GROWTH PERFORMANCE OF INDIGENOUS CHICKENS FED GRADED LEVELS OF TOASTED VELVET BEAN (*Mucuna pruriens)* MEAL

BY

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ABSTRACT

A feeding trial was conducted with 48, four weeks old growing indigenous chickens to study the optimum inclusion level of toasted velvet bean meal. Four isonitrogenous (16% crude protein), iso-energetic (2857 kcal/kg) with similar crude fibre (15%) diets were formulated. The diets incorporating graded levels (0, 10, 20 and 30 %) of toasted velvet bean seed meal were fed for 42 days in a completely randomized design. The birds were randomly allocated to four dietary treatments, each treatment was replicated three times with 4 birds per replicate. Feed intake and weight change did not differ significantly ($P>0.05$) across the treatments. Feed conversion ratio showed a significant difference between 10% inclusion level and 30 % inclusion level of velvet bean meal. The significant difference ($P<0.05$) on feed intake and weight change were observed on different weeks of the feeding trial. It was concluded that toasted velvet bean seed meal can be included up to 30% level in diets of growing indigenous chickens without any deleterious effects.

Key words: Toasted velvet bean, indigenous chickens, feeding, performance

Declaration

I HLABANO FABEULA, do hereby declare to Midlands State University that this dissertation is my own original work and that this work has not been submitted for a degree in any other institution of higher education

By

Hlabano Fabeula ………………………………..

Signature

Date ………………………………………

Certification of Thesis

We the undersigned certify that Hlabano Fabeula a candidate of BSc (Hons) degree in Animal and Wildlife Sciences under the faculty of Natural Resource Management and Agriculture has presented this thesis entitled:

GROWTH PERFORMANCE OF INDIGENOUS CHICKENS FED GRADED LEVELS OF TOASTED VELVET BEAN MEAL

The thesis is acceptable in form and content and the student by virtue of oral examination showed satisfactory knowledge of field covered by the thesis.

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Supervisor Date

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Chairperson Date

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External examiner Date

Dedication

I dedicate this thesis to my beloved parents Mr R and Mrs B Hlabano for their parental support and patience while I was away from home. I also like to dedicate this work to my siblings for their level of support.

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Above all, I thank my Almighty God, Jehovah, who look after my health and gave me the ability and patience to finalize this piece of work. This dissertation would not have been possible without the help of many individuals. First of all, I would like to express my deepest appreciation to my academic supervisor ir L Masaka for his limitless advice, constructive criticism and proper guidance, valuable suggestions and comments during the entire work. I also thank Matopos Research Institute for offering me a study place and for financial assistance of the study. I also wish to express my appreciation to Mr. R. Mwembe and Mr R Ndlovu together with all scientific research officers for their invaluable contributions in making this work successful. All in all, I will extend a big appreciation to my family back home for their moral and spiritual support.

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CHAPTER ONE

1.1 Background

Indigenous chickens, known as backyard, traditional, village chickens or road runners are native strains (*Gallus gallus domesticus*) reared in rural areas especially in developing countries. According to Muchadeyi, et *al,* (2004) in Zimbabwe, the average flock size is 17 chickens per household. Moreover other developing countries like Sudan they are approximately 18.8 (Khalafalla, *et al,* 2000). Village chickens plays important roles in the livelihoods of those keeping them include cultural, traditional roles, food and income generation .In some areas these chickens are kept typically for meat and eggs, sources of protein. Indigenous chickens are hardy and they can survive under harsh conditions with very little inputs. Mostly they rely on free range, scavenging for food and may occasionally benefit from kitchen wastes and left overs. Assan (2015) documented that in developing countries the production systems of indigenous chickens have got limited application of management interventions to improve flock productivity. In developing countries such as Zimbabwe their productivity is very low mainly due to poor nutrition, disease control and management. Therefore there is need for the supplementation or addition of high protein feed and disease control programs as measures or solutions to improve productivity of our indigenous chickens Tadelle, *et al.,* (2003) and Kingori, *et al*., (2007) supports the view.

The main challenge associated with indigenous chicken production is feed in terms of both quality and quantity. Chickens reared under a free-range system do not meet their nutrient requirements. Kingori, et al., (2007) in his book, documented that the food available on the range contains a lot of crude fibre hence protein and energy are found to be limited. Moreover even if these farmers supplement their flocks using grain supplementation like maize, maize bran and sorghum which are rich in fibres, they are leaving out a protein source.

The poultry industry competes with men for resources in terms of feed hence its high production cost (Mengesha, 2012). As a result farmers and researcher's attention is shifting to broiler and layer (Morden breeds) production which has higher profit margin and quick returns than indigenous chickens, with the respect to cost of production. Muchenje and Sibanda (1997); Kusina and Kusina, (1999) observed that indigenous chickens are now decreasing in numbers due to the less importance and interest given to these chickens, and if this continues they might get extinct. Hence there is a need to identify protein source or non-conventional feed ingredients that are available at village level and that can be used in place of sunflower or soybeans to supplement protein. The main objective of this study is to investigate the effects of feeding velvet bean meal on the performance of indigenous chickens. The study seeks to identify the best inclusion level of velvet meal that can be used by farmers in Zimbabwe and other developing countries in order to improve indigenous chicken productivity. Iso-nitrogenouse and iso-energetic diets were formulated to contain 10%, 20% and 30% toasted velvet bean, the diet with 0% velvet bean was considered as the control diet.

1.2Problem statement

Poor resource farmers in Zimbabwe cannot afford to buy concentrated feed to supplement their chickens and this is affecting performance of their chickens. Moreover Indigenous chickens suffer feed shortages especially in dry seasons since they rely on free range and there is a need to feed them to achieve increased growth performance. In Zimbabwe there is increased human-animal competition consumption for the plant proteins. Little attention has been paid to this industry in terms of research and development.

1.3Justification of the study

Poultry industry is characterized by high production cost due to major conventional feed ingredients that are competed for by both man and animal (Mengesha, 2012). In developing countries the increased need and competition between feed staffs and food is caused by the steep increase in both animal and human population (World Health Organization, 2010), definitely alternative feed resources should be identified and evaluated (Odunsi, 2003). Moreover, research and development should focus on this industry to provide information on status of poultry production in the communal areas.

1.4 Broad objective

To assess the effects of velvet bean meal on performance of indigenous chickens

1.5 Specific objective

To determine feed intake of indigenous chickens fed different levels of velvet bean meal.

To determine the weight change of indigenous chickens fed different levels of velvet bean meal.

To determine the feed conversion ratio of indigenous chickens fed different levels of velvet bean meal.

1.6 Research hypothesis

H_0: There is no significant difference in feed intake of indigenous chickens fed different levels of velvet bean meal

H_0: There is no significant difference on the weight change of indigenous chickens fed different levels of velvet bean meal.

H_0: There is no significant difference in feed conversion ratio of indigenous chickens fed different levels of velvet bean meal

CHAPTER TWO

LITERATURE RIVIEW

2.1 Origin of indigenous chickens

Some of the authors documented that the red jungle fowl *Gallus gallus ssp* is the chief maternal ancestor of indigenous chicken. They pointed out that they were domesticated in South-East and South Asia since 5400 BC (Crawford, 1990). According to Mwacharo, *et al*, (2013), the introduction of traditional chickens in Africa remains quietly little documented and recognised. Some of the authors pointed out that indigenous chickens were firstly found in African continent in Egypt around 2000BC. Hassaballah, *et al*, (2015) documented that in the current era indigenous chickens symbolise crucial, important animal genetic resource, sustainable, conservation, exploitation and upgrading of local strains are as a result significant issues.

2.2 Chicken production in developing countries

In the farming system of developing countries such as Zimbabwe the poultry section is very important. Several researchers pointed out that, when communal farmers asked to point out which farm animals they would like or favour to see more researched in the time ahead, farmers choose poultry second to cattle. The extensive systems is subjected by indigenous poultry strains and in some cases these chickens have been crossed with modern breeds include boilers and layers. Pedersen (1998) pointed out that poultry production in most developing nations is centred on the free range or the scavenging systems, where the birds were looking for feed on their own. In developing countries about 20% of the protein consumed by humans comes from indigenous chickens. Despite the importance of indigenous chickens very little attention and operations have been paid and initiated in this industry in order to increase or to improve their productivity. In developing countries of Africa very little information is available on the management and productivity of these traditional flocks. The study done in Sanyati, by Pedersen in 1998 support that even though the majority, approximately 80% of the farmers keep these indigenous chickens very little information is available on their management. The target of this project is to identify affordable feedstuffs that will help to improve the productivity of our indigenous chickens in Zimbabwe and other developing countries.

The survey done by Maphosa, *et al*, (2004) indicated that in some farming areas of Zimbabwe like

Nharira communal and Lancashire small-scale commercial area , indigenous chickens were rely on free range and they were released for about 11 hours per day and at times they were given kitchen wastes and water. They further stated that occasionally some of the farmers provide either sorghum or maize grain to their flocks but the amount of supplementation given were not even weighed and it can vary from a few grams to a kilogram for the whole flock including the chicks, cocks, cockerels and hens of different size and age and they were given at any feeding time. The younger birds compete for the same supplemented feed with the older birds. Of all the 40 farmers examined they point out that they provide clean water once a day and they said that their chickens reach an average body weight of 250 grams at week eight of age. The researchers find out that the hatchability was very high but the productivity was slowed down or hindered by the poor growth and high mortality due to poor nutrition and poor management.

