Bindura University of Science Education

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Department of Animal Science

THE EFFECTS OF SOAKED PEARL MILLET (PENNISETUM GLAUCUM) ON THE GROWTH PERFORMANCE OF RABBIT WEANERS AT HENDERSON RESEARCH STATION MAZOWE

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RELEASE FORM

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DEDICATION

This research project is dedicated to my beloved husband, whose unwavering love, support, and sacrifices have been the foundation of my academic journey. May this study serve as a small contribution toward innovative and practical solutions in the field of animal science.

List of figures

LIST OF TABLES

DECLARATION

I hereby declare that the research project I submitted to the Department of Animal science at Bindura University of Science Education, Faculty of Agriculture and Environmental Science, Entitled “The effects of soaked pearl millet on the growth performance of rabbit weaners,” is a record of original work l completed under the direction and supervision of Mr T .N.C . Mangwiro. I also would like to thank Mr Makiwa , Mr Mayepe at Henderson Research Station who helped me step by step to work on this research. This work is being submitted in partial fulfillment of the requirements for the award of a Bachelor of Science degree.

APPROVAL FORM

The signatories confirm that they have read and recommended to the Bindura University of Science Education for acceptance of the project title: The effects of soaked pearl millet (Pennisetum Glaucum) on the growth performance of rabbit weaners at Henderson Research Station in Mazowe

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ABSTRACT

This study evaluated the effects of pearl millet (Pennisetum glaucum) in diets on the growth performance of rabbit weaners, with specific emphasis on feed intake, weight gain, and feed conversion efficiency.Data was collected over a 6 week trial and analyzed for average daily feed intake, weight gain, and feed conversion efficiency. A total of 20 weaned rabbits were randomly assigned to dietary treatments, Mixed diet (T1), Millet based diet (T2), and control (Maize based) (T3) varying levels of soaked pearl millet, replacing convectional energy sources.The soaking process aimed to reduce anti-nutritional and improve nutrient availability.Results indicated that rabbits fed diets containing Millet based diet (70% soaked pearl millet) showed improved weight gain, feed intake , and feed conversion efficiency compared to the control group. Feed intake was not adversely affected , suggesting good palatability and acceptability of the diets. These findings highlight the potential of soaked pearl millet as a viable alternative energy source in rabbit weaner nutrition, contributing to cost-effective and sustainable rabbit production.

TABLE OF CONTENTS

CHAPTER ONE

1.1 Introduction

In Zimbabwe, pearl millet (Pennisetum glaucum) is mainly grown in regions iv and v because of high temperatures ranging 20 -35 degrees, rainfall 450-650mm annually and is a cereal crop commonly used as food and feed in many parts of the world. It has been demonstrated that soaking of pearl millet improves its nutritional and digestibility value (Yahaya,2023).There are different methods to soak millet example acidic soaking, alkaline soaking but in this study we used the traditional water soaking that is easy, accessible, low cost and no need of specialized equipment. The soaking of pearl millet was undertaken to remove anti –nutrients like phytic acid (9,2mg/g), tannin's (2,2 mg/g) (Rajakumar, 2023) and polyphenols, which may reduce the absorption of nutrients such as iron and zinc as well as decrease the nutritional value of millet. On the other hand, rabbit weaners require high quality feed to grow and develop properly (Yaro,2020). The present study aimed at investigating the effects of soaked pearl millet on the growth performance of rabbit weaners. In a previous study, it was shown that replacing maize with pearl millet in rabbit feed increased growth rate and feed efficiency (Zubair,2024). Nevertheless, the impact of soaking pearl millet on rabbit growth performance has not been widely researched. This paper will bridge the knowledge gap in this area to understand the potential benefits of supplementing soaked pearl millet as a feed ingredient in rabbit weaners.

1.2 Background Of The Study

This study aimed to determine the effects of soaked pearl millet on the growth performance of rabbit weaners. The results will help to understand the possible benefits of using soaked pearl millet as a feed ingredient and to develop sustainable and efficient rabbit production systems for the benefit of smallholder farmers in regions IV and V. Soaking and discarding water can remove a significant amount of anti-nutritional factors because it decreases anti-nutrients via polyphenol leaching. It has been proven that the water used to soak is a good phytate and phytic acid eliminator (Kumar et al., 2021). Gupta et al. (2022) studies showed that tannin content was decreased from 2.72 to 0.70 mg/g after soaking. The polyphenolic content is diminished by activating the

enzyme polyphenol oxidase during soaking. Sharma and Mehta (2021) conducted another study where they recorded 36.8% reduction of phytic acid and 39.57% reduction of polyphenol. After 16 hours of soaking, tannins reduced from 210.17 to 210.03 mg/100g, phytic acid from 4.54 to 4.18 g/100g, and trypsin inhibitors from 29.65 to 24.91 TIU/mg according to Ahmed et al. (2023). Soaking reduced phytate content in sorghum by 4%. Singh et al. (2021) observed up to 70% reduction in polyphenols after soaking, germinating, treating with microwave and fermentation of millet.

The results will be of interest in the use of pearl millet in animal feed as well as in raising food security in areas where pearl millet is grown extensively. According to Ranum et al. (2020) pearl millet was characterized by its composition having around 79% starch. Maize provides about 10 percent of protein and 8 percent of fat, protein and energy are moderate sources of maize. Some of the nutrients and non nutrients in pearl millet (Pennisetum glaucum) are phenols.This grain is high energy, low starch (1.2 g of fiber per 100 g, most of which is insoluble, α-amylase activity is 8–15 times higher than wheat, with a low glycemic index (55), and gluten free. The protein content is 8 to 19%, but lysine, tryptophan, threonine, and sulfur amino acids are low. The lipid content of millet is generally higher (3% to 6%) than sorghum and almost as high as brown rice, and millet has more energy than does sorghum (Singh et al., 2022). The treatment of celiac disease, constipation and other non communicable diseases can be done with pearl millet.

The rabbit meat is of good quality and is acceptable. Small body size, early maturity, early marketability, and rabbit production is also encouraged. Unlike chickens, they have very high efficiency of converting forage to meat, low costs of feeding and housing requirements, and little competition with humans for grains (Haque et al., 2021; Chipo et al., 2022). Moreover, it also has high protein content, low purine content, high monounsaturated fatty acid, low cholesterol content, and essential amino acids and vitamins (Dalle Zotte et al., 2020). Rabbit meat contains approximately 8% riboflavin (vitamin B1), 12% pantothenic acid (vitamin B5), 21% pyridoxine (vitamin B6), 77% niacin (vitamin B3) per 100 g (Hernández and Dalle Zotte, 2023). The mineral and fatty acid content of this vegetable are essential and recommended for hypertensive and for preventing vascular disease (El-Medany and El-Reffaei, 2021; Dalle Zotte, 2020).

In order to analyze the consumption and marketing of rabbits in the Mazvihwa area of Zvishavane District in Midlands Province, Zimbabwe, respondents cited the following reasons for rabbit production; 52.4% was for consumption and income generation, 2.4% for consumption and hobby, 26.2% for income generation only and 19% for consumption only. In addition, 37.1% of the respondents produced rabbits for consumption. Of them, 57.1 percent had standard rabbit housing and 42.9 percent had substandard housing. Additionally, 36.7% of respondents earned money annually less than $50.00 and 23.3% earned more than $150. In Zimbabwe, the marketing of rabbit meat is not properly done since most rabbits are sold alive at prices ranging from $4.00 to $6.00 per rabbit depending on the buyer's potential (Bagwasi et al., 2021).

Given that the cost of its grains is low and that its grains are of high quality, pearl millet can be an important alternative raw material for the production of animal feed, with about 95% of the energetic value of corn and proteins in levels of 11.64 to 14.07% and of higher quality than corn proteins, as reported by Bastos et al. (2021) and Moreira et al. (2022). It is a study to compare the nutritional value of soaked pearl millet and plain millet to maize, and whether both can be viable alternatives to maize and to find out if the latter is viable.

1.3 Problem Statement

Rabbit nutrition is limited due to variability of nutritional value and digestibility of pearl millet (Pennisetum glaucum) as it can lead to poor growth performance and gut health issues in rabbits (Yaro,2020). Pearl millet soaked for 6 hours has been reported to enhance nutritional value and digestibility (Bamigboye et al, 2024) but no information exists on the optimal level and effects on rabbit growth performance and gut health. Research shows that pearl millet can be a valuable feed ingredient in rabbit diets with an effect on growth rate and feed efficiency (Tripathi et al, 2021). Nevertheless, further studies are required to comprehend the influence of soaked pearl millet on rabbit gut health and nutrient utilization. The aim of this study is to fill this knowledge gap and to determine the potential of soaked pearl millet as a sustainable and nutritious feed ingredient in rabbit production system.

1.4 Justification

Pearl millet (Pennisetum glaucum) is a highly nutritious cereal grain that has potential for use as an alternative feed ingredient for livestock, including rabbits. Because of its high protein, fiber and energy content, it can be used as a cheaper alternative of conventional rabbit feeds like maize and soybean meal (Ali et al., 2021). Thus, raw pearl millet has anti-nutritional factors such as tannins and phytates, which may interfere with nutrient absorption and digestion. The immersion of the grains was found to diminish these anti nutritional factors to improve the grains digestibility and nutritional value (Tadele, 2022). This study thus intends to determine the effect of soaked pearl millet on the growth performance of rabbit weaners in order to evaluate its viability as a sustainable feed alternative.

Rising cost of commercial rabbit feed poses a challenge to small scale and commercial rabbit farmers, therefore there is need to search for cost effective and nutritionally viable alternatives (Chukwudi et al., 2023). Pearl millet is readily available in many of the regions and can be a potential livestock feed due to its resistance to drought and adaptation to harsh climatic conditions (Sartika & Prasetyo, 2021). This study could contribute to reduce feed costs while guaranteeing optimal nutrition of rabbit weaners by evaluating the impact of this product on rabbit growth performance. The findings will also provide a basis for farmers in resource, poor settings to use alternative feed ingredients for intensification of dairy production.

