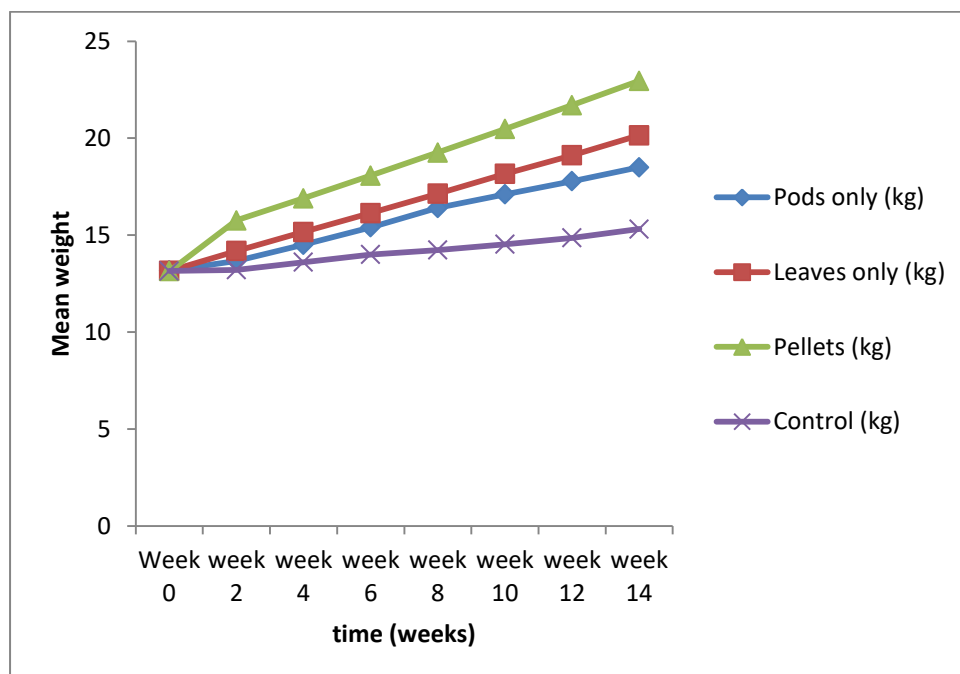


Figure 4.2 Mean Weight Gain

20 female Mashona goats were subjected to 4 different treatments (pods, leaves, pellets, and control) for a period of 14 weeks. The weights of goats for each treatment were recorded on a fortnightly basis period. Goats that were fed *D. Cinerea* pellets had the highest mean weight gain (22.96 kg) by week 14. The mean for pellets were followed by leaves only (20.15 kg), pods (18.5 kg) and control (15.31 kg). There was significant difference in weights gained by goats that were offered different treatments of pods only, leaves only, pellets and the control diet. Significant difference in the Average Daily Gain of goats for the treatments that were offered was also noted. The ADG was highest in goat fed pellets (0.09), leaves (0.07), pods (0.05), control (0.02)

4.3 Feed Conversion Ratios (FCR)

Feed Conversion Ratios for all treatments were recorded for a period covering 14 weeks. The recording were pellets (3.02), leaves only (3.87), pods only (4.05), control (8.09). Goats that were fed *D. Cinerea* pellets proved to have the lowest FCR (3.02). This suggests that *D. Cinerea* pellets had an effective feed conversion ratio as compared to leaves, pods and control diet. Control feed had the highest conversion ratio and means that it was the most inefficient feed for goats.

4.4 Feed Analysis Laboratory Results for *D. Cinerea* pellets

Results from laboratory analysis of *D. Cinerea* pellets are shown below on table 3.2

Test Parameter

Table 3.2 *D. Cinerea* Feed Analysis Results

Moisture Content	Crude Protein	Fat	Crude Fibre	Ash	Starch	Acid Detergent Fibre	Neutral Detergent Fibre
%	%	%	%	%	%	%	%
9.94	16.43	2.72	15.40	8.30	Not Detected	18.47	33.25

Table 3.2 above shows the nutritional values of different parameters that ranged from moisture content to Neutral Detergent Fibre. The percentage of crude protein was 1.03 % higher than that of crude fibre. No starch was detected in feed. The critical nutrient needed for growth performance change is Crude Protein (16.43 %).