In a study done in Botswana by Mushi, *et al*, (2006), it was found that more indigenous chickens approximately 71.4 % were scavengers. Sometimes they were provided food leftovers. They also found that only 28.6% were given commercial feed. On the other hand Blackie (2014) did a survey in Ghana and found out that scavenging feed was the most relevant feed resource available for the indigenous chickens. These included household wastes, harvested remains on the fields, vegetation, insects and other invertebrates derived from the soil. The author further stated that the majority of respondents (80.9%, n= 89) provided a few handful of maize or maize bran in the morning for their flock however this practice was done irregular with birds of different sizes including chicks scrambling for the small amount of grains and bran spread on the ground. 54.5% (n=60) of households provided water for their flocks whilst the remaining 45% (n=50) did not. According to Tadelle and Ogle (1996), said that the amount of scavenging feed resources available and household supplementation varies from season to season and depends on farming activities such as land preparation and sowing and harvesting and it can also depend on the life cycle of other invertebrate, insects and pest. Tadelle *et al*, (1996) reported that in drier months the protein supply may be critical whereas in rainy season the energy supply may be critical.

The average flock size per household reported in Zimbabwe and other countries in sub-Saharan Africa are 17 in Zimbabwe (Muchadeyi et al, 2004), 18.8 in Sudan (Khalafalla, *et al*, 2000) and 13 in Ethiopia (Gueye, 1997). In his study Blackie (2014) concluded that the average flock size and productivity was generally low with high mortalities occurring among chicks prior to weaning.

He mention that inadequate nutrition particularly during the dry season is found to be the major causes of high mortality and low productivity in village chickens. Small improvement in feed supplementation has been found to increase significantly the number of eggs laid per hen per year (Smith, 1990) and improved growth rate of village chickens.

2.3 Importance of indigenous chickens

Indigenous chickens play a crucial role in the livelihoods of communal farmers in developing countries. Some of the roles include many cultural and traditional roles, food and income generation. McAinsh *et al*, 2004 mention that indigenous chickens perform crucial social and economic roles and he said that they have special roles in traditional, religion and other customs. The author further stated that village chickens can be used as payments, gifts, and they can serve as an essential animal protein source. Village chickens have some advantages than modern breeds, they are natural, healthier and they produce sweet tasting and nutritious products and the meat is often tender with less fat and more muscle. Some researchers are also considered indigenous chickens as the chief source of income to the poor rural farmers (Mtileni *et al*, 2009., Muchadeyi *et al*, 2005; 2007., Swatson *et al*, 2001; 2004). Blackie (2014) pointed out that Village chickens play a pivotal part in the livelihood of rural communities and contribute significantly to their food security and income. Moreover some authors said that they are used in customary rites and festivals and play an important role in pest control. Indigenous breeds have got some of the advantages, they require minimal investment in terms of their inputs, their inputs can be produced at the homestead and they require minimum labour and it can be deduced from the family. Kingori *et al*, (2007) pointed out that village chickens are very hardy and they can adapt well to various environments and they can survive on inadequate feed supply that can fluctuate in quantity and quality in different seasons. According to Nhleko *et al*, (2003), he concluded that village chickens are the supreme domestic animals that can endure heat, cold, wet and drought. They can survive in poor housing in sheltered or unsheltered cages or roosting in trees.

2.4 Problems faced by indigenous chickens

Despite the importance of these indigenous chickens their productivity has been hindered by many constraints, resulting in low average flock sizes (15–20 birds) (Muchenje and Sibanda, 1997., Kusina and Kusina, 1999).These constrains may include feed shortages especial in dry seasons. Lack of knowledge about cheap and high nutrient quality feed stuffs. Mainly very little attention, nutritional supplements and proper housing is provided to the village chickens. Some of the farmers describe indigenous chicken production as low input (in terms of feed, attention ,disease control and other staffs they provide to their chickens) and low output (it terms of weight and number of eggs produced by their birds). However since poor resource famers in developing countries provide low inputs to their flocks, this will always lead to poor nutrition, higher predation, diseases and parasite infections and low productivity (Tadelle *et al*, 2003). Matthewman (1997) indicated that this production system is sustainable for the poor rural households, output in terms of weight gain and the number of eggs per hen per year are very low with high mortality rates. Oleforuh-Okoleh *et al,* 2017 pointed out that growth rate is the major characteristic of an animal, so to improve our birds we have to upgrade their growth rate.

In Zimbabwe more attention and researches is now shifted to modern chicken breeds such as broilers and layers rather than to our indigenous chicken breeds. Introduction of modern flock breeds with high profit margins and quick turnover have slowly replaced the indigenous chicken breeds in most rural communities as farmers preference has shifted to broiler production as a potential substitute. Due to thin profit margins and fierce competition with commercial breeds, less importance is being attached to indigenous chicken breeds, culminating not only to their decline in numbers but also the fear of total extinction fuelled by the current genetic erosion. It should however be borne in mind that through their ability to scavenge, escape predators, adapt to the harsh tropical conditions, indigenous chickens should be protected and preserved birds have shown greater potential to survive where genetically improved breeds have failed making them a better option for the poor rural farmers (Getu and Birhan, 2014). If proper attention and research on nutrition is attached to our indigenous chickens we achieve better productivity and better income. We have to draw attention to our indigenous chickens they will survive and helps us even the climate changes while those modern breeds can't survive.

2.5 Legumes in animal diets

The banning of animal protein source in animal diets such as the borne meal and the meat meal has led to increased concentration and interest in plant protein sources. The most common plant protein source used in animal diets is soybean however the increase in price due to demand and the increased use of genetically modified soya bean resulted in shifting from soybeans to other alternative plant protein sources specifically between organic poultry producers. The legume seeds double the protein found in grains. The crude protein content of legume seeds ranges from 25% in peas to nearly 50% in soybeans. The other important aspect is that legumes are reach and also high in iron and vitamin B, however legumes have got anti-nutritional factors that can limit their use in animal feeds. The presence of ant nutritional factors decrease the feed intake and can decrease the nutritional value of the grain and if consumed in excess can cause health problems to the animal. These ant nutritional factors found in legumes include tannins, oligosaccharides protease inhibitors, lectins, phytate, isoflavones, L-canavanine, and antivitamins. (Jacquie Jacob, 2015)

2.6 Velvet bean

Velvet bean (*Mucuna pruriens*) is a leguminous plant. According to the US Forest Service (2011) it vigorous trailing up to 6-18 m long and it has got a taproot with several, 7-10 m long, lateral roots. Velvet bean is an annual or sometimes short-lived perennial and it bears several white colours to dark purple flowers. The legume reproduce using cross-pollination and it produce clusters of about 10 to 15 pods after the flower pollination. The colour of velvet bean seeds ranges from white to glossy black and sometimes to brownish.

The FAO (2011) documented that velvet bean was originated in Malaysia and Asia and currently introduced and distributed in the tropical countries. In the southern states of United States of America it was introduced in the late 19th century (Eilittä *et al*, 2003). Ecocrop (2011) point out that the bean is originated from the sea level up to an altitude of 2100m. Velvet bean requires annual rainfall ranges from 650 to 2500 mm and it needs hot moist climate. It grow well in frost free areas during wet months. The seed prefer wide range of soils from sand to clay but it grows well in a well-drained area with light textured soils of considerable acidity (FAO, 2011).

Iyayi and Taiwo (2002) documented that Velvet bean is a better alternative protein source that can replace other cakes in livestock feeds during the periods of scarcity hence this will reduce the cost of animal feed. Reports to date on its chemical and nutrient composition show that it compares favourably to commonly consumed grain legumes (Ezeagu, *et al*, 2003; Eilitta, *et al*, 2003). It is well known that animal protein malnutrition has been the major challenge in many developing countries including Zimbabwe. Daily dietary intake of animal protein by an average Zimbabwean is still quite low when compared to the recommended 34g per day by Food and Agriculture Organization. This acute shortage of animal protein in the diets of many Zimbabweans has been attributed to low production of animal protein in relation to increase in human population and high cost of production especially the cost of feeds. It is quite obvious that any effort targeted towards reducing the cost of feeding will be one of the possible solutions. However, one of the aim of this study is to seek for an alternative feed resources, which have comparative nutritive value but are cheaper than the conventional feed stuff

Different parts of Velvet bean can be used to feed animals with an aim to find unconventional plant protein sources that are available at a village level in tropical environments. In the experiment velvet bean seed was used as protein source since there is a continually competition between man and animals on conventional protein feedstuffs such as soybean, groundnut cakes just to mention a few. Moreover due to this increase competition in conventional protein feed stuffs it leads to escalating cost of the conventional protein sources. However Sese, *et al* (2013) in their trial, they fed graded levels of velvet bean leaf to broiler chicks. This research goes along with Sese, *et al* (2013) because we have the same aim of identify alternative low cost protein source. The different between these experiments is that in this experiment velvet bean seed is going to be used while Sese et al used velvet bean leaf as protein source. The results of Sese *et al*, (2013) et al indicated that Mucuna utilis leaf meal should not exceed 5% in the diet of growing chicks since the performance and mortality observed beyond this level of inclusion is undesirable.