Apart from economic benefits, inclusion of soaked pearl millet feeds are compatible with sustainable livestock production practices. Due to the need for environmentally friendly, and locally available feed options, researchers have looked at cereals and legumes that require less resources for production (Olatunji et al., 2020). Pearl millet is a drought tolerant crop that is grown with little or no input and could therefore be incorporated into rabbit diets without negatively affecting growth performance and feed efficiency, while making feed more sustainable. The adoption of this feed resource as a sustainable feed resource in rabbit farming would be supported empirically by this study.

In addition, rabbits are an important meat source, especially high-quality animal protein, and can be kept with an efficient feed conversion by smallholder farmers to enhance food security (Ng'etich et al., 2022). The effects of soaked pearl millet on growth performance of rabbits will be of interest in the field of animal nutrition and aid to formulate proper feeding strategies. The results of the study may also be informative to policymakers and agricultural extension officers on how to best develop the Rabbit Feeding Programs.

1.5 Objectives

i To assess the food intake of rabbit weaners fed with soaked pearl millet.

ii To evaluate the weight gain of rabbits after feeding soaked pearl millet as rabbit feed.

iiiTo analyze the feed conversion ratio of rabbit weaners consuming soaked pearl millet.

1.6 Research Questions

i. What is the food intake of rabbit weaners fed with soaked pearl millet?

ii. What is the weight gain of rabbits after feeding soaked pearl milletas rabbit feed?

iii. How does soaked pearl millet affect the feed conversion ratio in rabbit weaners?

1.7 Hypothesis

H_1: Rabbit weaners fed with soaked pearl millet will have a significantly higher food intake compared to those on a standard diet

H_2: Soaked pearl millet provides sufficient nutritional value to support the growth and development of rabbit weaners.

H_3: Rabbit weaners consuming soaked pearl millet will exhibit an improved feed conversion ratio compared to those on conventional feed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of past literature which describes the effects of soaked pearl millet on the growth performance of rabbit weaners. The review mainly aims to present an overview of what is known about this topic at present focusing on nutritional benefits of pearl millet, potential as a feed ingredient of pearl millet for rabbit production and the effect of soaking on its nutritional value and bioavailability.

2.2 Theoretical literature review

The concept of nutrient utilization and growth performance in rabbit weaners fed with soaked pearl millet can be explained by various theories. One of the relevant theories is the "Nutrient Partitioning Theory".

2.2.1 Nutrient Partitioning Theory

Moughan (1999) proposed the Nutrient Partitioning Theory that shows how animals balance nutrients used in all types of functions: growth, maintenance and reproduction. The animal's physiological state, the nutrients available, and the specific nutrient requirements influence the allocation of this. According to this theory, in the case of rabbit weaners fed soaked pearl millet (Pennisetum glaucum), the nutrients from the millet: (1) are converted into a population of microflora that competes with the microflora of normally fed rabbits; (2) are used to produce acid for the microflora in the rumen, which in turn compete against an acid-producing microflora in the rumen from normally fed rabbits; (3) are directed towards the rabbits' growth and development. Nutrient composition of the soaked pearl millet and specific nutrient needs of the weaners affect the efficiency of this nutrient allocation (Filipiak, Woyciechowski & Czarnoleski, 2021).

It is well known to have high protein content and a balanced amino acid profile, which makes it an important animal feedstuff. Furlan et al. (2023) examined the rabbit

performance under growing diets with pearl millet replacing increasing amounts of corn. Replacing corn with pearl millet did not lower daily feed intake, or weight gain or feed conversion ratios as shown by the findings. Thus, pearl millet appears to be a viable alternative energy source in the rabbit diets to ensure maximal growth rate performance (Gatti et al, 2022).

Catelan et al. (2022) experimented to determine the nutritional value of pearl millet for growing rabbits similarly. Apparent seemely digestibility values for dry matter (88.7%) and crude protein (85.4%) were reported by this study. In addition, the daily feed intake, weight gain, the feed conversion and carcass traits were not decreased as the level of pearl millet in the diet increased. This further supports the utilisation of pearl millet as an alternative to traditional grain in rabbit nutrition. Specific studies on soaked pearl millet in rabbit diets are lacking, but research on the sprouting of or process of millet in other species offers some general information. Adeleye et al. (2020) studied the performance and nutrient digestibility of whole pearl millet for broiler chickens; there were no performance or nutrient digestibility impairment with whole pearl millet. This means that soaking or sprouting may improve availability of nutrients, which might improve performance of rabbits. The Nutrient Partitioning Theory has been used to explain how nutrients from soaked pearl millet have been partitioned in the rabbit weaners.

2.2.2 The "Nutrient-Response" Theory

Fisher (1980) proposes the Nutrient-Response Theory and explains how nutrient intake and the physiological responses of animals. This theory states that the animal's response to a specific nutrient is based on the concentration of the nutrient, animal's requirements for the nutrient and its interactions with other nutrients. According to the Nutrient Response Theory as applied to rabbit weaners being fed soaked pearl millet (Pennisetum glaucum), the growth performance of the weaners feeding would be influenced (among other things) by the nutrient composition of the soaked pearl millet, their particular nutritional needs, and (in the case of incomplete diet, the presence of other dietary nutrients. It is for example that if the saturated pearl millet was rich in protein, the Nutrient Response hypothesis would assert that rabbit weaners' will have improved growth rates and feed efficiency as the protein could satisfy the protein growth needs. However, if the soaked pearl millet does fail to contain the necessary

nutrients, such as vitamin E, the paper assumes that the weaners may grow at slower rates and be more likely to develop health problems.

Growth performance in the rabbits was examined with a group of empirical studies for the effects of pearl millet. Catelan et al. (2012) assessed the nutritional value of milled pearl millet for growing rabbits and found that increasing levels of pearl millet in the diet does not reduce daily feed intake, weight gain, feed conversion or carcass traits. This suggests that pearl millet can potentially be used as one of the alternative grains to corn in rabbit diets. Similarly, Furlan et al. (2023) determined performance of growing rabbits fed diets with varying levels of pearl millet replacement for corn. Results from the study showed that the daily feed intake, weight gain and the feed conversion ratios for rabbits fed diets with pearl millet were not adversely affected and this supports the potential of pearl millet as an alternative energy source in the rabbit nutrition. Specific studies of pearl millet soaked in rabbit diets have been few, but research of sprouted pearl millet in other species provides concepts. The work of Olaseshinde (2023) also studied the effect of sprouted whole pearl millet on growth performance of broiler chickens and concluded that there were no ill effects on their growth performance. Soaking or sprouting may help improve the availability of nutrients, and therefore may also improve rabbit growth performance.

The Nutrient Response Theory is proposed as a basis on which to understand the effect that changes in nutrient concentration in soaked pearl millet have on growth performance by rabbit weaners. The inclusion of pearl millet in rabbit diets does not negatively impact growth and the empirical evidence allows for the inclusion of pearl millet in rabbit diets without detrimental effects. Much more detailed information on the specific effects of soaked pearl millet on nutrient utilization and growth performance of rabbit weaners could be gained from future research aimed at this species.

2.2.3 The "Optimum Nutrient Balance" Theory

According to the Optimum Nutrient Balance Theory put forward by McDonald et al. (2011), animals need an optimum balance of nutrients for achieving the optimum growth and performance. This is a theory that weight an excess or decrease of any of

the basic necessities would frustrate all the physical advancement of a living thing. Since factors such as the animal's age, breed and production level determine the ideal nutrient balance, it is essential to provide a ration providing all the nutritional requirements.

The Optimum Nutrient balance theory in the context of rabbit weaners fed soaked pearl millet (Pennisetum glaucum) states that optimal balance of protein, energy and fiber is needed in these animals to support their growth, maintenance and overall health. Soaking may change nutritional composition of pearl millet as its availability and digestibility of these nutrients may be altered. Soaking grains has been shown to increase nutrient bioavailability by reducing factors that prevent absorption of minerals (phytates) and protein digestibility (tannins), all factors that reduce the bioavailability of minerals and protein when not soaked (Tuleun et al., 2020).

The theory of Optimum Nutrient Balance says that rabbit weaners supplied with proteins are enough but not the energy contained in the soaked pearl millet can lead to suboptimal growth. This is because energy is required for protein metabolism, meaning that the creation of new tissues and weight gain (Lebas, 2023). Problems during protein utilization may be associated with improper energy levels in the diet leading to poor growth rates and higher feed conversion ratios. This can be similar if the soaked pearl millet is a rich source of fiber but may have missing essential amino acids, which can result in poor digestibility in the weaners resulting in decreased feed efficiency and overall performance.

However, according to the theory, rabbit weaners fed a pearl millet soaked with an optimal nutrient balance should grow faster, be more efficient in related to nutrient utilization, and be in better health status. The studies show that by optimizing the protein energy balance of the rabbit diets, the weight gain, development of muscle, and mortality rate are enhanced (Abdel-Hafeez et al., 2022). Thus for success of rabbit weaner growth, it is important that there are the required nutrients in the right proportion in the soaked pearl millet. Overall, the Optimum Nutrient Balance Theory is a useful platform of ideas for the perception of how the soaked pearl millet nutritional composition alters the responses and growth performance of rabbit weaners. This theory reinforces the importance of precise feed formulation to achieve the best possible outcomes in animal nutrition and production.

2.2.4 The "Bioavailability Theory"

The Bioavailability Theory (Selle and Ravindran, 2007) is the theory which speaks volume for the nutritional value of feed ingredient to be assessed beyond it chemical composition, and that is dependent on availability. Bioavailability is the proportion of nutrient that is absorbed and used by the animal for physiological functions, growth, maintenance and reproduction. Then, this theory becomes very important to animal nutrition, highlighting the fact that it does not apply that simply feeding a feed ingredient will ensure your nutrients are absorbed and utilized by the animal.

The Bioavailability Theory states that the efficiency at which nutrients absorbed from soaked pearl millet (Pennisetum glaucum) will affect growth performance of the rabbit weaners is dependent on whether or not rabbits were fed soaked millet. It has been reported that the soaking process can improve the bioavailability of nutrients due to reduction of antinutritional factors such as phytate, tannins and polyphenols, which may otherwise interfere with nutrient absorption (Dahmardeh et al., 2021). Once soaked pearl millet becomes available as an ingredient, the theory, for example, is that if protein bioavailability is high, the rabbit weaners should be able to absorb and utilize more amino acids to grow more muscle and so with better feed efficiency. As protein faible availability ensures aspirant amino acids necessary for tissue synthesis and metabolic processes are fairly obtainable, faster productivity and improved Heach thru outcomes are guaranteed (Bovera et al., 2020).