4.5 Health observations

There were no signs of digestive disturbances or mycotoxicosis that were observed during the experimental period. Mortality rate was zero across all treatments.

4.6 Economic Feasibility of Pelleting *Dischrostachys Cinerea* pods and leaves

A market price research was carried out to find out the costs of commercial goat pellets and that of producing *D. Cinerea* pellets (pods and leaves). The price of goat pellets known as the Goat and Sheep Nuts produced by animal feed manufacturer Fivet was observed to be \$23.50 per 50 kg. On the other hand, \$9.61 was for producing a 50kg bag of *D. Cinerea* pellets. Production cost per kilogram of *D. Cinerea* amounted to \$0.19 while of commercial pellets was \$0.47.

4.7 Summary of Findings

A significant improvement in weight gain was noted on goats fed pelleted diets. Leaves showed higher feed intake than the pods and the control diet. Significant differences were observed among treatments ($p < 0.05$).

CHAPTER 5:

DISCUSSION

5.0 Introduction

This discussion hereby interprets the results presented in chapter 4 in relation to the existing literature. Emphasis is placed on *D. Cinerea* pellet feed laboratory analysis report, *D. Cinerea* pellet feed intake, growth performance of weaned Mashona goats, feed conversion efficiency as well as the economic feasibility of pelleting *Dischrostachys Cinerea* pods and leaves as supplementary feed during the dry season period. Comparison with previous studies on browse species and feed processing in small ruminants was done with the current study findings.

5.1D. *Cinerea* pellet feed Laboratory Results and Feed Nutritional Value

The positive impact of *D. Cinerea* pellets on goat growth performance of female Mashona goats prompted samples to be taken for laboratory analysis to find out the nutritional value of the treatment.

Laboratory analysis of *D. Cinerea* pellets which was done under Fivet Company indicated that the feed contained 16.43 % of Crude Protein. This percentage lies within expected nutritional quality (12 – 25 %) for supplementary goat feeding that mainly targets the dry season. Mudau reported that the range for browse species used in Southern Africa range between 12 -25 % (Mudau et al., 2021). On a similar note and view, Mupangwa et al (2020) highlighted that crude protein levels that range from 16 -22 % are deemed adequate for goat growth and body maintenance. The inclusion of leaf material may have attributed to high protein levels due to presence of higher nitrogen concentration. On another note, improved goat growth performance may have been attributed by efficient rumen microbial activity and tissue developed which might have been as a result of presence of dietary proteins (McDonald et al., 2011).

The recommended moisture content of livestock feeds ranges approximately 8 – 12 % for pellets. Thomas (1997) supports the idea that proper moisture control is vital for good pellet quality and storage stability. Therefore, the *D. Cinerea* pellets moisture content of 9.94 % fits within the expected pellet feed moisture range (8 % – 12 %). The moisture content obtained

of 9.94 % suggests that the drying as well as the storage procedures used in this study were effective in maintaining pellet stability, reduced the risk of fungal spoilage and has higher chances of enhancing feed shelf life. Emphasis on the importance of proper maintenance of pellet quality, storage stability was highlighted also by Behnke (1996) as a way of reducing microbial spoilage and increasing feed shelf life.

Moderate fat levels are essential in providing supplementary diet with energy, without negatively affecting rumen fibre digestion. Doreau and Ferlay (1994) reported that ruminant diets generally contain 2 – 5 % on dry matter basis. Therefore, the ether extract (Fat) content of 2.72 % that was obtained in this study was noted to have fallen within the moderate range (2 % - 5 %) commonly recommended for ruminant feeds. Van Soest (1994) reported that fat levels that are excessive have a tendency of reducing rumen microbial activity and reducing fibre digestion. The moderate fat content value obtained may have increased or maintained rumen microbial activity and increased fibre digestion. In this study, a moderate fat content of 2.72 % may have contributed to increased growth performance (mean weight 22.96) and reduced (FCR) Feed Conversion Ratio (3.02) for pelleted diet.