2.7 Nutritional values of velvet bean

Sidibé-Anago *et al*, 2009 pointed out that Velvet bean is reach in protein it contains 15-20% crude protein as per dry Matter basis. The seeds ranges from 24 to 30 % protein, 10-11mj/kg and 28% starch (Siddhuraju *et al*, 2000; Pugalenthi *et al*, 2005); Vadivel *et al,* (2007) pointed out that the bean is also reach in amino acids, fatty acids and have got desirable mineral composition. The limiting factor of velvet bean is the presents of anti-nutritional factors that decrease the nutritional value of the grain if consumed in large quantities especially in monogastrics.

2.8 Feeding velvet bean to poultry

Several studies have been done on the inclusion level of velvet bean meal on different types of birds. Many scholars contradicts from their findings that’s why this study seeks to identify the best inclusion level of velvet bean meal in order to come up with the best inclusion level of velvet bean meal that can be used by farmers without affecting productivity. Tuleun and colleagues (2009) they did an experiment on Japanese quail feeding with toasted mucuna meal in their experiment they came out with interesting results, they feed the toasted mucuna meal up to 15% and they found out that there is non-significant ($P > 0.05$) effect of dietary *mucuna* level on feed intake and gain weight of the experimental quails. Moreover Iyayi and Taiwo (2003) had reported significant decrease in feed intake and weight gain when fed broiler starter and finished with 12 and 18 % toasted mucuna seed meal as replacement of soya bean meal in the diets. However, Iyayi and Taiwo (2003) in another experiment reported a comparable feed consumption of layers fed 18 % toasted and autoclaved mucuna seed meal with the control diet.

On the other hand, Ani (2008) feed the 4weeks old pullets chicks and they found out that there were significant ($P<0.05$) differences among treatments in average feed intake, final body weight, and feed conversion ratio. Chicks fed 10, 15 and 20% processed Mucuna seed meal (MSM) diets had significantly ($P<0.05$) higher Final Body Weight than chicks fed the control diet. The feed conversion ratios of chicks fed 5 and 10% Mucuna seed meal diets were significantly ($P<0.05$) lower than that of chicks on the control diet. There was no mortality in all the treatments. Ani observed that birds fed 15 and 20% processed MSM diets had higher Average daily feed intake than those fed 0% MSM diet. This contradicts the earlier report of Ukachukwu and Szabo (2003) that broiler chicks fed 7.5 – 22.5% processed Mucuna seed meal had similar fed intake with those fed control diet (0% MSM). The result also contradicts the findings of Ferriera *et al*, (2003) and Iyayi and Taiwo (2003) that broiler chicks fed 18 – 20% processed MSM diets had lower feed intake than those fed control diet. The observed differences may be attributed to differences in processing methods. Ukachukwu and Szabo (2003) processed their Mucuna seeds by boiling for 45 minutes with addition of 4% wood ash, while Ferriera *et al*, (2003) and Iyayi and Taiwo (2003) used roasted Mucuna seed meal. It seems that the processing method (boiling for 80 minutes after soaking in an aqueous solution of K_2CO_3) enhanced chick's intake of dietary Mucuna Seed Meal.

Emenalom *et al*, (2005) did a feeding trial using soaked velvet bean seed with an aim to evaluate the broiler performance fed soaked velvet bean. They found out that the birds performs well when fed 25 to 30% velvet bean levels, but above 30% there was a significantly decline in growth rate but feed intake and feed conversion ratio were not affected. Vadivel *et al*, (2010) feed velvet bean meal as an unconventional protein component for poultry feed. They fed broiler birds from 20% up to 100% they find out that the inclusion level of velvet bean up to 40% does not affect the feed intake levels and the weight gain of the birds. They noticed that the inclusion level of velvet bean meal above 40 % resulted in the reduction of weight gain and average feed intake especially in the starter phase. The feed intake and the body weight gain of the chickens fed with the diets containing up to 40 % level were found to be similar to the control group without any significant(P >0.05) difference. They concluded that the inclusion level of velvet bean meal in the poultry diet as an alternative protein source up to 40% can encourages better performance of broiler birds in terms growth rate and feed intake. Tuleun, and colleagues (2008) fed velvet bean meal to 34weeks old laying hens. Diet 1 contained no velvet bean meal while diet 2 contained 20% of raw velvet bean, diet 3 contained 20% boiled velvet bean and diet 4 contained 20% of toasted velvet bean. The results showed that there is a decrease in feed intake in the group fed the 20% raw velvet bean and they concluded that the presents of ant nutritional factors or appetite depressants caused the reduction in feed intake. They observe that heat treatment resulted in improvement in weight gain and feed intake. Birds fed toasted velvet bean meal were preforming significantly similar to the bird on the control diet.

2.9 Anti-nutritional factors found in velvet bean

L-dopa

Siddhuraju *et al,* (2002) defines L-dopa as a strong anti-nutritional factor that may cause severe diarrhoea and vomiting when fed in large amounts in pigs. The L-dopa is more harmful in monogastric and less harmful in ruminants. They may cause skin irritations Pugalenthi *et al*, 2005). Matenga *et al*, (2003) and Mendoza-Castillo *et al,* (2003) did a trial fed velvet bean to goats and sheep they observe that L-dopa had no adverse effects. Some reseachers like Matenga et al (2003) found out that ensiling can minimise L-dopa concentration in the seeds by 10-47%. In velvet bean seed the L-dopa content varies from 1.6 to 7% (Cook, *et al*, 2005).

Alkaloids

Velvet bean seeds have several numbers of alkaloids, particularly the mucunain, serotonin and the prurienine. The mucunain is produced by the pod hairs when get in tourch with the skin they cause severe itching and can be very painful when the hairs coming in contact with the eyes. The negative effects of mucunain are influenced by the serotonin (Cook *et al*, 2005). Many studies reported that when cattle eats the hairy pods of velvet bean can results in death and haemorrhage (Miller, 2000). Pod hairs have the similar anthelmintic efficiency as piperazine against ascariasis in buffalo calves (Behura, *et al*, 2006)

Other antinutrional factors found in velvet bean contain trypsin and chymotrypsin-inhibiting they minimise the digestibility of the protein, induce pancreatic hypertrophy and hyperplasia, upturn trypsin secretion and, as a result, decrease nitrogen retention, growth rate and feed conversion ratio (Pugalenthi, *et al,* 2005). The other anti-nutritional factor is Phytate its content is slightly high in seeds and it reduces the availability of protein and mineral. Saponins and lectins are also found in velvet bean seeds. These ant nutritional factors can be well reduced by several treatments include soaking and heat treatments.

2.10 Processes of velvet bean to reduce ant nutritional factors

There is need to educate farmers on the danger in feeding improperly processed feed especially legumes which are informed to contain very high levels of anti-nutritional factors (Soetan and Oyewole, 2009). Velvet bean seeds are suggested to be processed before use in monogastric diets. Reports have shown that boiling, toasting, fermentation, sprouting, decorticating of seeds and chemical treatment were effective in reducing or eliminating anti nutritional factors in legume seeds. To improve the nutrient availability and utilization of the seed for better performance in monogastric animals (Shaahu *et al*, 2014). To enhance the nutritional quality and organoleptic acceptability of legume seeds, processing methods are employed to decrease or destroy the anti-nutritional factors present in them. Treatments applied to velvet bean helps to minimise the levels of antinutritional factors such as tannins and L-dopa (Vadivel *et al*, 2011). Some of the reseachers noticed reduction in bird's performance when fed the diet contained raw velvet bean meal (Ferriera *et al*, 2003; Emiola *et al*., 2007). Treatments, and mostly heat treatments, can help to minimise the undesirable effects of velvet beans (Carew *et al*, 2006).

Ant nutritional factors can be minimized by processing them using toasting method as described by (Ukachukwu and Obioha, 2007). Briefly the toasting involved heating sand in an aluminum frying pan after which the seeds were added and stirred continuously until the seed became crispy, with an aroma of toasted bean. The toasted seeds were then milled in a hammer mill and included in diet. Some scholars did feeding trials using toasted velvet bean include Tuleun *et al,* (2009) they came out with interesting results, they found out that there is non-significant ($P > 0.05$) effect of dietary mucuna level on feed intake and gain weight of the experimental quails.

Ani (2008) used the soaking method to minimize the presents of antinutritional factors in velvet bean. The process involves the burning of oil palm fruit bunch to produce ash and the addition of water to the ash to produce a filtrate. An aqueous solution of potassium carbonate (K_2CO_3) was prepared. Mucuna seeds were soaked in the aqueous solution of K_2CO_3 at room temperature ranges from 22^0 C to 24^0C for 24 hours in the ratio of 1kg seeds to 3 litres of the aqueous solution. The seeds were then removed from the solution and cooked in water for 80 minutes. Timing was taken from point of boiling (about 100^0C). The seeds were then sun dried for about 48 hours, and then they were grounded using a hammer mill and the seeds were used to formulate the experimental diets. Ani (2008) observed that birds fed 15 and 20% processed Mucuna seed meal diets had higher Average daily feed intake than those fed 0% Mucuna seed meal diet.

