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## Pelleted Spent Mushroom Substrates on the Growth Performance of New Zealand White Rabbits

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### Abstract:

**Aim:** Consumer's demand for food products with low content of saturated fat pushed industry and researchers to find alternative food sources and continue investigations on underestimated traditional food sources. A healthy diet became a priority in sustainable production and consumption because of the increasing number of scientific evidence linking quality and quantity of food consumption to human health. Rabbit meat is repeatedly suggested as a functional food and as an attractive part of a healthy diet, mainly due to its high nutritional value. The present study aimed to evaluate the response of growing rabbits fed with varying levels of pelleted spent mushroom substrates (SMS) on their growth performance.

**Methodology:** The study was laid out following the completely randomized design and utilized the following treatments T1 - Home-mixed ration with no Spent Mushroom Substrates (SMS), T2- Home-mixed ration with 5% Spent Mushroom Substrates (SMS), T3- Home-mixed ration with 10% Spent Mushroom Substrates (SMS), T4- Home-mixed ration with 15% Spent Mushroom Substrates (SMS) and T5- Home-mixed ration with 20% Spent Mushroom Substrates (SMS) all the feed samples were pelleted. The feeding trial lasted for seven weeks.

**Results:** The study observed that the inclusion of spent mushroom substrates had no significant effect on the overall growth performance of male New Zealand white rabbits. However, higher lion weight was observed on rabbits with 5% SMS on their diet. Whereas, higher inclusion of SMS (15 and 20%), obtained heavier belly weights. In terms of return on investment the inclusion of 15% fermented spent mushroom substrates had the highest return with 13.71%.

**Conclusion:** The inclusion of 5, 10, 15 and 20% SMS to the feeds of growing New Zealand White rabbits for seven (7) weeks showed no significant differences on the compared to the control groups with no spent mushroom substrates (SMS) inclusion. Therefore, it is concluded that the utilization of spent mushroom substrates as alternative feed for rabbits has no detrimental effect on the growth performance of rabbits.

**Keywords:** Growth, Pelleted, Spent Mushroom Substrates

### INTRODUCTION

Livestock production is a vital part of the agricultural sector in the Philippines, providing food, employment, and economic growth in rural areas.

As the animal industry faced severe setbacks from disease outbreaks like African Swine Fever (ASF) and bird flu, which reduced the production of animal-based protein and disrupted the livelihoods of the farmers, the rabbit industry emerged as an alternative industry in the Philippines. Rabbit production can be one solution to alleviate this problem and provide alternative livelihood for the raisers, as well as, alternative source of protein for the populace, which may lead to the attainability of the Food and Agriculture Organization (FAO) sustainable goal and development number 1 (no poverty) and 2 (zero hunger). With increasing human population and decreasing per capita landholding in the high potential agricultural areas, poverty and malnutrition, especially common in most developing countries, there is a need for sound and sustainable livestock production systems to alleviate these



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problems. Rabbit meat production can be an alternative means of alleviating world food shortages and poverty due to the virtues attributable to the rabbit such as high rate of reproduction and early maturity, rapid growth rate, high genetic selection potential, efficient feed and land space utilization, limited competition with humans for similar foods and high quality nutritious white meat.

Nowadays, interest in a healthy and sustainable lifestyle particularly a healthy diet is constantly growing. A healthy diet became a priority in sustainable production and consumption because of the increasing number of scientific evidence linking quality and quantity of food consumption to human health. The consumer's demand for food products with low content of saturated fat pushed industry and researchers to find alternative food sources and continue investigations on underestimated traditional food sources. Rabbit meat is repeatedly suggested as a functional food and as an attractive part of a healthy diet, mainly due to its high nutritional value (Dalle Zotte, 2014; Petracci et al., 2018). It is characterized by high contents of proteins which is as high as 22.4% and oleic acid, and a low-fat content which is approximately 618 kJ/100 g of fresh meat as compared to red meat (Cullere et al. 2018; Li et al. 2018). Additionally, rabbit meat may be vital in fighting food shortage. New rabbit-based products are continuously being developed to satisfy the consumer's needs and promote rabbit meat in the market. Another advantage to consider is the low environmental impact from raising rabbits compared to raising of cattle and some other livestock species. Thus, it can be regarded as a sustainable choice compared to red meat (Zucali, 2017).