The Crude Fibre (15.40 %), Acid Detergent Fibre (18.47 %) and Neutral Detergent Fibre (33.25 %) values that were obtained suggests that there was presence of moderate fibre levels and potentially good digestibility of the pelleted diets. The values above lie within the acceptable recommended ranges (Crude Fibre 10 -25 %, Acid Detergent Fibre 18 -35 %, Neutral Detergent 30 -50%). Lower Acid Detergent Fibre value is associated with improved digestibility and moderate Neutral Detergent Fibre concentrations tended to improve voluntary feed intake. In comparison to dry season feeds such as mature veld grasses and maize stover, the *Dischrostachys Cinerea* pellets that were produced basing on this study may have provided improved nutrient availability and intake potential.

Laboratory analysis of *D. Cinerea* pellets concluded that there was Ash content of 8.3 % and this falls within the acceptable ash range (5 – 10 %). This range may also include minerals for normal physiological functions in goats (McDonald et al., 2011). Minerals are essentially important for bone development, enzyme activity and metabolic processes.

In the pelleted sample of *D. Cinerea* diet starch was not detected and this is expected as browse species have very low or no detectable starch during laboratory analysis. Starch is

found in cereal feed products such as those containing maize and this may be the reason why it was not detected in this browse species diet.

In an overall view, the nutritional composition of *D. Cinerea* pellets suggests that *D. Cinerea* can be used as an ideal dry season supplementary feed for Mashona goats that are under smallholder farming conditions. Presence of high crude protein, acceptable moisture content and moderate fibre levels indicated a relatively high potential for supporting goat maintenance and growth. Pelleting also has a potential of utilising locally available browse resources in a more profitable manner such as improving goat weight gain as well as to increase market income generation.

5.2 Effects of Treatments on Feed intake

Feed intake is noted as a critical parameter in evaluating the acceptability and nutritional suitability of experimental diets in livestock. In this study, goats across all treatments were offered a fixed daily ration of 300g per animal over a period of 99 days. A total feed allocation of 29.7 kg per goat was offered for the entire experimental period. However, actual intake may have varied slightly among the subjected treatments due to differences in palatability, texture and feed nutrient compositions that were exhibited per each diet.

Goats fed pelleted diets generally showed improved feed intake compared to those fed unprocessed pods or leaves alone separately. Presence of such uniformity in results is associated with improved feed homogeneity, enhanced feed palatability and reduced selective feeding and this is due to pelleting process of feed that was done. Feed pelleting ensured consistent nutrient consumption across animals and this is critical for reliable performance evaluation.

The superior performance of the pelleted treatment is noteworthy. This is in support of other researchers who note that processing of forage into pellets often improves feed intake and digestibility by reducing particle size and selective feeding (McDonald et al., 2010). Similar findings were reported by Retnani et al. (2022), who observed improved intake and digestibility in small ruminants fed pelleted diets compared to mash forms. This may explain why pellets yielded better results than pods or leaves offered in their raw forms. There was better feed intake in goats fed on leaves only compared to those fed on pods only. The relatively lower feed intake observed in goats fed pods only may be explained by the

presence of condensed tannins in browse species. It can be noted that condensed tannins are known to reduce palatability and feed intake (Makkar, 2003).

The significant difference ($p < 0.05$) in Average Daily Gain and final weights between pellets and all other treatments, including other *D. cinerea* forms (as shown in the LSD tests for weeks 12 and 14), underscores the importance of feed processing. Similar enhancements in nutrient utilization and growth from pelleted roughage-based diets have been reported in sheep and goats (Sultan et al., 2019).

Smallholder farmers in Zimbabwe rely heavily on natural browse resources, often without supplementation (Charambira et al, 2021). The improved feed intake observed with pellets suggests that processing browse materials could efficiently enhance nutrient utilisation in smallholder systems.