Other scholars like Emenalom, *et al* (2005) processed velvet bean by cooking in maize cob ash solution and they find out that it is a successful method that improves the nutritional value of velvet bean. After they fed broilers they found out that up to 30% Crushed velvet bean or 25% Whole velvet bean could be incorporated into broiler diets without any negative effect.

Some researchers minimize the toxic of velvet bean by introducing them to the boiling and cooking method. Kaankuka *et al*, (1998) introduced velvet bean to the boiling water and cooked for 60 minutes. They observe that cooking method is a good method that can allow the use of velvet bean up to 40% inclusion level in the diets of growing pigs. Some of the reseachers such Cook *et al*, (2005) and Pugalenthi *et al* (2005) pointed out that many heat treatment methods have been introduced in order to minimise the content of ant palatable or antinutritional factors of velvet bean seed such as water soaking for 48 hours, boiling in water for one hour, soaking the seeds in 4% $Ca(OH)_2$ for 24 hours or autoclaving for 20 minutes

Emiola *et al,* (2003) found out that heat treatment resulted in improvements in the performance of the birds. They find out that the toasted velvet bean meal was comparing favourably with the control diet since they found a non-significant ($p > 0.05$) difference between the diet contained toasted velvet bean and the control group. Many investigators (Kaankuka, 1998; Emenalom and Udedibie, 1998;), have stated that the cooking method improves the nutritional value of velvet bean seed and they reported that this can be attributed to the diet improvement in terms of palatability of the diet, availability of resultant amino acids in the diet and the higher digestion of protein. The roasting method has been found to be a capable way of minimising the negative effects of velvet bean in Japanese quail and broiler birds diets (Emiola *et al*, 2007).

Some of the investigators introduced various treatments and they find out that the roasting method was less efficient as compared to the boiling method (Emenalom *et al*, 2005). Concerning wet treatments, observers find out that soaking alone in water without additives is less efficient so for that reason, it should be combined to other treatments such as boiling or autoclaving after the soaking process (Vadivel *et al*, 2011). Several investigators noticed that soaking the bean in sodium bicarbonate or pure water followed by boiling and drying was a successful method in eliminating the antinutritional factors (Vadivel *et al*, 2011) and some find that this method increase the inclusion level of velvet bean up to 20% (Ukachukwu *et al*, 2003; Emenalom *et al*, 2006; Ani, 2008). Additionally Iyayi *et al*, (2003) and Vadivel *et al*, (2011) found out that roasted and soaked plus boiled seeds can decrease the inclusion level of velvet bean by 6 to 10 %.

2. 11 Velvet bean in other domestic animals

Velvet bean is an important or valuable leguminous plant. Different parts of the plant can be used to produce animal feeds. Grounded Seeds and pods can be used to feed both ruminants and non-ruminants, moreover foliage and vines can be used as silage, hay or as pastures. (Eilittä , *et al*, 2003; Chikagwa, *et al*, 2009).

Fattening and growing cattle can be fed using grounded velvet bean. According to Sidibé-Anago *et al*, (2009) pointed out that zebu heifers and cows favours low quality hay and they can ingest 60.8 to 76 grams per kg of velvet bean hay. In areas with short rain period and low fertile soils velvet bean can be grown in such areas and it can be used to feed livestock especially ruminants. In developing countries such as Zimbabwe, farmers rely on free range and they noticed that this cost effective legume can be used to feed growing cattle on free grazing. It was found that animals can gain + 20 kg in 3 months when velvet bean hay is used to supplement at 1.5% body weight.

Velvet bean can be used to substitute commercial concentrate in pen fattening animal diets. When formulating a diet containing maize or maize bran and velvet bean hay a ratio of 5:3 can be used (Murungweni, *et al*, 2004). Small scale farmers depend on cattle as draught power and they fed them using velvet bean hay. During the periods of scarcity especially in dry season, farmers supplement their animals using velvet bean in order to retain the draught ability of the animal for the next season. (Murungweni, *et al*., 2004). Most farmers found it to be interesting and significantly beneficial.

In small ruminants velvet bean can be used but in young rams can cause severe diarrhoea and other metabolic disorders when consumed in large quantities or excess of 2.6 % of the body weight. Murungweni *et al*, (2004) found out that it is effective if velvet bean hay is offered at 2.5% body weight in the morning and offer under quality roughage feed stuffs like maize Stover late in the afternoon.

Velvet bean seed contain fairly high energy value and protein hence they are suitable feed stuffs for non-ruminants such as pigs (Pugalenthi, *et al*, 2005). To some extent, pigs are permitted to free range on the plant that have been left behind after collecting or harvesting but they are not allowed to consume in excess. Velvet bean can be processed in order to feed pigs without any adverse effect. Lizama *et al*, (2003) found out that velvet bean seeds processed using boiling method can be included into the pig diet up to 25% for 40kg pig. Moreover, Emenalom *et al*, (2004) also noticed that the inclusion level of up to 40% can be achieved when the process of cracking, soaking and then boiling is introduced to the velvet bean seeds. He further noticed that this treatment also permitted total substitution of the soybean meal even though the growth rate of 341-351 grams per day and feed conversion ratio of 2.53 to 2.58 is mantained.

2. 12 Other Uses and Advantages of velvet bean

In countries like Indonesia velvet bean seeds, pods and young leaves are used to produce many food stuffs involves tempeh made of boiled velvet bean seed fermented paste. Eilittä *et al*, 2003 said that in America velvet bean seed can be used to replace coffee and some use it as an ornamental or decorative on species (Wulijarni-Soetjipto *et al*, 1997). Velvet bean can be used in intercropping systems with the companion plants such as maize and it is beneficial because velvet bean plant have the ability to resist pest and some weeds so it can protect the other crop (Heuze, 2015). The plant can keep the soil safe from heavy rains especially in the wet periods and it also minimise soil erosion and avoids weed germination when after slashed into a dense mulch. Velvet bean also have the potential to preserve soil moisture (Buckles, *et al*, 1998).When recognised, the crop smothers weeds effectively (FAO, 2011). The plant is the one of the most appropriate plant that can return the invaded land with weeds, especially the Cyperus species, Cynodon dactylon, and the Saccharum spontaneum (Hellin, 2006). In Brazil, the bean can be used in crop rotation system with cotton plant in order to minimise the infestation of Fusarium oxysporum. It can also be successfully used to control nematode infestation (Wolf, *et al*, 2003; Wulijarni-Soetjipto, et al, 1997).

Velvet bean can be used as the soil improver and it grows fast and can have long growing season in frost free areas. It is possible for the bean to safeguard the soil during the wet season (FAO, 2011; Cook, *et al*, 2005). Furthermore, the bean is a Nitrogen-fixing legume that did not have any exact rhizobium condition, nevertheless Nitrogen fixation process is preferred by warm environmental temperatures (FAO, 2011). The legume offers approximately10 tones dry mater biomass per hacter and it also fixes approximately 331 kg of nitrogen per hacter and this is comparable to 1615 kg ammonium sulphate per hacter (Buckles *et al*, 1998; Cook *et a*l, 2005; Wulijarni-Soetjipto *et al*., 1997). The bean also produce 20 kg of potassium per hacter and 100 kg K/hacter (Buckles *et al*., 1998). Velvet bean is mostly grown as a fodder crop, cover crop and green manure because it can return to its normal state rapidly before the soil preparation process complete (Cook, *et al*, 2005).

CHAPTER THREE

METHODOLOGY

3.1 Study site

The experiment was carried out at Nutrition Unit, Matopos Research Station, and Zimbabwe. The geographical position is longitude 28^0 30'S and latitude $20^0$23'E at an altitude of 1340m and the site lies in the natural agro-ecological region IV, a semi-arid region that experiences variable and erratic rainfall (Vincent and Thomas 1961). The area receives 600 mm average annual rainfall between October and April with the temperatures ranging from 20.9^0C in June to 29.4^0C in October (Moyo *et al* 2011).

Velvet bean used was obtained from Matopos Research station. Pollard and growers concentrate were bought at the nearby agro feeds company. Velvet bean was toasted, to minimise the anti-nutritional factors like tannins, L-dopa and alkaloids. The particles size of both pollard and velvet bean was then reduce by grinding to pass 2 mm screen.

3.2 Processing of velvet beans

Weighed velvet bean seeds were toasted in a metal frying pan containing sand and heated by fire. Sand was used to achieve uniform heat in a frying pan. The seeds were constantly and continuously stirred to prevent charring until they become crispy with aroma of toasted beans. The toasted velvet bean were sieved out immediately, cooled, milled and taken to the laboratory to test for proximate composition.

3.3 Proximate composition of dietary ingredients

The proximate composition of moisture, crude protein (CP), ether extract, crude fibre (CF) and ash were determined by following AOAC (Association of Official Analytical Chemist, 1992) methods (Table 1). The nitrogen free extract (NFE) expressed as a percentage was obtained by subtracting the sum of the amounts of CP, EE, CF and ash from 100 %. The metabolisable energy (ME, kcal/kg) was calculated using the method found in MAFF (1984)

Table 1 Chemical composition (% DM) of poultry dietary ingredients

Ingredient	DM	CP	CF	EE	Ash	NEF	ME (kcal/kg)
Pollards	91.07	7.84	20.7	4.48	2.07	64.91	2834.7
Growers concentrate	90.08	27.0	7.27	3.91	10.23	51.59	2883.9
Roasted velvet bean meal	92.88	23.0	7.8	4.12	5.84	59.24	2884.8

3. 4 Experimental diets

The composition of the diets is given in Table 2. The diets were formulated with toasted velvet beans replacing growers concentrate as a source of protein. The velvet bean was included at 0, 100, 200 and 300 g/kg corresponding to 0 %, 23.5 %, 47.1 % and 70.6 % replacement of growers concentrate respectively. The diets were formulated to be iso-nitrogenous and iso-energetic.