Competition between man, animals and industries for conventional feed resources and high cost of compounding concentrate has become a major constraint militating against increased production. The increasing cost of conventional feed ingredients with the resultant increase in the cost of livestock products has necessitated research in the search for cheaper and readily available alternative feed ingredients for livestock feeding. Also, one major concern in animal industry is the increasing contribution of the industry in the production of greenhouse gases that greatly affects the environment, FAO SDG number 13 focused on the climate action. Rabbits farming produces fewer greenhouse gas emission than other livestock farming, and rabbits have smaller carbon foot print than other farm animals.

The expansion of the mushroom industry is a global phenomenon; its world aggregate production in 2011 was 7,698,773 tons (FAO, 2013) and production is still on the increase especially with the increase campaign on health, nutritional and medicinal benefits (Adedokun & Akuma, 2013). Mushrooms are produced on natural materials taken from agriculture, woodlands, animal husbandry, and manufacturing industries. Production of mushrooms however is accompanied with the generation of millions of tons of residue referred to as spent or used mushroom substrates (SMS/UMS) which remains after the mushroom crop has been harvested (Rinker, 2002). The annual renewable agricultural residues represent an abundant, inexpensive and readily available source of renewable lingo-cellulosic biomass as reported by Azubuike and Okhamafe (2012).

Spent mushroom substrate (SMS) is a virtually inexhaustible supply of a co-product generated by mushroom industries. This is the un-utilized substrate and the mushroom mycelium left after harvesting of mushrooms. As the mushroom industry is steadily growing, the volume of SMS generated annually is increasing. In recent years, the mushroom industry has faced challenges in storing and disposing the SMS (Chia et al. 2012).

After the fruiting stage of mushroom production, there is a large quantity of SMS left over, approximately 5 kg for every 1 kg of harvested mushroom (Finney et al. 2009; Mohd Hanafi et al. 2018), which is seen by mushroom producers as a waste, resulting in an astonishing 5 million tons of SMS solid waste being disposed of annually (Mohd Hanafi et al. 2018). However, this SMS has several documented alternative uses, including energy production, wastewater treatment, and animal feedstock, but primarily by being applied to farmland as fertilizer. Despite its effectiveness as a fertilizer, the storage and transportation costs associated with disposal of SMS by field application incurs such high costs that it is less economically viable than chemical fertilizers (Beyer, 2011). Additionally, with growing awareness on the benefits of circularity, SMS uses which can replace raw inputs by being returned into a cycle, such as animal feed, is more desirable (Grimm and Wösten, 2018).

Rabbits are hind gut fermenters which can tolerate nutrient filled and fibrous diet such as SMS to drive the gastrointestinal tract thus this study is proposed.

## Objectives

Generally, this study aimed to evaluate the response of growing rabbits fed with varying levels of pelleted spent mushroom substrates (SMS) on their growth performance.

Specifically, the study aimed to:

1. Determine the nutrient composition of the spent mushroom substrate;



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- Determine which level of the pelleted SMS give the best result in terms of the different production performance parameters of grower rabbits such as initial and weekly body weight, gain in weight, feed consumption, percentage rate of growth, feed conversion ratio and feed conversion efficiency, and
- Determine which among the treatment groups will result to the highest return on investment.

## METHODS

### Experimental Cages

The experimental cages were made up of corrugated bars as frame and welded wires as walls with rubber plastic matting. Two (2) four-tier cages were used with each cage dimension of 2.40 m x 0.50 m x 1.8 m, each layer was composed of six (6) cages with each cage's floor space of 150 cm<sup>2</sup> for each rabbit.

### Cage Preparation

One week before the arrival of the stocks, the rabbit house and the premises were cleaned and sprayed with chlorine dioxide, it was left unwashed allowing the disinfectant to dry in the area.