5.3 Effect of Treatments on Growth performance

The results demonstrate a clear positive effect of *Dichrostachys Cinerea* supplementation on Mashona goat growth performance, particularly when administered in pelleted form. Over the 14-week trial period, goats fed *D. cinerea* pellets achieved the highest final mean weight of 22.96 kg and Average Daily Gain (ADG): 0.09 kg/day, significantly outperforming the control group (15.31 kg) mean weight and Average Daily Gain (0.02 kg/day). Pods and leaves also promoted better growth than the control, though to a lesser extent than pellets. This attributes that pelleting has shown to improve feed efficiency and growth performance in goats (Adejoro et al., 2023).

The improved weight gained is also closely linked to reduced feed wastage and more consistent crude protein nutrient intake in pelleted diets.

5.4 Feed Conversion Ratio (FCR)

A critical finding is the Feed Conversion Ratio (FCR). The *D. cinerea* pellet group maintained a consistently low and decreased FCR to 3.02, indicating high efficiency in converting feed to body mass. As the FCR drops, the cost of production decreases, resulting in higher profitability in terms of production costs.

In stark contrast, the control feed had an exceptionally high FCR (>10), classifying it as highly inefficient. The FCR for leaves and pods was intermediate.

This demonstrates that *D. cinerea*, especially in pelleted form, provides a more balanced and digestible nutrient profile than the basal diet alone. Improved FCR with leguminous tree fodder supplementation is well-documented, attributed to higher protein content and improved rumen fermentation, leading to better microbial protein synthesis (Aregheore, 2004; Ben Salem & Smith, 2008).

The significant ANOVA results ($p=0.000$) for both ADG and FCR across all weeks confirm that the type of dietary supplement is a major determinant of growth efficiency in this context. The Least Significance Difference (LSD) comparisons further elucidate that by week 10-14, the control group was statistically inferior to all *D. cinerea* treatments, and the pellet group was often superior to the leaves group. This hierarchy (Pellets >Leaves>Pods>Control) suggests that the nutritional value or palatability of *D. cinerea* varies with the plant part and its presentation. In addition, the combination of pods and leaves in pellet form may have diluted anti – nutritional factors while maintaining adequate nutrient supply.

5.5 Nutritional Implications of *Dischrostachys Cinerea*

Browse species are valuable supplements during the dry season. However, their utilisation is often limited by anti – nutritional factors such as tannins (Min et al., 2003). Hence, processing methods including grinding and pelleting can improve utilisation of browse feeds (Olatunji et al., 2021).

Negative effects of tannins can be reduced by pelleting through binding them or altering their interaction with dietary proteins.

Therefore, pelleting pods and leaves together may enhance overall nutritional value and make the feed more suitable for goat supplementation particularly during the dry season.

5.6 Economic feasibility of pelleting *D. Cinerea* in Zimbabwe

In Zimbabwe *D. Cinerea* is found in abundance and is often regarded as invasive tree species. Its utilisation as livestock feed may offer nutritional and environmental benefits. Goat production by smallholder farmers in Zimbabwe faces feed shortage and limited supplementation practices (Charambira et al., 2021).

In contrast to this view, there are now several feed manufacturers now producing commercial feeds for goats in large scales. However, these commercial goats feed supplements such as Goat and Sheep Nut produced by Fivet for example, have a high price mark up and this is not feasible for financially constrained farmers. This paves way for improving local natural feed resources to enhance productivity and market participation (Setoboli et al., 2025). Regional evidence supports feed supplementation strategies as a pathway to improved goat productivity and food security (Cooke et al., 2024). Basing on the feasibility part, price investigation which was done at Fivet (animal feed manufacturer) showed that a 50 kg bag of feed is currently being purchased at \$23.50 and cost of pelleting *D. Cinerea* pods and leaves was \$9.61. The cost per kilogram of commercial feed was \$0.47 while that of *D. Cinerea* was \$0.19. There is a significant difference in terms of price per kilogram between the two feeds of \$0.28 in comparison. The comparison showed that pelleted feed from the local invasive plant was economically viable compared to commercial supplements. Therefore, pelleted *D.Cinerea* could contribute to sustainable goat production in Zimbabwe.

Future research should focus on optimizing the pelleting process, conducting long-term feeding trials, and evaluating the economic viability of using *D. Cinerea pellets* in different production systems.