Table 2 Composition of poultry grower diets with different inclusion levels of toasted velvet beans as a source of protein

	Toasted velvet beans			
Ingredients (g/kg)	0 %	10 %	20 %	30 %
Pollards	575	563	550	525
Growers concentrate	425	337	250	175
Velvet bean seeds	0	100	200	300
Total	1000	1000	1000	1000
Calculated analysis, %				
Crude protein (CP)	16.0	15.8	15.6	15.7
Crude fibre (CF)	15.0	14.8	14.7	14.5
ME, kcal/kg	2856	2856	2859	2859

3.5 Management of experimental birds

A total of 48 grower female indigenous chickens (boschveld) raised at Matopos Research Institute were used. The grower chicks were randomly allocated to four dietary treatments with three replicate per treatment and four birds per replicate. The birds were housed in pens with concrete floors measuring 150 cm x 65 cm in length and width respectively with grass hay used as litter material. The experiment ran for a period of 56 days with the first 14 days being the acclimatisation period and data collected during the remaining 42 days. Water and feed were provided *ad libitum*. During the acclimatisation period the birds were dosed with paperizine to control and prevent internal parasites; offered ox tetracycline (oxtetracycline dhydrate 268.8mg active ingredient) for prevention and control of bacterial infections and also dusted with huku dust for the control of external parasites.

3.6 Growth performance measurements

The weight of feed given and left over were measured daily (pen basis). Daily feed intake was calculated by subtracting left over feed from total feed offered. The body weight was weighed weekly per individual. Feed conversion ratio was also calculated by dividing feed intake by body weight change.

3.7 Experimental Design

The experimental design used was completely randomized design (CRD). The grower chicks totalling 48 were randomly allocated to 4 dietary treatments. Each treatment contain 12 birds. Each treatment was replicated three times and there were 4 birds per replicate.

3.8 Statistical analysis

The data collected was subjected to the mixed procedure of SAS with the repeated statement to account for covariance

The covariance structures used were:

1. Auto regression for weight
2. Unstructured for Feed conversion ratio
3. Compound symmetry for feed intake

Covariance structures were selected based on their AIC (Akaike Information Criterion)

CHAPTER 4

RESULTS

4.1 Feed intake

The average weekly feed intake during the feeding trial period varied among treatments without significant difference ($p>0.05$). The average weekly feed intake were 520.79, 539.46, 527.34, and 496.03grams per pen (four birds) for control, 10%, 20% and 30% velvet bean diet respectively. The significant difference ($p<0.05$) were observed on feed consumed in different weeks of the feeding trial. Week 1 was significantly higher to other weeks meaning week 2 to 6. Week 2, 4, 5 and 6 were statistically the same. Week 3 was significantly higher to other weeks (week 1, 2, 4, 5and week 6).

Week one showed the lowest feed intake (373.87g) and thereafter there was an increase in feed intake up to week 3. During week 3 the birds consumed an average of 648.34 grams per pen. There was a decrease in feed intake during week 4 (482.26), the intake decrease with an average of 166 grams. There was a slight increase from week 5 until the end of the feeding trial on week 6 (565.64g) Highest feed intake was observed on week 3 (648.34g) and the lowest intake was observed on week 1

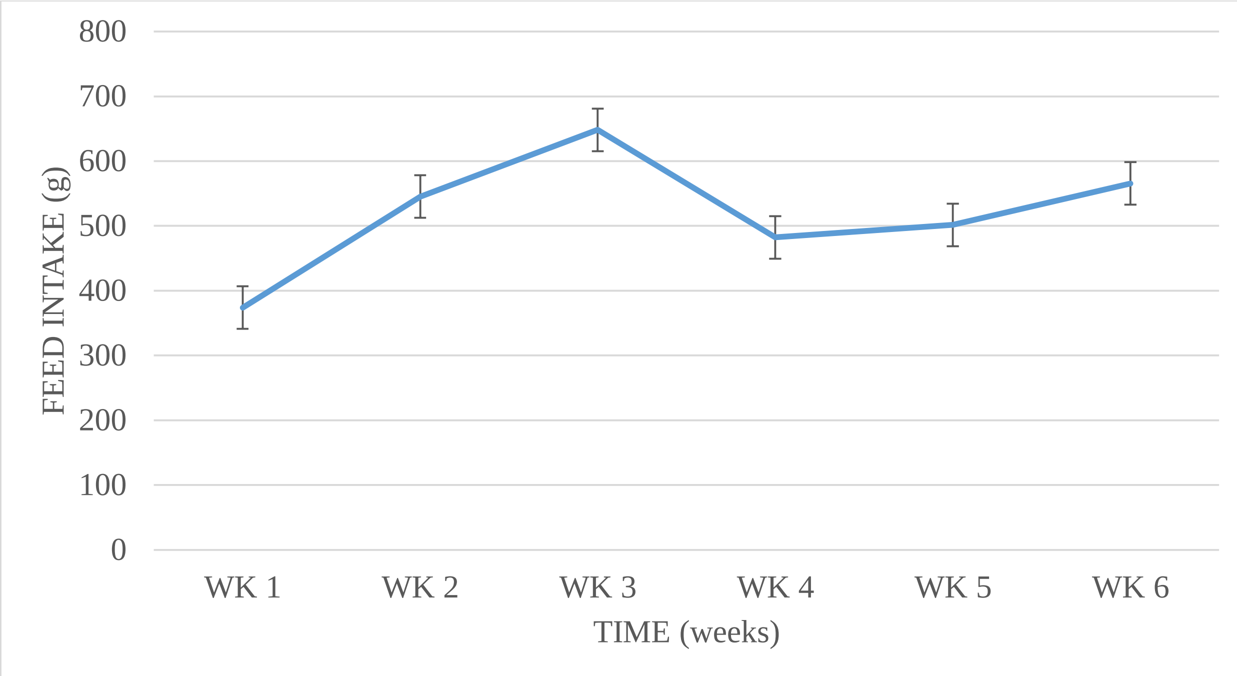

Fig 4.1: The graph shows the average feed consumed by 48 chickens during the feeding trial period.

4.2 Weight change

The body weight change showed a non-significant (p> 0.05) difference among the 4 dietary treatments. The weight gains for the whole feeding trial were 600.03, 640.03, 654.04 and 695.73 for 10%, control, 20% and 30% VB bean diets respectively. Statistically these birds performs equally among 4 diets. The significant difference (p<0.05) was observed on weight changes in different weeks of the feeding trial for the 48 birds. Week 1 was significantly different (p<0.05) from other weeks There was a non-significant different (p>0.05) on week 2 and week 3. Week 3 up to week 5 were significantly the same. Week 6 was significantly different to other weeks.

Week 1 showed the lowest weight change from initial weight and there is an increase in weight change up to week 3.There was a slight weight gain in week 4 and a sharp increase or sharp weight gain up to week 6. The highest average weight change of 637.54grams was observed on week 4 and the lowest weight change of 81.34 grams was observed on week 4.