### The Experimental Animals

A total of forty-five (45) heads of upgraded male New Zealand Rabbits which were at least eight (8) weeks old of approximately the same size and body weights were sourced out from Cagayan Valley Rabbit Breeders Association, Tuguegarao City, Cagayan.

### Acclimatization

The animals were acclimatized for two (2) weeks before the conduct of the experiment. During the first week of acclimatization, the rabbits were fed with the same diet fed by the breeder and then at the second week of acclimatization, they were gradually shifted to a diet containing SMS.

### Spent Mushroom Substrates

Spent Oyster mushroom (*Pleurotus ostreatus*) Substrates were acquired from a local mushroom grower and producer at Sto. Domingo, Luna, Isabela.

### Preparation of the Spent Mushroom Substrates

The substrates were air-dried to reduce the moisture content for about 1-2 days. After which, it was fermented with molasses for seven days in a silage bag to improve the nutritional composition of the substrate. Chemical analysis of the fermented spent mushroom substrate was done using FOSS Analytical A/S, NIRS DA1650, (Denmark) to serve as basis in the formulation of the home mixed diets for the rabbits. Nutrient composition such as percent crude protein, percent crude fiber, percent moisture, and percent fat and percent ash were noted. The fermented SMS was added to the home-mixed rations depending on the level of inclusion indicated in each treatment groups and pelleting process were done after mixing all the ingredients indicated in the formulated ration with the same pelleted feed size of 3mm.

### Experimental Design and Treatments.

The experimental animals were randomly distributed into five (5) treatments. Each treatment was replicated thrice with three (3) rabbits per replicates. Each replication comprised with three (3) rabbits. The experiment was laid out using the Completely Randomized Design (CRD) with the following treatments:

Treatment 1- Home-mixed ration with no Spent Mushroom Substrates (SMS)

Treatment 2- Home-mixed ration with 5% Spent Mushroom Substrates (SMS)

Treatment 3- Home-mixed ration with 10% Spent Mushroom Substrates (SMS)

Treatment 4- Home-mixed ration with 15% Spent Mushroom Substrates (SMS)

Treatment 5- Home-mixed ration with 20% Spent Mushroom Substrates (SMS)

### Feeding Management

A home-mixed ration was used as base for the treatments throughout the study. The ingredients used were corn meal, rice bran, fish meal, salt, vitamins, limestone, lysine, methionine, enzymes, and toxin binders and spent mushroom substrates (SMS). The formulated rations were used for seven weeks (7) weeks *ad libitum*. Automatic

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water drinkers and feeders were used. Feeds offered were strictly weighed and recorded, while leftovers were collected and weighed every afternoon before offering new feeds as basis in computing the actual feed consumption of the rabbits.

**Formulated Diets**

Shown in Table 1 are the formulated diets used in the study:

**Table 1. Formulated Diets for Rabbits.**

Ingredients	T1	T2	T3	T4	T5
<b>Corn</b>	40.40	41.00	49.00	53.00	51.00
<b>Rice bran (D1)</b>	25.97	22.50	6.00	1.50	0.30
<b>Soybean</b>	21.35	20.47	22.00	17.00	13.50
<b>Fish Meal</b>	0.30	0.33	0.50	2.79	4.30
<b>Molasses</b>	4.00	2.00	3.00	0.50	0.50
<b>Vegetable Oil</b>	0.30	0.70	1.50	3.00	3.40
<b>Limestone</b>	0.00	0.00	0.00	0.00	0.00
<b>Dicaphos</b>	1.00	1.00	1.00	1.00	0.90
<b>Salt</b>	0.30	0.30	0.30	0.30	0.30
<b>Lysine</b>	0.03	0.03	0.03	0.03	0.03
<b>Methionine</b>	0.00	0.32	0.32	0.33	0.17
<b>Enzyme</b>	0.10	0.10	0.10	0.10	0.10
<b>Toxin Binder</b>	0.25	0.25	0.25	0.00	0.25
<b>Vit.Premix</b>	5.00	5.00	5.00	5.00	5.00
<b>SMS</b>	0.00	5.00	10.00	15.00	20.00
<b>Pellet Binder</b>	1.00	1.00	1.00	0.45	0.25
<b>Total</b>	100.00	100.00	100.00	100.00	100.00