5.7Comparison with other literature

The findings of this study align with previous researches, showed that feed processing improves intake, digestibility and growth in small ruminants (Adejero et al., 2023; Retnani et al., 2022)

Comparing these results further to existing literature, the positive response to *D. cinerea* is consistent with studies on other multipurpose trees. For instance, work on *Leucaena leucocephala* and *Gliricidia sepium* has shown similar improvements in goat live-weight gain

and feed efficiency (Patra et al., 2012). However, the pronounced advantage of pellets highlights a potential area for technological intervention in smallholder systems. The results contrast with some studies where raw browse supplementation yielded only marginal benefits, possibly due to anti-nutritional factors like tannins (Mueller-Harvey, 2006). The fact that *D. Cinerea* performed well suggests that any such factors in this species may be present at non-detrimental levels or are mitigated by processing.

5.8 Study limitations

The study duration lasted for 14 weeks and this period may not reflect fully the long – term production effects of using *D. Cinerea* pellets on goats. In addition, one of the other limitations of this study was the inability to conduct detailed laboratory analysis of condensed tannin levels in *Dischrostachys Cinerea* pods and leaves that may have adverse effect on feed intake. Financial constraints hindered the carrying out of comprehensive biochemical analysis of anti – nutritional factors. Due to that the discussion of tannin effects was based on the existing literature rather than measured tannin concentration from experimental samples.

5.9 Conclusion of Discussion

The findings of the study indicate that pelleting of *Dischrostachys Cinerea* pods and leaves improves feed intake, growth performance and feed conversion efficiency as compared to unprocessed forms and the control diet. The combining of pods and leaves appeared to be nutritionally advantageous and may dilute anti – nutritional factors such as tannins.

Given the abundance of *D. Cinerea* in Zimbabwe and the feed constraints faced by smallholder farmers residing in the communal areas, pelleting this browse species presents a promising supplementary feeding strategy. Adoption of such innovations could otherwise enhance goat productivity, food security and contribute to improved livelihoods.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introductions

This chapter presents a summary of the major findings of the study titled:

“Evaluation of the effect and feasibility of pelleting sickle bush/ Mupangara (*Dischrostachys Cinerea*) pods and leaves on the growth performance of weaned Mashona goats in ward 10, Shamva District, Mash Central, Zimbabwe.

Conclusions which were drawn from the results are further outlined. The chapter also provide practical recommendations suitable for smallholder farmers and stakeholders such as government institutions (Division of Veterinary Services). The recommendations also suit similar agro- ecological regions where goat production is being practiced.

6.2 Summary of the Study

The study evaluated the growth performance of weaned Mashona goats and the economic feasibility of pelleting *Dischrostachys Cinerea* pods and leaves as a form of supplementary feed. Four treatments were used comprising of *D. Cinerea* pods only, *D. Cinerea* leaves only, pellets(pods + leaves mixture) and a control group. The feasibility component compared the processing cost of the local animal feed with the market price of the commercial protein pellets. A research carried out on the price of commercial goat pellets produced by local manufacturer Fivet showed that a 50 kg bag of pellets known as Fivet Goat and Sheep Nut is purchased at \$23.50. On the other hand, the cost of grinding, binding *Dischrostachys Cinerea* pods and leaves was \$ 9.61. This indicated that producing *D. Cinerea* pellets was cheaper with \$13.89. Comparing the processing costs of local feed with commercial pellets price also showed that it is highly feasible for a communal farmer having financial constraints to rely on the *D. Cinerea* pellets as a form of supplementary feed during the dry season.

6.3 Summary of Major Findings

There were several major findings that were found on the research study of using *D. Cinerea* mixed pods and leaves pellets as a form of supplementary feed for local Mashona goats. It was mainly found out that supplementation with *Dischrostachys Cinerea* pellets improved the growth performance of weaned Mashona goats as compared to the control group. The control which did not receive any form of the plant products proved to lag behind in terms weight gain and growth performance. Goats that were fed with pellets (pods + leaves) showed better feed intake and uniform growth due to improved feed palatability and reduced selective feeding.