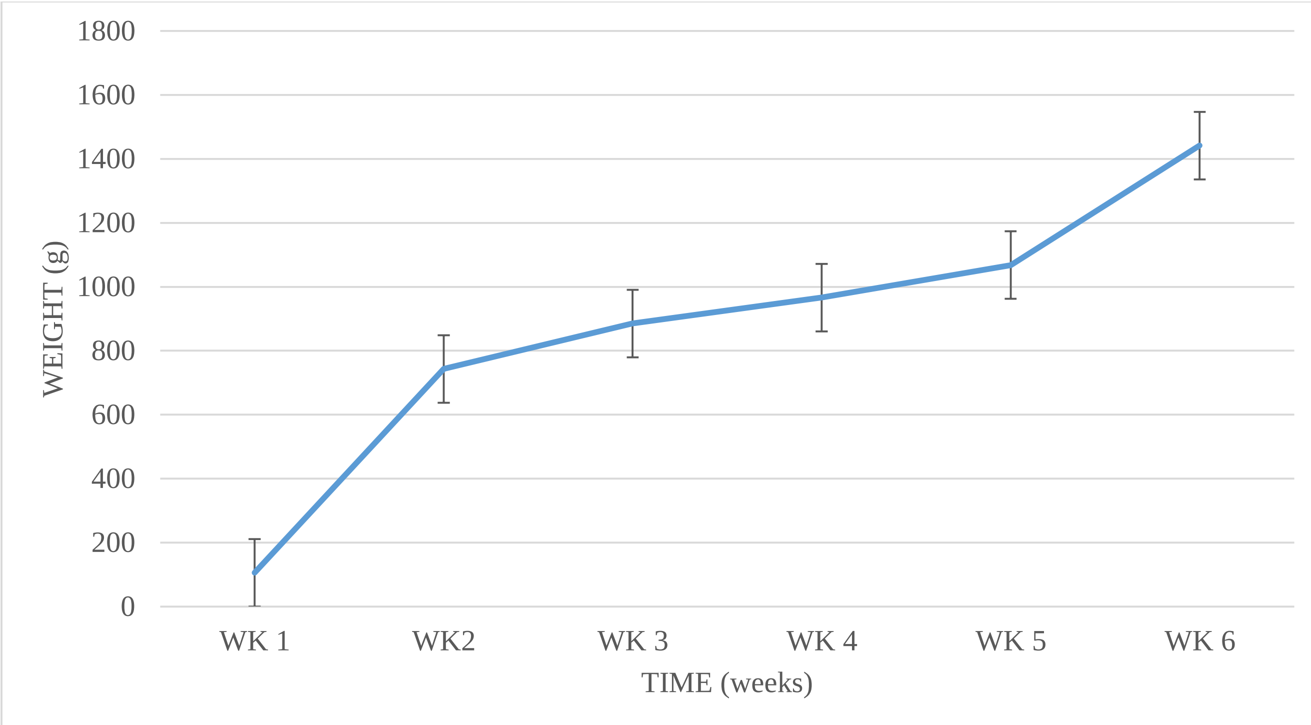

Fig 4.2: the graph showing the average weight changes from week 1 up to week

4.3 Feed conversion ratio

There was a significant difference ($p<0.05$) on Feed conversion ratio among the 4 treatments. A significant difference was observed on treatment 2 and 4 .The highest FCR of 5.6 was observed on treatment 2 and the lowest of 4.5 was observed on treatment 4. Treatment 1 and 3 showed similar FCR

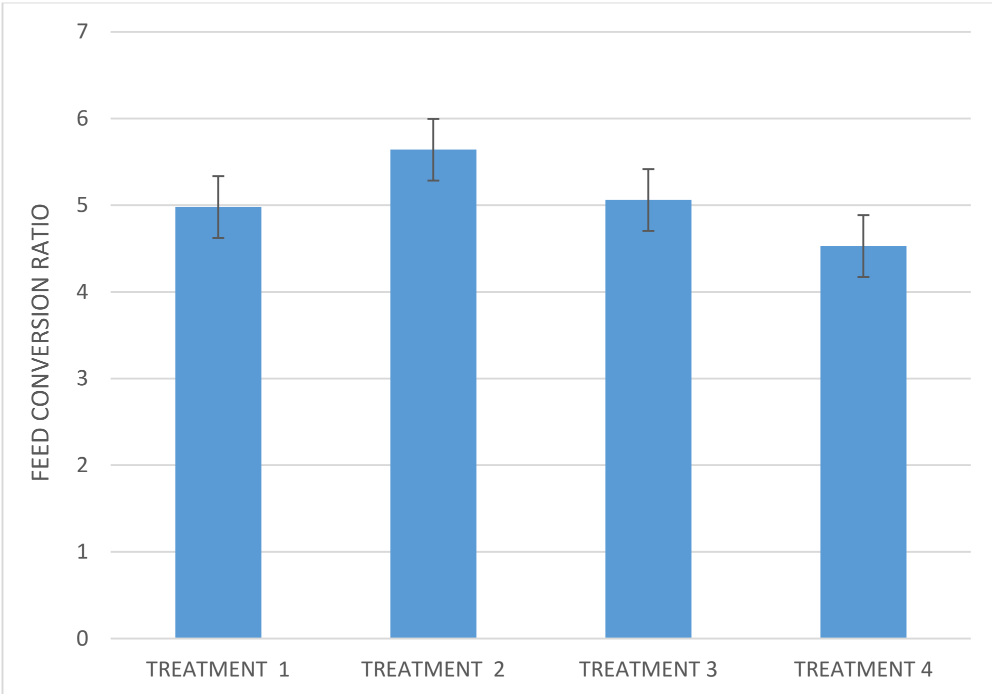

Figure 4.3: Feed Conversion Ratio for the 4 treatments

CHAPTER 5

DISCUSSION

5.1 Feed intake

The average weekly feed intake during the trial period varied from 496.03 grams for treatment 4 (30% VB) to 539.46 grams for treatment 2 (10%VB) without a significant different (p>0.05) among treatments. This suggests that the mucuna seeds used for this study had no adverse effect on the feed intake of indigenous chickens. Carew *et al* (2003) found a reduced feed intake when raw velvet bean were introduced into broiler diets. Emiola *et al* (2003) have made a similar observation. Jayaweera *et al* (2010) pointed out that this will be reversed when velvet beans are heated before feeding because they contain anti-palatability factors such as antitryptic factors, L-dopa, tannins just to mention a few and it's possible to remove them by heat treatment. Tuleun *et al* (2008) found significantly reduction in feed intake in the group fed the raw velvet bean diet and he suggested that this could be due to the presence of appetite depressant(s). They pointed out that heat treatment gives rise to feed intake improvements as indicated by the feed intake of the birds fed toasted velvet bean meal, their feed intake were compared favorably with that of the control group.

Some of the investigators like Emenalom and Udedibie (1998), Kaankuka (1998) and Olomu (1995) reported that cooking method can improve the nutritional value of legume seeds and they further stated that this can be attributed to the increase in availability of resultant amino acids, higher protein digestion and increase in palatability of the diet. Iyayi and Taiwo (2003) also found that the inclusion level of velvet bean meal up to 33.3 % had no adverse effect feed intake. Meanwhile toasted velvet beans were used in this current study the comparable feed intake were observed in all diets , the results were walking in line with the previous observation of Iyayi and Taiwo (2003) and. In this trial the toasted VB used resulted in high feed intake as compared to findings of Carew *et al* (2003) used raw velvet bean. Moreover their palatability and free from anti palatable factors like tannin, trypsin inhibitor, phytate contents and haemagglutinating activities, made them significantly the same as the control diet which is composed of grower concentrate. The 4 diets were properly formulated, there were iso-nitrogenouse and iso-energetic hence non-significant variation was observed among these 4 diets.

There was a significant different ($p<0.05$) on feed consumed during the feeding trial from week 1 up to week 6. Week one showed the lowest feed intake this could be caused by the adaptability of the birds. The first 2 weeks of the feeding trial were regarded as the adaptation period but during first week of the proper feeding trial there is an indication that the birds were not fully adapted to velvet bean meal and thereafter there is an increase in feed intake during week 2 to 3 resulted in the adaptability of the birds. Some of the scholars like Kaankuka (1998) pointed out that the palatability of feed will increase the feed intake. In addition the feed intake increased with time because the birds were growing and increasing in size and age.

There was significantly decrease in feed intake during week 4 this might be caused by the higher environmental temperatures. Mark et al (2013) documented that birds subjected to higher environmental temperatures spend more time cooling their body by panting, drinking more water, elevating their wings as well as more time resting and they spend less time feeding. The experimental birds in this trial showed similar abnormal behaviors stated by Mark et al (2013). In a recent study done in 2012 by Sohail colleagues they concluded that birds subjected to higher temperatures had significantly reduced feed intake by −16.4%, they lower body weight by −32.6% and they have poor or higher feed conversion ratio of +25.6%. If the temperature rises above upper critical temperature (UCT), birds will start to consume less feed and production will drop as a result. The most efficient temperatures for growing chickens are between 20°C – 24°C. When temperatures rise above 24°C a significantly reduced feed intake will be noticed. Some publishers' pointed out that heat stress impairs overall poultry production by modifying the bird's neuroendocrine profile both by decreased feed intake and by activation of the hypothalamic-pituitary-adrenal (HPA) axis. There wasn't enough time frame for observing the feed intake of the birds from week six therefore this resulted in poor feed intake as compared to week 3, however if the birds were given enough time frame the birds could have performed significantly the same to what is shown on week 3

5.2 Body weight change

The body weight change showed a non-significant ($p> 0.05$) different among 4 treatments. The weight gains for the feeding trial were 600.03, 640.03, 654.04 and 695.73 for 10%, control, 20% and 30% mucuna bean diets respectively. Statistically body weight change showed a non-significant but in reality the diet containing 30%VB has got the highest weight change of 695.73

and the diet with 10% VB contain the lowest weight change of 600.3. The present study goes along with Tuleun and collegues (2008) they find a non-significant difference in body weight change between the toasted velvet bean meal and the control diet and they concluded that heat treatment is a successful antidote, and that toasting method can converts velvet bean to poultry feed ingredient that is comparable to grower concentrate and correctly processed soybean. These findings are in agreement with the findings of Ukachukwu (2002), who observed that toasting velvet bean improved the growth rate of broiler chicks, bringing them to par with that of the control diet. However these results contradicts the findings of Ferriera *et al* ,(2003) and Ukachukwu and Szabo (2003) that chicks fed 12 – 22.5% processed MSM diets had lower weight gain than those fed 0% MSM diet.