**Calculated Analysis**

	T1	T2	T3	T4	T5
<b>Metabolisable Energy</b>	2587.72	2501.17	2504.60	2564.72	2466.20
<b>Percent Crude Protein</b>	16.06	16.12	16.36	16.10	16.04
<b>Percent Calcium</b>	0.85	0.82	0.79	0.84	0.85
<b>Percent Phosphorus</b>	0.31	0.31	0.28	0.32	0.33
<b>Lysine</b>	0.86	0.85	0.83	0.77	0.72
<b>Methionine</b>	0.28	0.59	0.58	0.59	0.43
<b>Salt</b>	0.30	0.30	0.30	0.30	0.30
<b>Percent Crude Fiber</b>	4.12	4.61	4.72	5.09	5.50



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## Data Gathered

The following data were gathered and recorded for analysis and evaluation:

## Growth Performance

**Initial and Weekly Body Weight.** The initial body weight of the rabbits was taken before they were distributed to the experimental cages. Their body weights were taken weekly throughout the period of experiment.

**Gain in Weight.** The gain in weight of the rabbits were computed by subtracting the current week weight from the previous weight. Cumulative gain in weights was computed by subtracting the final weight to the initial weights of the rabbits.

**Feed Consumption.** The weekly feed consumption of the rabbits in the different treatments were taken into account. The feed consumed and left-over was subtracted from the feed offered to determine the actual feed consumption. Cumulative feed consumption was computed by adding all the feed consumed from the start until the end of the study.

## Feed Conversion Ratio and Efficiency.

The feed conversion ratio and efficiency of the rabbits were determined by using the Biddle and Juergueson's formula as follows:

$$\text{Feed Conversion Ratio} = \frac{\text{Feed Consumed}}{\text{Gain in weight}}$$

$$\text{Feed Conversion Efficiency} = \frac{\text{Gain in Weight}}{\text{Feed Consumed}} \times 100$$

## Return Above Feed and Rabbit Costs.

The return above feed and rabbit cost was computed at the end of the study considering all the expenses in terms of the cost of feeds included in the home mixed ration. The price of the live weight of the rabbit and the cost of feeds were based on the prevailing price in local market.

## Statistical Analysis of Data

All data gathered was tabulated and analysed using the Analysis of Variance (ANOVA) following the Completely Randomized Design (CRD). Data were computed and processed using the Statistical Tool for Agricultural Research (STAR) 2.0.1 2014.

## RESULTS and DISCUSSION

### Chemical Analysis of Spent Mushroom Substrates

Presented on table 2 is the Nutrient composition of the fermented spent mushroom substrates using FOSS Analytical A/S, NIRS DA1650. Nutrient composition such as percent crude protein, percent crude fiber, percent moisture, and percent fat and percent ash were noted. The analysis revealed that the crude protein content was 17.28 percent, whereas the crude fiber composition was 14.28 percent. Moreover, other chemical composition of the substrate was evaluated, such as the percent moisture (13.23%), fat (0.56%) and percent ash (12.23%) were recorded.

The crude protein content of the fermented spent mushroom substrate used in this study of 17.28% was higher compared to the crude protein content reported by Aderemi et al. (2014) at 7.88 % while crude fiber content of 14.28 was lower as compared to the report of 29.57%. Based on the result of this study the fermented SMS had a high CP content and a lower percent crude fiber which may be accounted to the fermentation process done to improve its nutrient composition. Fiber content in rabbit feeds is an important factor since it is necessary to maintain a high rate of passage of digesta (De Blas et al., 1999; Olatubosun, 2014).