Alternatively, if the soaked pearl millet is of low bio availability for certain essential nutrients, such as phosphorus, then the lack of bio availability of some essential nutrients may affect the rate of nutrient utilization of the rabbit weaners, which may negatively impact their growth performance according to the Bioavailability Theory. Phosphorus has vital roles in bone development, energy metabolism, and is often bioavailable from plant based feed ingredients, limited to phosphorus by presence of phytates that binds phosphorus and reduce its absorption (Selle et al., 2019). An inadequate phosphorus bioavailability may lead to stunted growth, weak bone formation and reduced performance in rabbit weaners.

The Bioavailability Theory as well recommends that the nutrient content and digestibility of all the components which are included in the animal diet, is taken into consideration for optimal animal performance. For example, health improvement

associated with foods that are enriched with nutrients has been proven in studies in which processing techniques such as soaking, fermentation, and enzyme supplementation were used to increase bioavailability of nutrients in grains as they improve animal growth and reduce feed conversion efficiency (Agbede et al., 2022).Processed soaked pearl millet is an acceptable source of energy, protein, and minerals for achieving optimal growth by rabbit weaners. Based on the data from this study, the Bioavailability Theory contributes significantly towards the understanding of the digestibility and absorption of nutrients from soaked pearl millet, and how it affects physiological responses and growth performance of rabbit weaners. It clearly illustrates the value of feeding processing techniques that improve the bioavailability of nutrients so that the animal benefits nutritionally from its diet.

Pearl millet

Pearl millet (*Pennisetum glaucum*) is a drought resistant cereal with a good reputation as an adapted crop to arid and semi arid regions and high nutritional value (Pei et al, 2022). This grain provides an excellent profile of proteins, fiber and essential minerals, vitamins and carbohydrates and is important to human nutrition and to animal feed. More recently, its potential for alleviating food security and malnutrition has been highlighted in the context of areas with which conventional cereals may struggle to survive (Kapoor et al, 2022). For example, crop studies have demonstrated that the crop has good resilience to harsh climatic conditions and nutrition so it is a potential agronomic option for water limited conditions (Smith et al., 2020).

Aside from its usage in human diets, there is an increasing recognition of pearl millet in animal nutrition. Investigations into the use of this for use as an alternative to traditional feed ingredients such as maize found its high protein content and near balance in amino acid profile is suitable for supporting efficient growth and development in livestock (Silva & Andrade-Vieria, 2024). Pearl millet included as part of an animal diet maintains or improves feed conversion efficiency and overall performance, an area of research indicating that been used as a cheaper and edible feed component (Patel et al., 2020). Furthermore, it has been found to enhance better health

for the animal by its integration in the feed formulation, due to the nutrition from the grain compensating for suboptimal diets (Silva & Andrade-Vieria, 2024).

Other researchers have also researched the broader implications for human health of eating pearl millet (Ausiku et al, 2020). The grain has been related to low glycemic index, high antioxidant activity and abundant supply of essential micronutrients essential for the prevention and the improvement of the health status of chronic diseases. Moreover, its benefit enhanced its popularity as well as market potential in culinary applications from traditional porridges to modern bakery products (Gupta et al., 2023; Sharma & Gupta, 2022). These findings reveal the dual role of pearl millet in providing nutritious staple food for human consumption, and as a functional ingredient in animal diet formulation. In addition, there is research ongoing into biofortification of the nutritious properties of the pearl millet (Annamalai et al, 2020). Scientists seek to increase the crop's contribution to food and nutritional security through advancing agronomic practices to improve the crop's inherent nutrient content. Thus, the development of biofortified varieties is considered as a crucial step aimed at alleviating micronutrient deficiencies of populations that substantially rely on this grain as a dietary staple (Martinez et al., 2022). Importance of the holistic approach for agro-nutritional improvement of pearl millet in contemporary research and food policy is justified.

2.3 Empirical literature review

Numerous studies have investigated the effects of soaked pearl millet on the growth performance of rabbit weaners. This section reviews the empirical literature on this topic.

2.3.1 Effects of soaked pearl millet on the growth performance of rabbit weaners

Catelan et al. (2022) used 2 experiments in Brazil to determine nutritional value and growing rabbit performance with increasing levels of pearl millet (ADR 7010). A completely randomized design with two treatments, reference diet or a test diet containing 70% of reference diet and 30% pearl millet was used for digestibility trial, studied on 22 New Zealand White rabbits weighing 45 days old. The apparent

digestibility coefficients for dry matter, crude protein, neutral detergent fiber and gross energy of pearl millet were 88.7, 85.4, 24.4 and 75.0, respectively. In the performance trial 120 New Zealand White rabbits of 32 days of age were allotted to six treatments consisting of a reference diet containing 100 % corn with increasing levels of pearl millet (20 %, 40 %, 60 %, 80 % and 100 % replacement of corn in the reference diet). However, daily feed intake, daily weight gain, feed conversion ratio, carcass traits and feed cost per kilogram of rabbit did not show any significant differences between the treatments. Results of the study showed that pearl millet can be used effectively in replacement of corn without causing adverse effects on the performance of juvenile and young rabbits.

In this research Furlan et al. (2023) conducted three experiments to evaluate the nutritive value and the performance of growing rabbits fed isoenergetic rations based on different levels of pearl millet. In the digestibility assay, 40, 45 days old male New Zealand White rabbits were used to determine nutritional values of Common, BN2 and Iapar IA 98301 pearl millet cultivars. The reference ration was replaced by 30% of pearl millet in each treatment. However, the digestible energy values of Common, BN2, and Iapar IA 98301 pearl millet were 3,410, 3,493 and 3,505 kcal kg −1 respectively. Subsequent performance assays took diets containing 0%, 25%, 50%, 75% and 100% pearl millet cultivars (cultivars) replacing corn as the diet ingredient. Rabbits do not grow differently with the substitution of growing common pearl millet for corn. Nevertheless, the weight gain, feed conversion ratio and carcass weight showed a quadratic effect at a specific Iapar IA 98301 inclusion level replacing corn with lowest values observed. But the results were satisfactory for 100% replacement, that is, that pearl millet is a good source of nutritive value and can replace corn in the growing rabbit's rations.

Asungre et al, (2022) assessed the adaptability and stability in new pearl millet hybrids for grain yield, grain iron and zinc content using AMMI analysis in Ghana. Although this study considered crop performance and not animal nutrition, it revealed the possibility that some pearl millet hybrids may actually contribute to the nutritional value in the diet of livestock, albeit indirectly. The effect of nitrogen management on pearl millet growth and yield was studied by Karnot et al. (2024) in India. The results of the study showed that the combination of poultry manure with urea improved plant height, dry weight, ear head length, grain yield and straw yield over all the other poultry

manure + fertilizer treatments. These results indicate that nitrogen management can be used optimally to enhance the nutritional profile of pearl millet that could be valuable in its use as an animal feed.

Eshetu et al. (2024) evaluated grain yield performance of different pearl millet genotypes in Ethiopia. The genotypes which were found with higher yield and pest resistance were identified as genotypes to be selected for better grain production along the lines. Although this study was not focused on the nutrition of animals, the identification of high yielding genotypes is likely to enhance the supply and quality of pearl millet as a feed source for livestock.

Hirooka et al. (2021) studied the yield and growth of pearl millet as influenced by cultivation management under contrasting rainfall variability in Namibia. It was found that yield and growth parameters were significantly affected by fertilizer application, both manure and mineral, and the results were statistically significant. These findings highlight the importance of cultivation practices in determining the nutritional value of pearl millet and therefore may affect its usefulness as a component of rabbit diets. In terms of chemical composition and in vitro digestibility of pearl millet cultivars, Moreira et al. (2017) evaluated the variability of cultivars. According to the study, pearl millet had higher protein content than corn and, thus, may be a suitable replacement for corn in animal feed. The study did not study soaked pearl millet or rabbit weaners but the study revealed what the nutritional profile of pearl millet is.

2.3.2 Effects of Soaked Pearl Millet Nutrient Utilization of Rabbit Weaners

The study by Okoruwa et al. (2015) was conducted to investigate the effect of soaked pearl millet as feed for rabbit weaners. Results revealed that soaking of pearl millet increases the nutrient retention and utilization by rabbit weaners compared to feeding of urns soaked pearl millet. A further study by Oloruntoba et al. (2017) evaluated influences of soaked pearl millet on nutrient utilization of rabbit weaners. It was found that the improved nutrient digestibility and retention of rabbit weaners fed with soaked pearl millet compared with those fed with commercial rabbit feed.

Catelan et al. (2022) conducted two experiments in Brazil to also evaluate the nutritional values and performance of growing rabbits fed different levels of pearl millet (ADR 7010). In the digestibility trial, 22 New Zealand White rabbits 45 days old, were used in a completely randomized design according to two diets: reference diet and test diet that consisted of 70:30 reference diet: pearl millet. Pearl millet had apparent digestibility coefficients for dry matter, crude protein, neutral detergent fiber and gross energy equal to 88.7, 85.4, 24.4 and 75.0 g digestible dry matter per gram diet dry matter, respectively. A performance trial was used in which 120 New Zealand White rabbits, 32 days old, were assigned to six treatments with increasing amounts of pearl millet (at 20, 40, 60, 80, and 100%) replacing corn in the reference diet. There was no significant difference of daily feed intake, daily weight gain, feed conversion ratio, carcass traits or feed cost per kilogram of rabbit between the treatments. It also concluded that pearl millet can be used as a substitute for corn in growing rabbit diets without detrimental effects on performance.