The significant improved growth rates (comparative to the control group) in this current trial, might be attributed to the velvet bean processing method used. Various investigators reported that velvet bean seed contain toxic substances that hinder the performance of monogastric animals (Udedibie and Carlini, 1998). Therefore depression in quantity of feed consumed and weight gain of birds fed high levels of processed MSM had been attributed to the effects of residual antinutritional factors (tannins, hydrocyanic acid, phytic acid, L-dopa and lectins) present in processed MSM (D'Mello and Devendra, 1995; Carew et al, 2002). Efforts aimed at minimizing these toxic elements have shown no more than partial detoxification when fed to birds. The processing method adopted in the present trial may have contributed to the effective detoxification of velvet bean seed, hence, improvement in the growth performance of chickens

The body weight changes for the 48 hens resulted in significant variations over the study period. The average gains were 105.7, 637.54, 141.94, 81.34, 101.56 and 373.73 grams for week 1, 2, 3, 4, 5 and week 6 respectively. Week 1 was significantly different ($p<0.05$) to any other weeks and has lower weights because the birds were still young as compared to other weeks, the birds were 51 days old. There were 7,14,21,28 and 35 days younger to week 2,3,4,5 and 6 respectively. Week 1 was a starting point. There is a higher weight change from week1 to week 2 this was due to the increase in feed intake since the birds were now fully adapted to the diet and the environment. There was a rapid decrease in feed intake during week 4 and this might be due to higher enviromental temperatures but there is a slight increase in weight, however the researcher concluded that velvet bean meal is a good quality feed that can be consumed in low quantity but giving better weight gains. However the trend shown by the graph indicated that the birds were increased weights as they grow.

5.3 Feed conversion ratio

There was a significant difference ($P < 0.05$) on feed conversion ratio between diet 2 with lowest level of velvet bean meal and diet 4 with highest level of velvet bean meal. The highest Feed conversion ratio of 5.6 was observed on treatment 2 and this showed that there was a higher feed intake and the birds were gaining less and this indicates a poor feed efficiency and low feed utilization of diet 2 as compared to diet 4. The lowest feed conversion ratio of 4.5 was observed on diet 4 that contain highest levels of velvet bean meal this indicated that feed consumption was very low and the weight changes were very high and this is attributed to better feed efficiency and higher feed utilization of diet 4 as compared to diet 2. Since there is non-significant difference on diet 4 that contain highest level of VB and control diet this indicated that VB seed meal did not impair nutrient utilization in the growing chickens.

The significant difference on diet 2 and 4 can be attributed to the palatability of the diet. Diet containing low levels of VB (diet 2) seems to be more palatable that those containing highest levels of VB (diet 4). However the diet containing the highest level of velvet bean meal is a good quality feed that can be consumed in low quantity but giving better weight gains than the diet with low levels of VB.

Generally the feed conversion ratio in this experiment were very high in all treatments as compared to the findings of Tuleun *et al* (2008) and Vadivel *et al*, (2010). The FCR were 5.0, 5.6, 5.1 and 4.5 for control, 10%, 20% and 30% toasted velvet bean meal respectively. Tuleum *et al,* (2008) noted the FCR of 1.60 in the laying hens fed toasted velvet bean meal and Vadivell *et al,* (2010) noticed the FCR of 2.72 on broilers fed 100% VB. The poor FCR may be attributed to the nature of village chickens, these chickens are much less efficient in feed utilization than modern breeds (broiler and layer). In addition village chickens have got greater feed wastage characteristics. Village chickens have some natural feeding behavior in most cases, when the chickens were eating they were also scratching. In some cases the birds scratching without a clear indication that they were feeding. Scratching results in feed wastage, feed spillage and miscalculations of feed intake and contributes to inferior feed conversion. Gadzirayi and Mupangwa (2014) noted higher feed conversion ratio of 4.5 on indigenous chickens and Tuleun *et al,* (2009) noticed FCR of 5.09 on quail birds fed on toasted velvet bean meal they said that the greater feed wastage characteristics of the quails and indigenous chickens may cause higher FCR. Similar observations made in this study may also be due to the fidgety nature of the indigenous chickens. On the other hand indigenous chickens are not reared for commercial purpose unlike modern breeds.

Increased FCR might be attributed to the presents of internal parasites or other microbes in experimental birds. During the feeding trial no recognizable disease detected, maybe the birds were suffering an illness that is staying below the surface of clinical detection. If a bird is being affected by internal parasites and microbes it consume more feed but is directed towards maintenance rather than growth. When a bird is being affected by the enteric disease more changes occur in feed utilization since various microbes and parasites can decrease the effectiveness of digestion and absorption of nutrients of the diet. For an example a bird with sub-clinical coccidiosis it’s not possible for that bird to successfully absorb nutrients, because the oocytes will damage several cells lining the cut. In recent times the phenomenon called feed-passage has been detected in broiler birds. Undigested feed particles are observed in the excreta, as a result feed efficiency will be affected. The cause of this problem is not yet revealed, but it might be the significances of a microbial challenge

Moreover higher FCR in all the diets might be due by higher environmental temperatures experienced in other weeks of the feeding trial, some observers pointed out that optimum temperatures permits the birds to convert nutrients in a diet to growth instead of using the calories for temperature regulation. During week 4 and week 5 the birds were affected by higher environmental temperatures, at high environmental temperatures, birds tend to have low feed intake and they convert this feed less efficiently. The birds use a natural cooling mechanisms during hot weather for example painting. This biological mechanism require a lot of energy, just as the warming mechanisms used during cool weather.

There was low mortality among the birds fed the graded levels of toasted velvet bean meal, only two birds died and their death was not subjected to feed and this approves that the toasting method was very effective in detoxifying or eliminating antinutritional factors contained in velvet bean seed.

CHAPTER 6

6.1 Conclusions

Indigenous chickens fed on toasted velvet bean meal at an inclusion level of 10% to 30% performed equally to the birds fed on grower concentrated feed, therefore velvet bean meal could be fed to indigenous chickens and gives good performance and it is a cost-effective source of protein. The outcomes of this feeding trial indicated that velvet bean seed is a good source of protein and other nutrients, even though the raw velvet bean contain several anti-nutritional factors the toasting method used in this trial was more effective in minimizing their maximum levels.

6.2 Recommendations

- The researcher recommends farmers to use velvet bean as a protein source to indigenous diets since it can be available at a village level. Velvet bean meal can substitute grower concentrate up to 70.6% and it could be a considerable opportunity for smallholder farmers in villages and other developing countries where conventional proteins and concentrated feed are scarce
- The study recommends to process velvet bean seed using toasting method because the process is very simple and effective. The method improves the nutritional value of the seed at the same time improves the palatability of the diet and it encourages the better performance of birds. Utilization of these processing procedures through practice could then form the starting point in the usage of this long neglected humid legume in monogastric animal nutrition.
- After conducting a small-scale feeding trial and evaluation, the use of toasted velvet bean seed as a cost effective and alternative source of protein is recommended. The use of this non-conventional feed ingredient will minimize competition in the poultry industry and it also reduces the over- dependence on conventional protein sources like soybean and sunflower. Additionally, the use of velvet bean meal in the formulation of poultry diet would minimize the feed production cost and eventually might help in the expansion of poultry industry in Zimbabwe.
- The study recommends to feed VBM diet to Indigenous chickens containing up to 30% inclusion level because the birds perform well in terms of feed intake and growth without any adverse effect

Appendix

Output

```
The SAS System     00:57 Friday, September 14, 2017  31

                      The Mixed Procedure

                       Model Information

     Data Set                     WORK.LAW
     Dependent Variable           weight
     Covariance Structure         Autoregressive
     Subject Effect               animal
     Estimation Method            REML
     Residual Variance Method     Profile
     Fixed Effects SE Method      Model-Based
     Degrees of Freedom Method    Between-Within
             Class Level Information
       Class     Levels    Values

       animal        46    1 2 3 4 5 6 7 8 9 10 11 12 13
                           14 15 16 17 18 19 20 21 22 23
                           24 25 26 27 28 29 30 31 32 33
                           34 35 36 37 39 40 41 42 43 45
                           46 47 48
       trt            4    1 2 3 4
       time           6    1 2 3 4 5 6

                 DF    Chi-Square      Pr > ChiSq

                  1          3.91          0.0479


                Type 3 Tests of Fixed Effects

                      Num     Den
         Effect        DF      DF    F Value    Pr > F

         trt            3      42       0.61    0.6093
         time           5     210       6.37    <.0001
         trt*time      15     210       0.92    0.5450

                Least Squares Means
                                Standard
Effect      trt    time    Estimate      Error       DF    t Value    Pr > |t|

trt         1              1076.86      105.15       42      10.24      <.0001
trt         2               897.71      105.15       42       8.54      <.0001
trt         3               907.81      105.15       42       8.63      <.0001
trt         4               946.58      115.19       42       8.22      <.0001
time               1        638.61      105.70      210       6.04      <.0001
time               2        743.24      105.70      210       7.03      <.0001
time               3        885.18      105.70      210       8.37      <.0001
time               4        966.52      105.70      210       9.14      <.0001
time               5       1068.08      105.70      210      10.10      <.0001
time               6       1441.81      105.70      210      13.64      <.0001
                                Standard
Effect      trt    time    Estimate      Error       DF    t Value    Pr > |t|

trt*time    1      1        644.92      206.31      210       3.13      0.0020
trt*time    1      2        748.67      206.31      210       3.63      0.0004
trt*time    1      3        888.25      206.31      210       4.31      <.0001
trt*time    1      4        969.92      206.31      210       4.70      <.0001
trt*time    1      5       1069.50      206.31      210       5.18      <.0001
trt*time    1      6       2139.92      206.31      210      10.37      <.0001
trt*time    2      1        625.08      206.31      210       3.03      0.0028
```

trt*time	2	2	730.25	206.31	210	3.54	0.0005
trt*time	2	3	876.00	206.31	210	4.25	<.0001
trt*time	2	4	952.25	206.31	210	4.62	<.0001
trt*time	2	5	1049.67	206.31	210	5.09	<.0001
trt*time	2	6	1153.00	206.31	210	5.59	<.0001
trt*time	3	1	627.33	206.31	210	3.04	0.0027
trt*time	3	2	728.56	206.31	210	3.53	0.0005
trt*time	3	3	869.48	206.31	210	4.21	<.0001
trt*time	3	4	954.92	206.31	210	4.63	<.0001
trt*time	3	5	1058.67	206.31	210	5.13	<.0001
trt*time	3	6	1207.92	206.31	210	5.85	<.0001
trt*time	4	1	657.10	226.00	210	2.91	0.0040
trt*time	4	2	765.50	226.00	210	3.39	0.0008
trt*time	4	3	907.00	226.00	210	4.01	<.0001
trt*time	4	4	989.00	226.00	210	4.38	<.0001
trt*time	4	5	1094.50	226.00	210	4.84	<.0001
trt*time	4	6	1266.40	226.00	210	5.60	<.0001