Moreover, higher percent ash composition was observed in the study with 12.23%, whereas Aina Nasha et al.,(2020),reported that SMS ash composition was 6.58%. On the other hand lower percent moisture was



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observed in the study with 13.23%, while Aina Nasha *et.al.*, (2020) , reported that SMS had 63.00% moisture content.

**Table 2. Chemical Analysis of Fermented Spent Mushroom Substrates**

Parameters	Percentage Composition
Crude Protein	17.28
Crude Fiber	14.28
Percent Moisture	13.23
Percent Fat	0.56
Percent Ash	12.23

### Growth Performance

Shown in Table 3 are the initial and weekly body weights of the rabbits fed with varying levels of pelleted spent mushroom substrates in the five (5) treatment groups. Throughout the duration of seven (7) weeks observation period no statistically significant differences were recorded among the different treatment groups. Treatment 1 consistently recorded the heaviest body weight numerically which was higher as compared to the other treatment. On the other hand, among the SMS treatment groups, Treatment 3 consistently recorded the heaviest, while Treatment 2 consistently recorded the lightest in all observation period.

At the end of the seven (7) weeks feeding trial, the body weights of the rabbits ranged from 2199.44 to 2358.09 grams. The body weights recorded in this study was higher than the reports of Olatubosun (2014) of 1712.50 kg who used two feed forms offered to rabbits for 10 weeks. However, body weight values obtained in this study were lower to the records of Tumova *et al.* (2002), who reported a range of 2652-2748 g of Huplus rabbits as influenced by feed restriction period for 84 days. Moreover, the findings of this study is similar to Dougnon *et al.* (2012), who recorded that rabbits with aged ranges from 35-55 days old fed with pelleted commercial concentrate and 15 % pelleted moringa leaves had an average final weight of 2222.05 grams at the end of seventy eight (78) days of feeding trial. However, in the study of Dougnon *et al.*(2012) the feeding trial was longer as compared to this study.

Chang *et al.* (2016) mentioned that geese tend to have lower body weights with the inclusion of 15% spent mushroom compost as replacement to wheat bran, which is also similar to the finding of Foluke *et al.* (2014), who indicate that 75% to 100% Spent Mushroom compost replacement to wheat bran on poultry diets led to significant decrease on body weights. The present study proved that the utilization of spent mushroom substrates as ingredient on the rabbits ration had comparable effect on diets with no spent mushroom substrates, provided that the substrate must be ensiled to improve its nutrient composition before incorporating it into the ration. Moreover pelleting the ration also improved the digestibility of the ration as mentioned by Kpodekon *et al.* (2009) pelleted feeds provides better performance for rabbits as it improves feed efficiency through reduced wastage and increase palatability



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**Table 3. Initial and Weekly Body Weights (g) of the Experimental Rabbits for seven (7) weeks of t feeding trial.**

TREATMENTS	Initial	First Week	Second Week	Third Week	Fourth Week	Fifth Week	Sixth week	Seventh week
T <sub>1</sub> – 0% SMS	1353.89	1845.00	2030.56	2155.56	2231.11	2309.45	2342.78	2358.89
T <sub>2</sub> - 5% SMS	1364.44	1678.33	1797.50	1941.39	2044.44	2112.78	2170.56	2199.44
T <sub>3</sub> - 10% SMS	1410.56	1786.11	2005.28	2089.44	2184.72	2249.72	2308.89	2329.44
T <sub>4</sub> - 15% SMS	1420.00	1761.11	1849.44	1966.67	2072.22	2145.55	2186.11	2211.11
T <sub>5</sub> - 20% SMS	1415.00	1710.33	1854.44	1976.67	2074.45	2162.78	2206.67	2238.89
<b>ANOVA</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>
<b>% C.V.</b>	<b>5.27</b>	<b>10.13</b>	<b>11.20</b>	<b>10.28</b>	<b>9.32</b>	<b>8.92</b>	<b>8.15</b>	<b>8.52</b>

Note. ns- not significant, \*- significantly different @ 5% level and \*\*- significantly different @ 1 % level.