In addition, pods alone provided higher energy value, while the leaves provided higher crude protein. Although browse leaves generally contain higher crude protein than the pods, growth performance in goats is primarily driven by metabolizable energy intake (Van Soest, 1994). Pods of browse species such as *D. Cinerea* have been previously reported to possess higher digestible energy and palatability, resulting in improved feed intake and weight gain (Osuga et al., 2008). Moreover, high fibre fractions and condensed tannins in leaves may reduce protein availability and overall feed digestibility (Makkar, 2003; Min et al., 2003). Similar pod supplementation that improved goat performance has been reported by Mahgoub et al. (2005).

Furthermore, it was noted that pelleting as a form of feed processing enhanced feed utilisation efficiency compared to feeding animals with pods or leaves separately. A Zimbabwean author Charambira also supports the use of improved processing such as pelleting as having greater efficiency and better production outcomes (Charambira et al., 2021). Basing on the economic perspective, locally processed feed of *D. Cinerea* pellets proved to be significantly cheaper than the commercial pellets although all of them provide Crude protein ranging between 15 -18 %.

6.4 Cost and Practical Feasibility in Ward 10

The cost of coming up with a 50 kg bag of *D. Cinerea* pellets was compared to the cost a 50 kg commercial bag of goat pellets, this showed that utilisation of local feed plants was cheaper and highly feasible. Prices compared comprised of Fivet Goat and Sheep Nut (pellets) with a price of \$23.50 and the total cost producing *D. Cinerea* pellets being \$9.61. This showed that producing local animal feed was \$ 13.89 cheaper than the cost of same 50 kg bag of commercial feed.

Basing on the practical feasibility of utilising the local plant in ward, Shamva District of Zimbabwe, it was noted that several factors can drawn in favour of the its utilisation as a supplementary feed for goats during the dry season. *Dischrostachys Cinerea* is generally found in abundance and is regarded as an invasive plant. Utilising it for goat production has a potential of reducing its environmental impact as an invasive plant.

Using *D. Cinerea* as source of animal feed can be regarded as predominantly ideal for smallholder farmers particularly in the communal areas where it is readily available. This helps to reduce mortalities of weaned goats due to feed shortage, enhanced food security and income generation. Practically, this limits reliance on the use of expensive commercial feeds by farmers who already suffer from financial constraints.

6.5 Conclusions

Basing on the findings of the results several conclusions were drawn. According to the results it showed that *D. Cinerea* can favourably, preferably and successfully be used as supplementary feed for weaned Mashona goats. Furthermore, the aspect of pelleting (pods + leaves) produced better growth performance compared to feeding pods or leaves separately and this implies the efficiency of pelleting animal feeds. Additionally, pelletingshowed that it can improve feed palatability reduced feed wastage and enhanced effective nutrient utilisation. Conclusion was also made that the use of local available *Dischrostachys Cinerea* plant promotes low- cost and sustainable goat production in ward 10, Shamva District of Mash Central, Zimbabwe. Finally, further studies are needed to identify ideal and efficient *D. Cinerea* pellet feeding duration for one to get optimal Mashona goat growth performance.

6.6 Recommendations

There are several recommendations directed to the farmers, government, non- governmental organisations and future researchers that may help in enhancing income generation, improving food security and goat productivity in the marginalised areas such as communal areas.

6.6.1 Recommendations to the farmers

- Farmers in ward 10 of Shamva District are encouraged to adopt pelleting of *Dischrostachy Cinerea* pods and leaves as cost effective supplementary feed that can improve goat growth performance.
- Farmers should properly dry both the pods and leaves before processing into pellets to avoid mould contamination that can adversely affect the health of Mashona goats.
- Pellets should be properly stored to curb diseases such as aflatoxicosis that can cause liver damage, immune-suppression, and reduce productivity in small ruminants (Smith & Moss, 2011).
- Farmers are also encouraged to seek goat productivity guidelines from recognised animal health officials.
- Lastly, supplementation should be practiced particularly during the dry season period when natural grazing would be limited.