The SAS System 00:57 Friday, September 14, 2017 73

The Mixed Procedure

Model Information

Data Set	WORK.MAS
Dependent Variable	intake
Covariance Structure	Compound Symmetry
Subject Effect	pen
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
pen	3	1 2 3
trt	4	1 2 3 4
time	6	1 2 3 4 5 6

Dimensions

Covariance Parameters	2
Columns in X	35
Columns in Z	0
Subjects	3
Max Obs Per Subject	

Number of Observations Read	72
Number of Observations Used	72
Number of Observations Not Used	0

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
trt	3	6	1.49	0.3089
time	5	10	19.33	<.0001
trt*time	15	30	1.00	0.4797

Least Squares Means

Effect	trt	time	Estimate	Standard Error	DF	t Value	Pr > |t|
trt	1		520.79	30.5567	6	17.04	<.0001
trt	2		539.46	30.5567	6	17.65	<.0001
trt	3		527.34	30.5567	6	17.26	<.0001
trt	4		490.42	30.5567	6	16.05	<.0001
time		1	373.87	32.8583	10	11.38	<.0001

time		2	545.30	32.8583	10	16.60	<.0001
time		3	648.34	32.8583	10	19.73	<.0001
time		4	482.26	32.8583	10	14.68	<.0001
time		5	501.61	32.8583	10	15.27	<.0001
time		6	565.64	32.8583	10	17.21	<.0001
trt*time	1	1	439.07	48.9211	30	8.98	<.0001
trt*time	1	2	551.88	48.9211	30	11.28	<.0001
trt*time	1	3	665.87	48.9211	30	13.61	<.0001

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The Mixed Procedure

Least Squares Means

Effect	trt	time	Estimate	Standard Error	DF	t Value	Pr > |t|
trt*time	1	4	441.71	48.9211	30	9.03	<.0001
trt*time	1	5	493.85	48.9211	30	10.09	<.0001
trt*time	1	6	532.33	48.9211	30	10.88	<.0001
trt*time	2	1	378.61	48.9211	30	7.74	<.0001
trt*time	2	2	608.02	48.9211	30	12.43	<.0001
trt*time	2	3	710.99	48.9211	30	14.53	<.0001
trt*time	2	4	502.33	48.9211	30	10.27	<.0001
trt*time	2	5	506.31	48.9211	30	10.35	<.0001
trt*time	2	6	530.50	48.9211	30	10.84	<.0001
trt*time	3	1	369.87	48.9211	30	7.56	<.0001
trt*time	3	2	525.02	48.9211	30	10.73	<.0001
trt*time	3	3	603.27	48.9211	30	12.33	<.0001
trt*time	3	4	498.98	48.9211	30	10.20	<.0001
trt*time	3	5	534.77	48.9211	30	10.93	<.0001
trt*time	3	6	632.12	48.9211	30	12.92	<.0001
trt*time	4	1	307.91	48.9211	30	6.29	<.0001
trt*time	4	2	496.27	48.9211	30	10.14	<.0001
trt*time	4	3	613.22	48.9211	30	12.53	<.0001
trt*time	4	4	486.00	48.9211	30	9.93	<.0001
trt*time	4	5	471.51	48.9211	30	9.64	<.0001
trt*time	4	6	567.62	48.9211	30	11.60	<.0001

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The GLM Procedure

Class Level Information

Class	Levels	Values
trt	4	1 2 3 4
pen	3	1 2 3

Number of Observations Read	46
Number of Observations Used	46

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The GLM Procedure

Dependent Variable: fcr fcr

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	11.60719946	1.05519995	0.69	0.7346
Error	34	51.66930922	1.51968557		
Corrected Total	45	63.27650868			

R-Square	Coeff Var	Root MSE	fcr Mean
0.183436	24.29855	1.232755	5.073370

Source	DF	Type I SS	Mean Square	F Value	Pr > F
trt	3	6.98451749	2.32817250	1.53	0.2239
pen	2	0.55157336	0.27578668	0.18	0.8348
trt*pen	6	4.07110861	0.67851810	0.45	0.8423

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	3	6.86896632	2.28965544	1.51	0.2304
pen	2	0.52856248	0.26428124	0.17	0.8411
trt*pen	6	4.07110861	0.67851810	0.45	0.8423

The GLM Procedure
Least Squares Means

trt	fcr LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	4.98126455	0.35586579	<.0001	1
2	5.63725315	0.35586579	<.0001	2
3	5.06301173	0.35586579	<.0001	3
4	4.52514803	0.39342444	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: fcr

i/j	1	2	3	4
1		0.2012	0.8719	0.3959
2	0.2012		0.2618	0.0436
3	0.8719	0.2618		0.3178
4	0.3959	0.0436		

pen	fcr LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	5.03340525	0.32077309	<.0001	1
2	4.93095233	0.32077309	<.0001	2
3	5.19065052	0.30818882	<.0001	3

Least Squares Means for effect pen
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: fcr

i/j	1	2	3
1		0.8227	0.7259
2	0.8227		0.5632
3	0.7259	0.5632	

NOTE: To ensure overall protection level, only probabilities associated with pre-planned Comparisons should be used.

The GLM Procedure
Least Squares Means

trt	pen	fcr LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	1	5.44225716	0.61637764	<.0001	1
1	2	4.71893357	0.61637764	<.0001	2
1	3	4.78260293	0.61637764	<.0001	3
2	1	5.50739589	0.61637764	<.0001	4
2	2	5.29313479	0.61637764	<.0001	5
2	3	6.11122877	0.61637764	<.0001	6
3	1	4.51901944	0.61637764	<.0001	7
3	2	5.27159352	0.61637764	<.0001	8
3	3	5.39842222	0.61637764	<.0001	9
4	1	4.66494852	0.71173159	<.0001	10
4	2	4.44014743	0.71173159	<.0001	11
4	3	4.47034816	0.61637764	<.0001	12

Least Squares Means for effect trt*pen
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: fcr

i/j	1	2	3	4	5	6
1		0.4124	0.4544	0.9409	0.8652	0.4481
2	0.4124		0.9422	0.3721	0.5145	0.1195
3	0.4544	0.9422		0.4115	0.5620	0.1367
4	0.9409	0.3721	0.4115		0.8073	0.4932
5	0.8652	0.5145	0.5620	0.8073		0.3546
6	0.4481	0.1195	0.1367	0.4932	0.3546	
7	0.2970	0.8200	0.7642	0.2648	0.3807	0.0766
8	0.8459	0.5303	0.5785	0.7884	0.9804	0.3422
9	0.9602	0.4411	0.4847	0.9012	0.9046	0.4192
10	0.4148	0.9546	0.9013	0.3772	0.5092	0.1338
11	0.2947	0.7690	0.7183	0.2649	0.3713	0.0849
12	0.2727	0.7772	0.7224	0.2424	0.3519	0.0684

Least Squares Means for effect trt*pen
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: fcr

i/j	7	8	9	10	11	12
1	0.2970	0.8459	0.9602	0.4148	0.2947	0.2727
2	0.8200	0.5303	0.4411	0.9546	0.7690	0.7772
3	0.7642	0.5785	0.4847	0.9013	0.7183	0.7224
4	0.2648	0.7884	0.9012	0.3772	0.2649	0.2424
5	0.3807	0.9804	0.9046	0.5092	0.3713	0.3519
6	0.0766	0.3422	0.4192	0.1338	0.0849	0.0684

The GLM Procedure
Least Squares Means

Least Squares Means for effect trt*pen
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: fcr

i/j	7	8	9	10	11	12
7		0.3940	0.3202	0.8777	0.9337	0.9558
8	0.3940		0.8852	0.5237	0.3834	0.3645
9	0.3202	0.8852		0.4414	0.3160	0.2945
10	0.8777	0.5237	0.4414		0.8246	0.8375
11	0.9337	0.3834	0.3160	0.8246		0.9746
12	0.9558	0.3645	0.2945	0.8375	0.9746	

NOTE: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

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