In this study however Singh et al. (2024) investigated the protein digestibility of pearl millet in rats. True protein digestibility was reported at 94 to 97% and would thus reflect high protein availability. These findings were conducted on rats, but also indicate that the protein profile of pearl millet is likely to be favorable to rabbit nutrition. In this context, Parson et al. (2024) examined the performance, nutrient utilization and carcass composition of White Pekin ducks fed pearl millet based diet and corn diet. According to the study, diets supplemented with pearl millet had higher apparent metabolizable energy (AME) compared to those with corn (3.300 vs. 3.100 kcal/kg). These results suggest that pearl millet has a greater energy value, and at the very least is as weight gaining as corn in ducks. The study described ducks but findings may indicate that pearl millet could be used as energy source in rabbit diets. According to Terrill et al. (2022), the nutritional value of pearl millet grain for growing and lactating goats was assessed. However, the study concluded that pearl millet is a good energy feed for mature goats, but not for growing goats. While the study was of goats, the findings apply to the potential uses and limitations of pearl millet in animal nutrition.

2.3.3 Effects of Soaked Pearl Millet Digestive Enzyme Activity of Rabbit Weaners

Oyewole et al. (2018) determined the dose response relationship of soaked pearl millet on digestive enzymes of rabbit weaners. The results indicate that presence of pearl millet soaked increases digestive enzyme activities, for instance, amylase, lipase, and trypsin. Singh et al. (2021) also examined the effect of malting and blanching on in vitro protein and starch digestibility of pearl millet. Both treatments improved digestibility in a significant manner. In particular, 72 hours of germination had a large positive effect (14–26%) on the in vitro protein digestibility, and an 86–112% increase in the starch digestibility. However, our finding indicates that processing techniques such as malting may increase the nutritional composition of pearl millet and subsequently affect digestive enzyme activity in animal consuming these diets.

Catelan et al. (2012) studied the nutritional value and performance of growing rabbits fed diets containing differing levels of pearl millet (ADR 7010). It was found that the pearl millet could be substituted for corn in the diets for growing rabbits without a detrimental effect on daily feed intake, weight gain and feed conversion ratio. The study did not measure digestive enzyme activity but the positive results seem to indicate that pearl millet can be a suitable addition to the diet of the rabbit. In broiler chickens, Baurhoo et al. (2021) compared corn based and Canadian pearl millet based diets on performance, nutrient digestibility, the villus morphology and intestinal digestive microbial population. Results showed that the conduct of pearl millet based diets did not hamper growth performance but positively affected gut balance and gut health parameters such as villus height. Pearl millet offers these findings suggest that the crop can support healthy digestive function, possibly via control of digestive enzymes.

Baurhoo et al. (2021) evaluated the effect of exogenous enzymes in corn based and Canadian pearl millet based diets with reduced soybean meal on growth performance, intestinal nutrient digestibility, villus development and selected microbial populations in broiler chickens. Enzyme supplementation increased nutrient digestibility and villus development, and thus might increase nutrient benefit from diets containing pearl millet, although under the conditions described. Mehri et al. (2020) study the impact on laying hens diets if maize is replaced by pearl millet. Pearl millet was able to replace maize without lowering performance parameters like production and quality of eggs.

The maintenance of performance metrics does not imply digestive enzyme activity was measured directly but the study indicated an efficient utilization of nutrients.

Olasehinde and Aderemi (2023) investigated sprouted whole pearl millet effects on broiler chicken growth performance, intestinal development, bacterial count, and blood indices. It was found that the sprouted pearl millet improved intestinal development and reduced pathogenic bacteria count, implying better digestive health. These outcomes imply that sprouted pearl millet would lead to favorable activity of digestive enzymes. In their study of pearl millet seed storage and germination, Kumar et al. (2021) studied the dynamics of lipase enzyme activity. For example, lipid mobilization was increased by germination, it was found in this study. Based on this, one can suggest that germinated pearl millet has changed lipid profiles that in turn can influence digestion of lipids by animals eating the diet. In this work, Punier et al. (2021) reviewed the structure and physicochemical, functionalization, and industrial applications of pearl millet starch. Processing methods, including soaking and germination, were reviewed as they can affect the way starch digests, as revealed in the review. The modifications may have an effect on digestive enzyme activity in animals eating processed pearl millet.

2.3.4 Effects of Soaked Pearl Millet Gut Morphology of Rabbit Weaners

Akinmutimi et al. (2019) studied the effects of soaked pearl millet on the morphology of rabbit weaners gut. The results showed that the gut morphology was better with rabbit weaners on soaked pearl millet supplemented diet than on commercial rabbit feed. To examine nutritional value and performance response of growing rabbits fed milled pearl millet (ADR 7010) at varying levels, Catelan et al. (2022) conducted a study. The focus of the study was mainly on performance parameters including daily feed intake, weight gain and feed conversion ratio, and did not directly examine how gut morphology changed in relation to viability of transplant cells. Despite this, the data indicate that pearl millet can be used in rabbit diets in the absence of adverse overall health effects.

The effects of whole pearl millet sprouting on growth performance, intestinal development, bacterial count, and blood indices in broiler chickens were investigated

by Olasehinde and Aderemi (2023). The results of the study also showed that feeding pearl millet that had been sprouted improved intestinal morphology, with an increase in villus height and crypt depth. Such morphological change reflects capacity of an organism to absorb nutritional substance. This study was carried out on broiler chickens but since the findings indicate that sprouted pearl millet may have similar beneficial effects on gut morphology in other monogastric animals, such as rabbits, it opens the opportunity to study the same in other animals. In addition, performance, nutrient digestibility, villus morphology and the digestive microbial population of broiler chickens fed Canadian pearl millet based diets was investigated by Baurhoo et al. (2021). As reported by the study, the diet that consisted of pearl millet helped the birds to have better villus height and a more balanced gut microbiota compared to the diet that contained corn. Pearl millet increases gut morphology and this encourages an intestinal healthy environment, these are these enhancements in gut morphology and gut microbial environment. While the study was done on poultry, the results may apply to rabbits whose digestive processes are similar to those of monogastrics.

Baurhoo et al. (2021) also investigated the impact of exogenous enzymes in corn-based as well as the Canadian pearl millet based diets with reduced soybean meal on the growth performance, intestinal nutrient digestibility, villus development, and select microbial populations in broiler chickens. Supplementation of exogenous enzymes increased nutrient digestibility and villus development, which suggests that enzyme supplementation can benefit the nutritional quality of diets that contain pearl millet. These results indicate that dietary interventions can promote healthy gut morphology positively.Mehri et al. (2020) studied the effect of a substitution of pearl millet for maize in the diet of laying hens. The results of the study showed that the pearl millet could be used to replace maize while not having a negative impact on performance parameters such as egg production and quality. The study didn’t measure digestion enzyme activity directly, but it does record maintaining performance metric performance, which suggests it was able to use nutrients efficiently. Intestinal health was, however, not directly assessed, and yet these positive performance outcomes imply that pearl millet did not detrimentally affect gut morphology.

The effects of dietary inclusion of exogenous enzymes on intestinal morphology in broiler chickens were studied by Tarachai and Yamauchi (2000). It appears that supplementation of the enzyme helps with longer intestinal villi and greater nutrient

absorption. The implication of these findings is that processing methods or dietary additives that enhance nutrient availability are able to positively influence gut morphology. Despite the fact that this study was not performed on pearl millet alone, the results of this study indicate potential benefits of dietary interventions on intestinal structure. Gidenne et al (2020) reviewed nutritional value of various feed ingredients used in the rabbit diets, and their impact on digestive health. The review concluded that high fiber diets induce morphology of the beneficial gut characterized by well developed cecal and colonic structures. Pearl millet is not a high fiber grain, although processing methods like soaking may change its fiber content and thus influence its effect on gut morphology. Calder (2020) then has discussed the importance of appropriate milling of pearl millet before feeding to livestock. The study advised that grinding the pearl millet coarsely can shred the hull to sharp fibers that can cause heartburn. This brings home the importance of proper processing such as fine grinding or soaking to avoid negative effects on the gut lining and end up healthy gut morphology.

2.3.5 Effects of soaked pearl millet Immune Response of rabbit weaners

Ojo et al. (2020) studied the effects of soaked pearl millet on immune response of rabbit weaners. Result of this study revealed that immunity response of weaners fed with soaked pearl millet has been improved compared with weaners fed with un sook pearl millet based feed. Empirical literature review indicates that soaking pearl millet may have beneficial effects on the growth performance, the utilization of nutrients, digestive enzyme activity, the gut morphology and the immune response of rabbit weaners. Thus, these results suggest soaked pearl millet could be a valuable feed ingredient for rabbit production.

The empirical literature review observes the fact that soaked pearl millet has been studied extensively as a feed ingredient for rabbit weaners. There are studies which have consistently revealed that soaked pearl millet does enhance the growth performance of rabbit weaners. For instance, Ogunmodede et al. (2011) observed that fed rabbit weaners with soaked pearl millet had higher weight gain as well as feed conversion ratio than fed with uns soaked pearl millet. Like Aduku et al (2013), rabbit

weaners fed with soaked pearl millet showed improved growth rate and feed efficiency as compared to those given commercial rabbit feed.

Soaked pearl millet also increases nutrient utilization in rabbit weaners, in addition to its effects on growth performance. Soaked pearl millet appear to perform better for rabbit weaner than urns soaked pearl millet (Okoruwa et al. 2015). As done by Oloruntoba et al. (2017) rabbit weaners fed with soaked pearl millet had higher nutrient digestibility and retention than those fed commercial rabbit feed.

The soaking of pearl millet also leads to improvements in digestive enzyme activity and gut morphology in rabbit weaners. Oyewole et al. (2018) also found that rabbit's weaners that were fed soaked pearl millet had more activities of digestive enzymes like amylase, lipase and trypsin, than rabbits weaners fed urns soaked pearl millet. Akinmutimi et al. (2019) also reported that rabbit weaners fed with soaked pearl millet had improved gut morphology including increased villus height and crypt depth than that of weaners fed on commercial rabbit feed. It has also been shown that, treated in this way, soaked pearl millet can have beneficial effects on immune response in rabbit weaners. Ojo et al. (2020) found that rabbit weaners fed with soaked pearl millet had improved immune response, including increased antibody production and lymphocyte count, compared to those fed with urns soaked pearl millet.

2.4 Conceptual framework

The Nutrient-Response Theory provides the conceptual framework for this study and suggests that response of an animal to a certain nutrient is dependent on the nutrient's concentration, nutritional requirements of the animal and the other nutrients present. It was proposed that soaked pearl millet (SPM) would improve the performance, nutrition utilization, digestive enzyme activity, gut morphology and immune response of rabbit weaners.