6.6.2 Recommendations to Government and NON –Governmental Organisations

- Government should enhance refresher courses of agricultural extension advisors while at the same time assisting in carrying out of new innovations. This would help in the training of farmers on the harvesting, processing and safe inclusion levels of *D. Cinerea*.
- Innovation centres that are community based should be established and these would help in the processing of the feed. These established centres will reduce individual pelleting costs as they would be government sponsored.

- Furthermore, policies should be formulated and these should promote utilisation of these invasive species such as *D. Cinerea* for livestock feeding while at the same time controlling bush encroachment.

6.6.3 Recommendations to future researchers

- Future researchers should further their studies on the evaluation of anti –nutritional factors such as tannins in *D. Cinerea* as a way of improving further efficient use of the plant on the growth performance of Mashona goats.
- Studies should be done in future to investigate on the long- term reproductive and health effects of using *D. Cinerea* pellet as supplementary feed for Mashona goats.
- Moreover, immense research should also be done to assess optimal inclusion levels in goat diet to avoid occurrence of adverse health issues that can happen due to high inclusion levels and long – term use.

This study demonstrated that pelleting *Dischrostachys Cinerea* pods and leaves can be nutritionally beneficial, economically sustainable as a supplementary feed for weaned Mashona goats found in Ward 10 of Shamva District. The technology tries offer practical alternative to expensive commercial goat pellets. This makes it suitable for resource – constrained small- holder farmers suited in Mashonaland Central Province, Zimbabwe.

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Appendices A: Mature *D. Cinerea* dry leaves& mature dry pods

Appendices B: Grinding of *D. Cinerea* Pods & Leaves



Appendices C: Mature ground D. *Cinerea* Pods



Appendices D: Mature ground D. *Cinerea* leaves



Appendices E:Mixing of ground *D. Cinerea* pods and leaves with mixture of water and molasse



Appendices F:D. *Cinerea* pelleting process



Appendices G:D. *Cinerea* pellets



Appendices H:Storage of package trial feeds



Appendices I: Laboratory analysis Report for Nutritional Value of D. Cinerea

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FM/QA/055a
Revision 05
Issue Date: 28/04/2026
Report No: 4480
Customer Name: Mukucha Eunice Tafadzwa
Address: N/A
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Email: eunicemukucha85@gmail.com

FEED ANALYSIS LABORATORY REPORT

Sample Type: Feed Sample *	Number of Samples: 1	Sample Lab Number: 4480
Sample Receiving Date: 18/05/26	Date Tested: 18/05/26	Date of Reporting: 19/05/26

Test Required : NIR	Method Used : FL 10
Deviations from method? Yes/No	Reason for Deviation : N/A

Results :		TEST PARAMETER								
Sample Description *	Basis (As Is/DM)	Lab Number	MC %	CP %	FAT %	CF %	ASH %	STARCH %	ADF %	NDF %
Goat Maintenance	As Is	4480	9.94	16.43	2.72	15.40	8.30	ND	18.47	33.25

KEY: DM-Dry Matter; MC-Moisture content; CP-Crude Protein; CF-Crude Fibre; ADF-Acid Detergent Fibre; NDF- Neutral Detergent Fibre

Interpretation and Comments:
Fivet only offers results interpretation as a support service to Fivet customers using Fivet Nutrition products.
Fivet Laboratory regrets that no interpretation service will be given on full feeds from other feed manufactures, as manufacturers of different feed companies may have different intended specifications.

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FM/QA/055a
Revision 05
Issue Date: 28/04/2026
Report No: 4480
Customer Name: Mukucha Eunice Tafadzwa
Address: N/A
Cell: 0772 758 151
Email: eunicemukucha85@gmail.com

Information marked * has been provided by the customer.

Reported By: E. Chakodzongwa

Signature:

Date: 19/05/2026

Authorised By: B. Msonthe

Signature:

Date: 19/05/2026

Appendices J: Mashona goat feeding on *D. Cinerea* pellets



Appendices K: Similarity Report



Eunice Mukucha
MUKUCHA EUNICE TAFADZWA Research Project Chapter 1 -
5-3 30.4.26-1-1-1-4-1 31.5 .26-1-1-1

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