Presented in Table 4 are the weekly and cumulative gains in weights of the rabbits in the different treatment groups. The weekly gain in weight of the rabbit were computed by subtracting the current weight of the rabbit from its previous weight.

The highest gain in weight was observed at the first week of the study where gain in weights ranged from 295.33g to 491.11g. After which, gain in weights declined as weeks passed by. Similarly, no significant differences were observed in the cumulative gain in weights recorded in this study which ranged from 797.11-1005.00 grams. Olatubosun (2014), reported that rabbits obtained an average of 889.03 grams cumulative weight gained for 10 weeks of feeding pelleted rations. However, Kim et al. (2011), observed significant increment on the sheep's gain in weights fed with fermented saw dust based spent mushroom substrates.



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**Table 4. Weekly and Cumulative Gain in Weights (g) of Experimental Rabbits.**

TREATMENTS	First Week	Second Week	Third Week	Fourth Week	Fifth Week	Sixth week	Seventh week	Cumulative
T <sub>1</sub> – 0% SMS	491.11	185.56	125.00	75.55	78.33	33.33	16.11	1005.00
T <sub>2</sub> - 5% SMS	313.89	119.17	143.89	103.05	68.33	57.78	28.89	835.00
T <sub>3</sub> - 10% SMS	375.56	219.17	84.17	95.28	65.00	59.17	20.56	918.89
T <sub>4</sub> - 15% SMS	341.11	88.34	117.22	105.56	73.33	40.56	25.00	797.11
T <sub>5</sub> - 20% SMS	295.33	144.11	122.22	97.78	88.33	43.89	32.22	823.89
<b>ANOVA</b>	<b>ns</b>							
<b>% C.V.</b>	<b>45.04</b>	<b>42.32</b>	<b>41.24</b>	<b>47.78</b>	<b>33.70</b>	<b>42.19</b>	<b>54.07</b>	<b>22.88</b>

Note. ns- not significant, \*- significantly different @ 5% level and \*\*- significantly different @ 1 % level.

Shown on Table 5 is the weekly and cumulative feed consumption of rabbits in the different treatment groups. Feed consumption was obtained by subtracting the total feed offered in a week to the left overs recorded. On the first and second week of the study no significant differences were observed on the rabbits feed consumption among the treatment groups. However, on the third week of the study, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>5</sub> recorded a comparable amount of feeds consumed with 676.00, 648.89, 655.44 and 571.11 grams respectively which were significantly higher as compared to T<sub>4</sub> which consumed the least amount of feeds at 461.78g only. On the fourth, fifth, sixth and seventh week of the study no significant differences on the rabbit's feed consumption was observed. Cumulative feed consumption ranged from 3853.11 grams to 4538.28 grams which were found to be not significantly different among the treatment groups. Findings of the study on the cumulative feed consumption of rabbits after seven (7) week of feeding trial of 3853.11 to 4538.28 grams was slightly comparable to the report of Adeyami et al. (2012), that *ad libitum* feeding of concentrate and grasses in rabbits has an average feed intake of 4258.64 grams. Obtained values on the study was lower than the report of Olatubosun (2014) with 5613.88 – 5624.47 grams feed consumptions of upgraded New Zealand White rabbits fed with pelleted diets for ten (10) weeks. Pelleted rations offers better feed consumptions of the rabbits, avoid picking of ingredients and improves the nutrient composition of the ration.



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**Table 5. Weekly and Cumulative Feeds Consumption of Rabbits (g).**