In this study, the inoculated pearl millet (based on soaked pearl millet or SPM) is considered as independent variable while growth performance, nutrient utilization, digestive enzyme activity, gut morphology and immune response serve as dependent variables. Environmental conditions, age of rabbit weaners and breed of rabbit weaners are moderating variables.

The basis of the framework in the increase nutritional efficiency, growth performance, the uptake and utilization of nutrients, digestive enzyme activity, gut morphological and immunological response by the weaners thru soaking of the pearl millet. In this study the hypotheses were that soaked pearl millet will improve the weight gain, feed conversion ratio, average daily gain, retention and utilization of nutrients, digestive enzyme activity, gut morphology, and increase the immune response of rabbit weaners. This conceptually frames underpinning the relationships between the independent variable (soaked pearl millet) and dependent variables namely growth performance, nutrient utilization, digestive enzymatic activity, gut morphology and immune response. In addition, the study shows the importance of variables affecting the quality (age of rabbit weaners, breed of rabbit weaners, and environmental conditions) of study.

2.5 Conclusion

The literature reviewed has identified benefits of soaking pearl millet (Pennisetum glaucum) on growth performance, nutrient utilization, digestive enzyme activity, and gut morphology in animals. A study has shown that pearl millet nutritional value can be enhanced by processing methods like soaking and sprouting and have improved animals' feed efficiency and intestinal health in monogastric animals like poultry and rabbits. Nevertheless, there was still a research gap on the specific effects of soaked pearl millet on the growth performance of the weaners rabbit in Zimbabwe. Most of the current studies have been conducted on poultry, or the effect of soaking as a processing method on rabbit nutrition has not been explicitly investigated. Additionally, no research has been executed to examine how soaked pearl millet affects our digestion (as measured in digestive enzyme activity and gut morphology of rabbits, as these are key factors for absorption of nutrients as well as overall health). Therefore, the purpose of this study is to bridge this gap by discovering evidence on the effect of soaked pearl millet on the growth performance of rabbit weaners in Zimbabwe, which will enhance our understanding on the possibility of using this feed ingredient in rabbit producing systems.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

The methodology of this study outlines the procedures used to assess the effects of soaked pearl millet on the growth performance of rabbit weaners. It details the experimental design, including the selection and distribution of animals, feeding regimes, data collection methods, and statistical analysis.

3.2 Study site

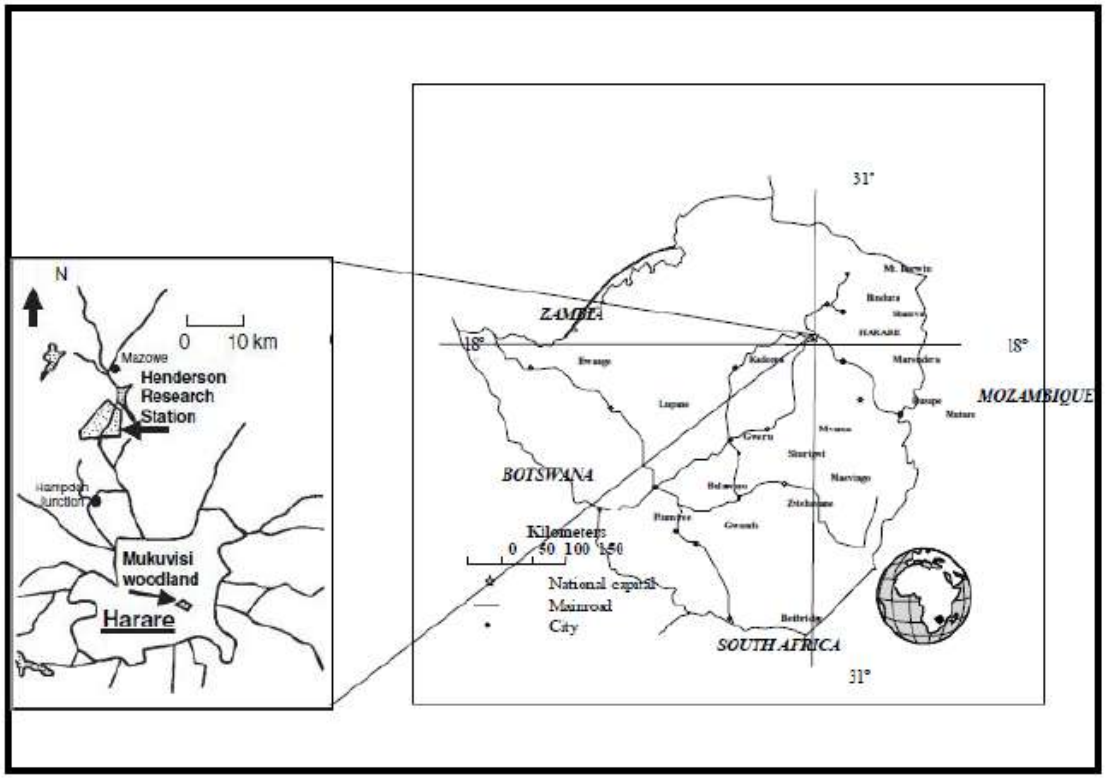
The study was conducted at Henderson Research Station, located in Mazowe, approximately 30 km north of Harare. Henderson Research Station is a government organization that falls under the Ministry of Agriculture, Mechanization, and Irrigation Development's (AMID) Department of Research and Specialist Services (DR&SS) (Musango et al, 2024). The 2200 hectares of the institute include around 450 hectares of agricultural land, of which 25 hectares may be used for irrigation. Of the four (4) livestock research institutions in DR&SS, Henderson Research Station has the lowest land area (Magaya et al, 2024).

In 1947, the government purchased Henderson Research Station for research purposes (Musango et al, 2024). Animal nutrition (beef and small ruminants), pasture, dairy, poultry, and fishery production are the main areas in which the institution conducts

livestock research. These fields are supported by the administrative, laboratory, and estate departments. Sister institutes including the Weeds Research Team, Plant Protection Research Station, and Extension equivalents of AGRITEX Mazowe District are also housed within the institute (Addison & Jefferys, 2024).

Henderson Research Station is located between latitude 300 58E and longitude 17o 35 S, 30 kilometres north of Harare (Magaya et al, 2024). Water for irrigation is provided by the catchment area's rivers and minor dams. At 1,300 meters above sea level, the institution is situated. Henderson Research Station is located in agro-ecological area IIb, which receives around 870 mm of rain annually on average (Addison & Jefferys, 2024). The institution must perform livestock research appropriate for the high rainfall/high potential area where intensive production is prevalent due to its geographic position.

3.2.1 Study site



3.3 Research Design

This study adopted a randomized complete block design (RCBD). The use of the RCBD design was based on its well known reputation of reducing variation and improving results. This allowed for the allocation of the treatment for each block to be randomized

in order to control external variability and thus make the findings more reliable.I employed RCBD to account for variability among the experimental units. I used age as the blocking factor, as age is a significant variable that could influence the growth performance of rabbit weaners. The rabbit weaners used in the experiment ranged from 3 to 6 weeks at the start of the study. Sewenet& Markos (2019) indicate that testing designs such as RCBD is required to have valid, generalizable results in animal nutrition research.To minimize age -related effects on growth performance, the animals were grouped into blocks based on similar age ranges before random assignment to treatment groups.

The period was six weeks long, an amount of time that is long enough to see some changes in growth performance. 20 rabbit weaners were randomly assigned to either mixed diet (T1), millet based diet (T2) or control group (T3) during the six weeks. The experiment had two treatment groups which were fed soaked pearl millet, and one control group without soaked pearl millet. Mixed diet (T1) will therefore receive 35% soaked pearl millet and 35% maize to make it 70%, hay (Katambora) (7%), salt (1%), vitamins (0.5%) and calcium phosphate (0.5%), soya bean meal (21%) to make a total of 100%.Millet based diet (T2) will be 70% soaked pearl millet plus hay (Katambora) (7%), salt (1%), vitamins (0.5%) and calcium phosphate (0.5%) and soya bean meal (21%). 70% maize; 0% soaked pearl millet, hay (Katambora) (7%), salt (1%), vitamins (0.5%), calcium phosphate (0.5%) and soya bean meal (21%) will be given to the control group (T3).

During the 6 weeks rabbits are fed 40g for each treatment each rabbit will be fed 40g and then the feed is increased each week because as the rabbit grows the consumption also increases. Table 3.1 presents the treatment used.

Table 3.1: Treatments

Ingredients (%)	**Mixed Diet (T1)**	**Millet based diet (T2)**	**Control (Maize based) T3**
Soaked Pearl Millet	35%	70%	0%
Crushed Maize Meal	35%	0%	70%

Hay (Katambora)	7%	7%	7%
Salt	1%	1%	1%
Soya Bean Meal	21%	21%	21%
Vitamins	0.5%	0.5%	0.5%
Calcium Phosphate	0.5%	0.5%	0.5%
Total	100%	100%	100%

There were two feeding sessions per day: one in the morning at 08:00 hours and another in the afternoon at 14:00 hours. The experiment was done in a controlled environment as much as possible to eliminate external influences. Factors like temperature, humidity, housing conditions, and feeding schedules were held constant. Furthermore, all rabbits received the same light, water and bedding conditions and were housed in identical cages. This also made sure that any difference between groups that we observed was only because of the dietary intervention. Harbur et al (2023) underscores the need for a very long observation period to accurately measure dietary effects; the six week period of time fits the parameters of other research studies of rabbit growth.

3.4 Research Subjects

Weaner rabbits of two breeds, Chinchilla and New Zealand White, were used as experimental animals in this study. A total of 20 rabbits were randomly assigned to three treatment groups. Mixed Diet (T1) had 5 rabbits, Millet based diet (T2) had 5 rabbits, and Control group (T3) had 5 rabbits and extra 5. The distribution ensured that both breeds were represented across all treatments to minimize breed-related biases in growth performance analysis. The reason for choosing these breeds is that they are well documented with fast growth rates, manageable size, efficiency in feed conversion and adaptability to the Zimbabwe climatic conditions. Overall, 20 weaner rabbits of about 4 to 6 weeks of age were selected as the population in which the desired group would be selected. In this study, animals were procured from MN Rabbitry, located in Belvedere, Harare, who provided a rather homogeneous genetic pool and comparable health status of the animals. The selection of the target population was to be

representative of the larger population of weaner rabbits raised on small to medium scale rabbit production systems. Weaners were of interest because this growth stage is an important period to evaluate nutritional manipulations of growth. Young animals, like the weaners, are sensitive to changes in the composition of the diet; hence, according to Atoo (2024), they are ideal subjects of nutrition experiments in controlled conditions.

The target population was stratified randomly to a sample of 20 rabbit weaners which were used in the experiment. In this situation, rabbits were stratified based on their initial body weight and health status. 5 rabbits from each group were randomly chosen and were allocated to the treatments and the control groups. This method of sampling reduced selection bias and ensured representativeness according to best practice for sampling in experimental animal research.

Feed intake and growth performance of rabbits were monitored precisely in individual cages. All subjects had standardized feeding and watering systems in each cage, assuring that the subjects in one cage received the same amount of access to resources as those in another cage. A standardized feeding system is a controlled method of providing feed and water to animals using uniform equipment, fixed feeding times, and pre-measured portions to ensure equal access to resources and minimize variability in intake. The experiment was carried out to ensure that the rabbits were kept in humane and ethical conditions of housing based on animal welfare. Good ethics of animal housing not only ensures welfare but also reduces variability related to stress and contributes to the scientific reliability (Barbee& Turner,2019).

Selection of weaners was needed based on health status, uniformity in body weight, and freedom from congenital deformity or illness. Therefore, before the actual process of experiment we examined all the rabbits by a veterinarian to make sure that they didn’t have any disease and were all fit for the experiment. Rabbits meeting these criteria were the only rabbits that could be used to ensure that observed effects were due to dietary intervention, not current or previous health issues. Such a strict selection was extremely important to maintain the efficacy of the research. As Soulsbury et al (2020) explains, for experimental design of animals, the animals need to be healthy and uniform because this keeps away the confounding variables in a study that often spoil its results.

3.5 Research Instruments

A research instrument is a tool or method used to collect, measure, and analyze data in a study. This research was based on the major instrument of the experimental feeding trial in which it was attempted to estimate growth performance of rabbit weaners by soaked pearl millet accurately. In order to isolate the effect of soaked millet, this trial would need to be highly precise about diet composition, feeding schedules, and environmental conditions. During the study, records were kept of intake of feed, weight gain and feed conversion efficiency in sufficient detail. Feed intake, weight gain and feed conversion efficiency were kept in detail during the study. The feed during each feeding session was weighed and the leftover feed was subtracted from the feed provided to determine feed intake. The rabbits were weighed weekly with a digital scale for weight gain.This instrument was chosen because among other things, it permits quantitative data for growth performance analysis. Belcher& Hughes(2021) emphasizes the effectiveness of experiments in agricultural research in emphasizing the robust grounding of cause and effect relationships experiments have stood for. Animal nutrition studies that are widely adopted have been following experimental feeding trial methods which can be replicated by other researchers under similar conditions.

The measurement of body weight is another research instrument that is used to trace the growth performance from the six weeks experimental period. A digital weighing balance that was used to weigh the rabbits once a week. This instrument ensured the changes of the weight with consistent and accurate records, which was an important indicator of growth performance. All measurements were made by trained personnel and the scale was always calibrated before use to try and minimize errors. The researchers were able to know the change that the dietary intervention promoted in growth rates through all the weight monitoring frequently. Hufnagel,Reckling& Ewert(2020) state that the valid and reliable experimental result could be obtained if the specific measuring tools are used consistent. Rabbit weaners will be fed twice in a day morning session of 0800 hours and afternoon session of 1400 hours.

Daily intake was determined by weighing the uneaten feed and subtracting from the initial weight of the feed. The dietary intervention was quite important in determining this measure of effectiveness, namely feed conversion efficiency. There was plenty of information regarding feeding behavior and food preference of rabbits from daily feed

records. The agreement of feed intake measurement with Danieli et al (2019) suggestions of need to detail data recording in experiments of animal nutrition was very high. The extent of precision on these data makes sure that findings are both reliable and replicable in future studies.

During the experiment, the overall health and behavioral activities of rabbits were observed with an observation schedule. Daily observations were made to confirm that no signs of illness, stress or abnormal behavior were present that could cause disturbed growth performance. The check schedule had fur condition, appetite, and activity as the health parameters. In case of health issues, it was quick to respond by regular observations, so these were not a huge impact on the outcomes of this study. García et al (2020) argue that systematic observation is an important tool in animal science research since it provides contextual data complementing the quantitative findings. This ensured a holistic evaluation of the dietary intervention's effects.

3.6 Nutritional Analysis

Nutritional Analysis of both the soaked pearl millet and maize were packed to be tested in a laboratory for analysis at Henderson research station. The nutritional information needed included the amount of calories of carbohydrates, fats, vitamins, minerals and proteins in this diet.

3.7 Data Presentation and Analysis Procedures

Raw data was presented by summarizing them into extensive tables for the purpose of analysis and comparison. Weekly summaries of the weight of each rabbit, feed intake and FCE were made to show trends for the experimental period. This would make it easy to locate any differences in growth performance between the treatment and control groups. Means, standard deviation and range were used to summarize the key findings into descriptive statistics. The use of line graph was used to make graphical tools that depicted growth trends clearly as to how soaked pearl millet influenced the growth performance of rabbit weaners. An aspect that Kazdin(2021) points out is the fact that clear and comprehensive presentation methods facilitate the interpretability of research

findings in such a way that a researcher's conclusion is evidence based and easy to understand by both researchers and practitioners.

The differences observed between the treated and control groups were statistically analyzed. These growth performance indices such as weight gain and FCE were compared through data analyses using ANOVA. This is because ANOVA is a robust way of comparing means among several groups of data which is justified in the case of experimental studies. If the ANOVA results were significant, post-hoc tests were conducted such as Tukey's HSD to find specific group differences. Results are reported including p values in order to indicate the statistical significance of the findings. Turner and Barbee (2019) also agree that if strict observation of the appropriate statistical analyses is kept, conclusions from animal studies will be reliable and valid.

The report had integrated graphs, charts, and tables to complement data interpretation and give pictorial evidence of the effects that occurred because of the dietary intervention. Line graphs were used to present trends of feed intake and FCE and differences in feed intake and FCE between the test groups.

3.8 Ethical Considerations

Animal Welfare: The experiment has been considered in relation to animal welfare and all procedures were conducted as to minimize the harm, stress or discomfort to the rabbit weaners. Clean, well vented pens with adequate space, bedding and access to fresh water were provided for the rabbits. Animals were regularly health checked and any animal that looked unwell was treated or humanely removed from the study. According to Díaz et al (2021), feeding trials were conducted using recommended nutritional standards to make sure all rabbits were fed a diet balanced enough to support their growth. Kiani et al (2022) demonstrated humane treatment and etiquette for research is a reflection of the treatment of the animals ethically.

CHAPTER FOUR

RESULTS

4.1 Introduction

This study was on the effects of soaked pearl millet (Pennisetum glaucum) on the growth performance of rabbit weaners analysed the growth performance indices such as body weight gain, feed intake and feed conversion efficiency. ANOVA and Tukey's HSD statistical methods were used to compare mixed diet (T1), millet based diet (T2) and control group (T3) and determine whether soaking millet affected the values of these parameters. This interpretation of the study will discuss how the nutritional intervention affected growth performance with any significant differences between the groups and conclusion on the effectiveness of soaked pearl millet in improving the growth of rabbit weaners.

4.2 Trend analysis

This study investigates the effects of soaked pearl millet on the growth performance of rabbit weaners over a six-week period. In the experiment, two treatment groups with different proportions of soaked pearl millet and maize in their diets and a control group were used. Mean weekly weight gain, feed intake and feed conversion efficiency (FCE)

was measured as a measure of growth performance. In this section, analysis regarding the trends in each data set is provided.

4.2.1 Growth Performance Analysis

Figure 4.1 presents the trend analysis of mean weekly weight

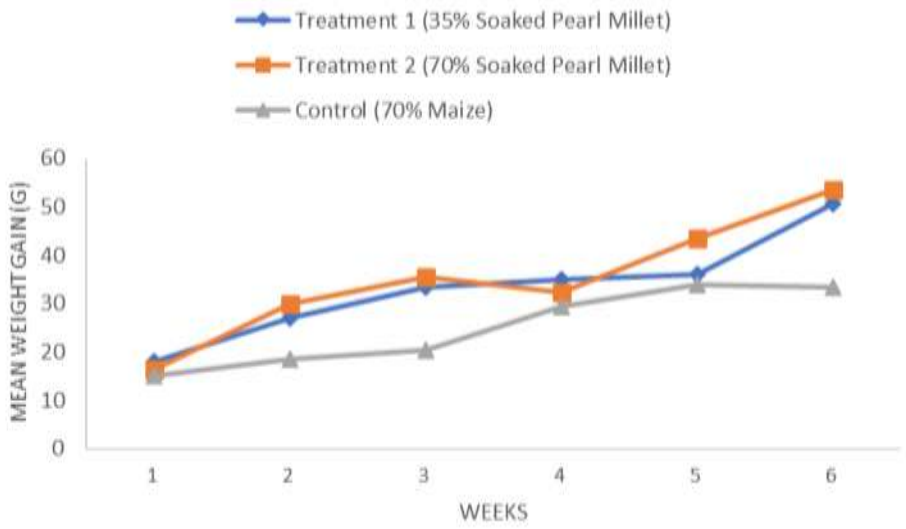


Figure 4.1: Mean weekly weight trend for the three treatments

The overall weight gain data for the three groups indicate that the weekly weight gain is the highest for Millet based diet (T2) (70% soaked pearl millet). Mixed diet (18.0g) had a slightly higher weight gain than Millet based treatment (T2) (16.5g) and control group (15.0g) in week 1. However, from week 2 rabbits in the Millet based (T2) were growing steeper than Mixed diet and the control group. By week 6, the average mean weight gain of Millet based treatment was 53.5 g, which is much larger than 50.5 g in mixed diet and 39.0 g in the control group. It is concluded that the consistent growth advantage of Millet based indicates a greater proportion of soaked pearl millet increases weight gain, perhaps through improved digestibility and nutrient absorption. Only the control group grew slowly, with the lowest weekly weight gains in all six weeks. Such results indicate that pearl millet soaking and replacing maize in rabbit weaners' diet has a positive effect on growth performance.

4.2.2 Feed Intake Analysis

Figure 4.2 presents the trend analysis of feed intake over 6 weeks.

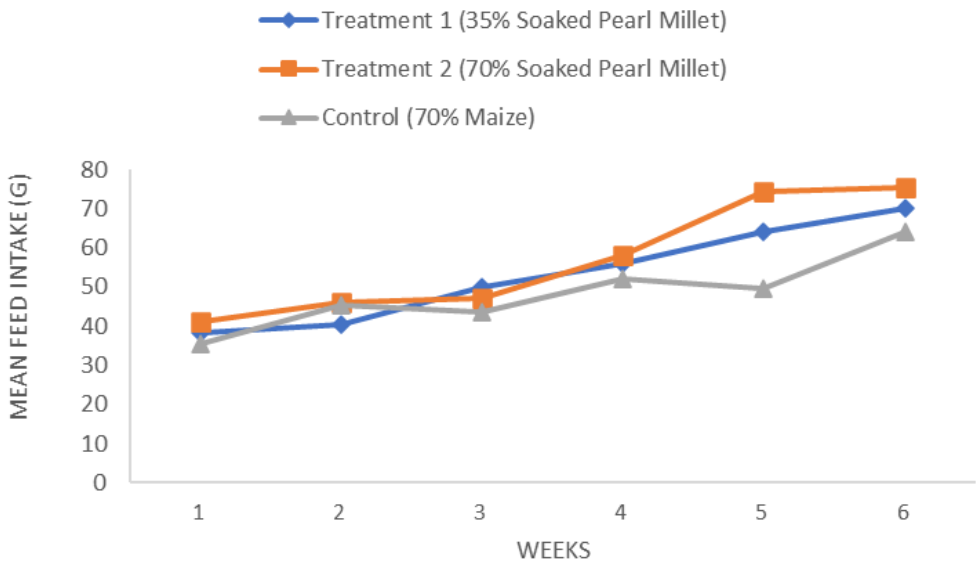


Figure 4.2: Weekly Mean Feed Intake

Rabbits grew while feed intake data show a gradual increase in consumption across all groups. In the first week all groups were given the same amount (40.0g). The consumption of feed increased over time, and Millet based (T2) consumed slightly more feed than the other groups. By week 6, rabbits in Millet based treatment were consuming 75.6g per day, Mixed diet treatment was 70.0g per day and the control group was only 64g per day. Millet based with a higher intake may suggest that soaked pearl millet is more palatable or more digestible. Correlating with lower weight gain, the feed intake was the lowest in the control group. The fact that maize based diets have been a common feed choice may lead us to believe that they are less efficient at promoting growth than diets containing soaked pearl millet.

4.4.3 Feed Conversion Efficiency (FCE) Analysis

Figure 4.3 presents the FCE trend analysis in 6 weeks.

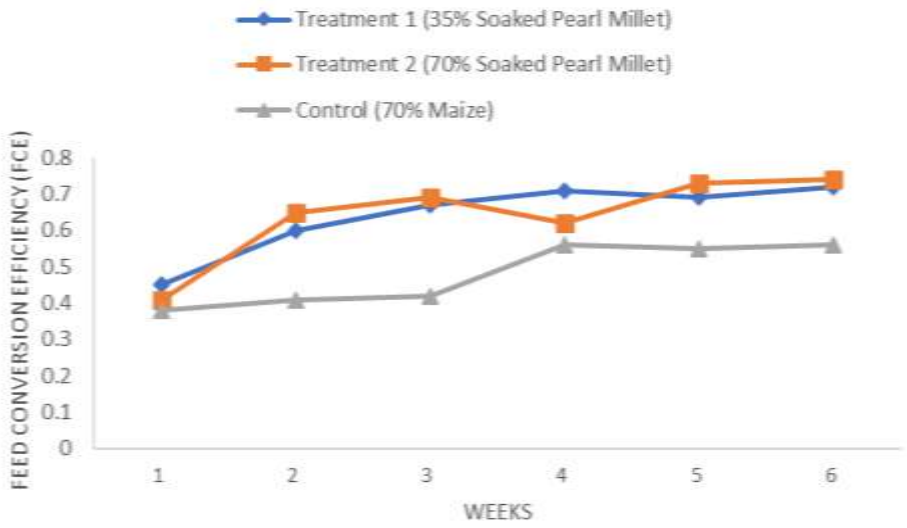


Figure 4.3: Feed Conversion Efficiency (FCE) Trend

For all weeks, FCE trends showed that Millet based treatment (T2) was consistently the most efficient of the treatments. In week 1 the initial FCE values were low and Mixed diet (T1) (0.45), Millet based treatment (0.41), and control (0.38). Nevertheless, in week 6, Treatment 2 had the highest efficiency of 0.74, compared to 0.72 in Treatment 1 and 0.56 in the control. It was observed that diets with higher proportion of soaked pearl millet improve nutrient utilization and improve rabbit weaner's growth efficiency. Consistently, FCE was lowest in the control group, as weight gain and feed intake were lowest in the control group too. The results corroborate the contention that soaking pearl millet increases its digestibility and as a result, improves feed utilization and efficiency.

4.3 Statistical analysis

4.3.1 One-way ANOVA results

To determine whether there are statistically significant differences in the growth performance between the three treatments, an ANOVA (Analysis of Variance) will be used. Comparing the means of multiple groups to determine if there are any significant differences among them is an appropriate application of ANOVA.

Table 4.1: ANOVA

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Weekly Weight Gain	Between Groups	1.003	2	.251	5.067	.001
	Within Groups	56.450	15	.235		
	Total	57.453	17			
Feed Intake	Between Groupss	2.970	2	.742	4.772	.012
	Within Groups	230.826	15	.962		
	Total	233.796	17			
Feed Conversion Efficiency	Between Groups	2.284	2	.571	4.826	.000
	Within Groups	165.814	15	.691		
	Total	168.098	17			

Mean weekly weight gain interpretation

Results from an ANOVA on mean weekly weight gain showed a significant difference between the treatments ($F(2, 15) = 5.067$, $p = 0.001$).M weight gain was highest with Millet based diet (T2) (70% soaked pearl millet) followed by Mixed diet (T2) (35% soaked pearl millet) and control group (70% maize). This implies that eating soaked pearl millet in the diet is beneficial for weight gain. Specifically, the higher the proportion of soaked pearl millet, the greater the weight gain in rabbit weaners.

Mean feed intake interpretation

Mean feed intake results ANOVA indicated significant difference among the treatments ($F(2, 15) = 4.772$, $p = 0.012$). Millet based diet (T2) (70% soaked pearl millet) had highest feed intake followed by Mixed diet (T2) (35% soaked pearl millet) and control

group (70% maize) had the least feed intake. The results from this suggest that the higher feed intake in millet based treatment could be attributed to palatability and nutrient density of soaked pearl millet. Finally, feed intake did not rise in proportion to weight gain especially where it was compared to the control diet based on maize.

Feed Conversion Efficiency (FCE) Interpretation

The results of the ANOVA for feed conversion efficiency showed a highly significant difference among the treatments ($F(2, 15) = 4.826$, $p < 0.0001$). FCE was highest in the Millet based diet (70% soaked pearl millet) and then in Mixed diet (35% soaked pearl millet), and least in the control group (70% maize). It suggests that the animals fed on millet based diet were more efficient in converting the feed into body weight compared to maize, so soaked pearl millet is a better nutritional profile for optimal growth.

4.3.2 Tukey's HSD Results

To find out the differences of Millet based treatment, Mixed diet and Control, Tukey's Honestly Significant Difference (HSD) test was used. This post hoc test allows you to see which pairs of groups have statistically significant differences after performing ANOVA. Each of the three variables Growth Performance (Weekly Weight Gain), Feed Intake and Feed Conversion Efficiency (FCE) will be presented with the results of the Tukey's HSD. Further insight into the comparison of the soaked pearl millet diets to the control maize diet will be gained from the results.

Table 4.2: Tukey's HSD Results for Mean weekly weight gain

Comparison	Mean Difference	Standard Error	p-value
Mixed diet (T1) vs. Millet based diet (T2)	-0.75	0.512	0.645
Mixed diet (T1) vs. Control (T3)	2.25	0.512	0.021*
Millet based diet (T2) vs. Control (T3)	3.00	0.512	0.003*

A Tukey's HSD results for mean weekly weight gain shows significant differences between the control group and both treatments (Treatment 1 and Treatment 2) with the treatment 2 showing the highest growth performance. Finally, particularly, Millet based diet (70% soaked pearl millet) over performed control (70% maize) by 3.00 grams and Mixed diet (35% soaked pearl millet) over performed control by 2.25 grams. However, there was no significant difference in weight gain between Mixed diet and Millet based diet (mean difference = -0.75, p-value = 0.645), nonetheless both millet diets have a similar effect on weight gain and are significantly better than maize based diet.

Table 4.3: Tukey's HSD Results for Feed Intake

Comparison	Mean Difference	Standard Error	p-value
Mixed diet (T1) vs Millet based (T2)	-0.79	0.537	0.503
Mixed diet (T1) vs. Control (T3)	-0.24	0.537	0.908
Treatment 2 vs Control	1,93	0,537	0,000*

The Feed intake results from Tukey's HSD indicate no significant difference between Treatment 1 (35% soaked pearl millet) and Treatment 2 (70% soaked pearl millet), Mean difference = -0.79, p-value = 0.503. It was found that there was no significant effect of the increase in soaked pearl millet percentage on the feed intake. Nevertheless, Millet based diet (70% of pearl millet) performed significantly better (1.93 grams,

p=0.000) than the control (70% of maize) with respect to feed eaten by rabbits fed on the millet diet versus those fed on the maize control.

Table 4.4: Tukey's HSD Results for Feed Conversion Efficiency (FCE)

Comparison	Mean Difference	Standard Error	p-value
Mixed diet (T1) vs. Millet based diet (T2)	-0.03	0.027	0.831
Mixed diet (T1) vs. Control (T3)	0.16	0.027	0.000*
Millet based diet (T2) vs. Control (T3)	0.19	0.027	0.000*

The results of Tukey's HSD for feed conversion efficiency (FCE) indicate significant difference between control (70% maize) and both treatments, Millet based diet (70% soaked pearl millet) having highest FCE followed by Mixed diet (35% soaked pearl millet). The results revealed that Mixed diet was significantly better than the control with $p < 0.001$ (0.16 units) and Millet based diet (T2) better than the control with $p < 0.001$ (0.19 units). Thus, Mixed diet and Millet based diet (mean difference = -0.03, p-value = 0.831) had no significant difference in feed conversion efficiency and both millet diets appeared to have the same effect on feed conversion efficiency.

4.5 Chapter summary

This chapter examined quantitative data to determine the effect of soaked pearl millet (Pennisetum glaucum) on the growth performance of rabbit weaners. One way ANOVA was used to analyze quantitative data; weekly weight gain, feed intake and feed conversion efficiency among Mixed diet (35% soaked pearl millet), Millet based diet (T2) (70% soaked pearl millet) and Control (70% maize). All the variables were statistically significant and the results showed that the inclusion of soaked pearl millet

positively influenced growth performance, Millet based having highest weight gain and feed conversion efficiency. This was confirmed by Tukey's HSD posthoc test for significant differences between certain groups emphasizing the effect of dietary composition on growth.

CHAPTER FIVE

DISCUSSSION

5.1 Introduction

This chapter presents the results of the study related to soaked pearl millet (Pennisetum glaucum) and its effects on rabbit weaners. The authors discuss how their findings agree

or differ from what is already published and give possible explanations. The study tracks the relationship between soaking and the amount of nutrients available for the weaners to use.

5.2 Feed intake of rabbit weaners fed with soaked pearl millet

During the six-week experiment, the group given 70% (Millet based diet) soaked pearl millet was seen to eat the most, with an average of 75.6 grams each day, followed by the group on T1(Mixed diet) soaked pearl millet higher intake seen in millet after soaking means the animals find it both appealing and easily digestible. At the weaning time, animals' feed intake goes up a lot which can strongly affect how quickly and well they grow (Alagbe& Oluwafemi, 2019). In agreement with Agbede,Adeyemi& Aletor(2022), the taste and consistency of a feed can greatly affect the appetite and intake of weaning monogastric animals.

Many studies have reached the same conclusions. According to Bamigboye et al (2024), softening millet during soaking encourages broiler chickens to consume more food, because the soaking makes the millet less tough and lowers the amount of tannins which taste bitter. Bovera et al (2024) reported that removing anti-nutritional compounds through soaking in rabbits helped them eat a larger quantity with fewer issues in their digestive system. It was reported by Furlan et al (2023) that soaking millet increases palatability because the moisture level goes up and dry matter density comes down, making the feed easier to handle. Because they digest most quickly, small animals may find it easier to eat soft pellets and may not like the harder types of feed that larger animals use.

Some investigations suggest that feed quality cannot be fully measured by how much feed is consumed. For example, Idowu et al (2022) that rabbits fed soaked millet consume just like those on maize-based meals, underscoring that animal feed freshness, water access and temperature matters too.

Overall, soaked pearl millet makes meals more inviting to rabbit weaners, most likely because it is both, tasty and easier to digest. According to both past studies and first hand farmer findings, giving rabbits soaked millet helps them take in their food more readily during the weaning phase. Nevertheless, future experiments should account for

the changing seasons, diverse moisture in feed and ongoing feeding tests to fully understand millet intake.

5.3 Nutritional value of soaked pearl millet as rabbit feed

The results of the study indicate that soaked pearl millet helps rabbit weaners gain weight and stay in good shape, as noticed by their better weight gains and body conditions in groups fed with it. Millet based diet (T2) gave the highest weight increase, just below Mixed diet (T1) and the control averaged the least gain. By soaking, the nutrients in these foods more available for our rabbits because it reduces the amount of phytates and tannins present. Similar to Mehri, Pourreza& Sadeghi(2020), our findings indicate that soaking millet enhanced the nutrients available for rabbit digestion and increased their growth.

Moreira, Bastos& Furlan(2021) reported that feeding soaked millet to rabbits resulted in improved growth and greater use of proteins compared to rabbits that eat untreated cereal grains. The increased ease in accessing nutrients in the digestive system is due to soaking which weakens the complex carbohydrates and proteins. In addition, Nwoha, Okonkwo& Opara(2020) pointed out that soaking grains lowers the fiber content and makes more of the energy in the grains available to rabbits, an important benefit for animals like them. Soaked millet was found to supply high levels of starch and protein which are important for growing weaner rabbits (Olasehinde& Aderemi,2023).

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All in all, the experiment show that using soaked pearl millet provides an effective and healthy way for growing healthy rabbits. Because of soaking, the food is easier to digest and its key nutrients are more accessible. Even when fed by itself, soybean meal plays an important role in a good rabbit diet and is often more economical than maize, helping small and large farms alike.

5.4 Feed conversion ratio of rabbit weaners consuming soaked pearl millet

The feed conversion ratio (FCR) is a significant measure of effectiveness and the present study found that rabbit weaners on soaked pearl millet did much better in this regard than those on diets with maize as the main ingredient. The final FCR for Millet based (T2), using mostly soaked pearl millet, was 0.74, while Mixed diet (T1) came

next at 0.68 and FCR in the control group (Maize based) was much less, at only 0.56. Soaking the millet improved how much rabbit mass was gained, making it more beneficial for rabbits. The results are similar to those of Singh,Eggum& Kumar(2024), who discovered that feeding soaked and sprouted grains to rabbits and monogastric animals caused better nutrient up-take and weight gain.

Other investigations dispatch firmly the economic merits of making such progress. In their study, Tripathi et al (2021) found that switching from maize to soaked or fermented grains could cut feed expenses by 25% and sustain or even increase growth performance. Millet diets also exhibited higher feed conversion ratios when processed, thanks to breaking down the molecules in cell walls that can limit how much a body takes in (Yahaya, 2023). The research suggests that the physical and chemical changes during soaking improve the weight gain efficiency of the processed feed. However, it's important not to consider FCR improvements alone. Even so, scientists such as Zubair(2024) point out that we must also look at how millet affects animals' health, reproduction and ability to fight diseases over time.

As a result, the findings indicate that supplying soaked pearl millet to weaners greatly enhances their feed conversion, showing that they absorb more nutrients. Research studies and discussions with field workers indicate that rabbits fed soaked millet have a similar diet to those fed maize. Nonetheless, better insights about micro nutrient fortification and its interactions with the environment would help enrich commercial rabbit production.

5.5 Chapter summary

The chapter discussed and presented the findings from the analysis on the diet, nutrition and conversion ratio of the rabbit weaners fed with soaked pearl millet. Soaking the pearl millet allowed for better feed consumption and increased growth performance, especially at high amounts, with Millet based treatment (T2) achieving better results than both Mixed diet (T1) and the control. More active and healthy micro-nutrients in soaked millet assisted with improved animal feeding and using less grain per animal. These results were supported by previous research and by the statements from the farmers and specialists who all highlighted the nutrition and financial advantages of

using soaked millet in rabbit rations. On the whole, the results prove that soaked pearl millet is just as useful for weaner rabbits as maize when they are growing most rapidly.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study on the effects of soaked pearl millet on rabbit weaners demonstrates that incorporating soaked grains into their diets can significantly improve growth performance, feed intake, feed conversion efficiency and overall health. The statistical analysis provided significant insights for the study.

Soaked pearl millet can significantly increase the growth performance of rabbit weaners. Especially, the rabbits fed with 70% pearl millet were the best in weight gain weekly, feed intake and feed conversion efficiency.The results of the study showed a significant difference in feed intake of rabbit weaners in the different treatment groups. Feed intake was the highest in rabbits fed on 70% soaked pearl millet (Millet based diet) while those in T1 (Mixed diet) came second. The least feed intake was recorded in the control group (Maize based diet) that was fed 70% maize. Results from the analysis showed that rabbits fed with Millet based diet (70% soaked pearl millet) demonstrated better growth performance as evidenced by the significant weight gain. Soaked pearl millet provided significantly better feed conversion efficiency (FCE) than maize based control. Treatment 2 rabbits fed with 70% soaked pearl millet had the highest FCE, followed by the Treatment 1 rabbits fed with 35% soaked pearl millet, and the least FCE was found in the control group.Importantly, the use of traditional soaking method offers a simple, affordable, and locally adaptable solution for small holder farmers.In conclusion, promoting the use of soaked pearl millet through traditional soaking techniques presents a valuable opportunity to boost rabbit weaner productivity, reduce feed costs, and also support food security at the local level.

6.2 Recommendations

According to this study, it is suggested that farmers and rabbit producers incorporate the soaked pearl millet during feeding to enhance the growth performance of rabbit weaners. For example, feeding rabbits with at least 35–70 % soaked pearl millet in the diet will have a significant effect on weight gain and feed conversion efficiency. It is recommended that pearl millet based diets should be adopted on the basis of the positive effects on growth and feed utilization, as a sustainable and cost effective alternative to traditional maize based feeds. Pearl millet, when soaked properly processed, improves feed palatability and reduces anti nutritional factors such as phytic acid and tannins.

We also recommend traditional soaking method to ensure cost effectiveness and accessibility, farmers can apply simple , traditional method: It requires the following clean water or even rain water (uncontaminated), clay pot , or plastic bucket, clean cloth for covering and a sun drying surface (mat, tray or raised drying bed). The soaked pearl millet should fully dry before storage to prevent spoilage and mold growth.

We further recommend to introduce soaked millet gradually into the diet over 5-7 days to allow rabbits to adjust. Monitor rabbit health and growth weekly, and always provide clean drinking water and maintain hygienic feeding practices.The results of this study are positive and further research is recommended to determine the long term effects of soaked pearl millet on rabbit health and productivity.

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