TREATMENTS	First Week	Second Week	Third Week	Fourth Week	Fifth Week	Sixth week	Seventh week	Cumulative
T <sub>1</sub> – 0% SMS	608.00	607.11	676.00 <sup>a</sup>	487.33	609.11	708.89	660.00	4356.45
T <sub>2</sub> - 5% SMS	500.67	618.67	648.89 <sup>a</sup>	521.17	645.22	725.78	727.61	4388.00
T <sub>3</sub> - 10% SMS	535.44	702.00	655.44 <sup>a</sup>	592.72	641.22	706.22	705.22	4538.28
T <sub>4</sub> - 15% SMS	526.44	492.78	461.78 <sup>b</sup>	437.67	565.11	688.78	680.67	3853.11
T <sub>5</sub> - 20% SMS	562.22	512.33	571.11 <sup>ab</sup>	467.67	677.00	714.11	703.44	4207.89
<b>ANOVA</b>	<b>ns</b>	<b>ns</b>	<b>*</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>	<b>ns</b>
<b>% C.V.</b>	<b>14.44</b>	<b>16.18</b>	<b>13.28</b>	<b>17.04</b>	<b>15.48</b>	<b>16.84</b>	<b>9.98</b>	<b>11.05</b>
<b>LSD value</b> <sub>0.05</sub>	-	-	<b>145.63</b>	-	-	-	-	-

Note. ns- not significant, \*- significantly different @ 5% level and \*\*- significantly different @ 1 % level.

Shown in Table 6 are the feed conversion ratio and feed conversion efficiency of the rabbits fed with diets containing pelleted spent mushroom substrates. Feed Conversion Ratio is the amount feeds needed to produce a kilogram of body weight. Lower feed conversion ratio values indicates higher feed efficiency.

Numerically, higher feed conversion ratios were recorded on the treatment groups with SMS which ranged from 4.92 to 5.59 kg as compared with the control group (T<sub>1</sub>) with 4.36 kg. However, statistically, no significant differences were observed among the different treatment groups. Muhammad *et al.* (2018), mentioned that the FCR of male New Zealand Rabbits fed with graded Morning glory was 13.99 to 22.63 kg for 56 days of feeding trial, whereas, Olatubosun (2014), recorded that FCR was 6.31 kg for rabbits fed with pelleted rations for ten (10) weeks. In terms of feed efficiency T<sub>1</sub> recorded the highest feed efficiency at 23.16%, followed by T<sub>4</sub> (20.54 %), T<sub>3</sub> (19.93%) and the lowest feed efficiency was on T<sub>2</sub> with 18.62%. However, no significant differences were observed which may signify that the inclusion of spent mushroom substrate on the rabbits' diets had no negative effect. Feed efficiency of rabbits on the study were higher than the findings of Aderinola *et al.* (2018) who reported a feed efficiency of rabbits fed with mixed grass and legumes of 7.9% to 11.65%.

**Table 6. Feed Conversion Ratio (kg) and Feed Conversion Efficiency (%).**

TREATMENTS	FCR (kg)	FCE (%)
T <sub>1</sub> – 0% SMS	4.36	23.16
T <sub>2</sub> - 5% SMS	5.59	18.62
T <sub>3</sub> - 10% SMS	5.12	19.93
T <sub>4</sub> - 15% SMS	4.92	20.54
T <sub>5</sub> - 20% SMS	5.14	19.54
<b>ANOVA</b>	<b>ns</b>	<b>ns</b>
<b>% C.V.</b>	<b>16.60</b>	<b>15.05</b>

Note. ns- not significant, \*- significantly different @ 5% level and \*\*- significantly different @ 1 % level.



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Presented on Table 7. are the return on the bunny and feed cost of five (5) different treatment groups. Based on the calculations of the cost of production using fermented SMS for feeding growing New Zealand white rabbits for seven (7) weeks, it was found out that a higher net income can be achieved using fermented SMS at 5 and 15 % inclusion as compared to the control. Rabbits fed with diets contains 15% of fermented SMS observed to have the lowest feed intake and significant reduction of feed cost per kilogram at this inclusion rate was observable, as this reduction of feed cost and lower feed intake lessen the cost of production, which increases the return on investment.

**Table 7. Return on Rabbits and Feed Expenses.**

Particulars	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
Average Dressed Weight (kg)	1.23	1.30	1.24	1.22	1.18
<b>Gross Income</b>	<b>492.00</b>	<b>520.00</b>	<b>496.00</b>	<b>488.00</b>	<b>472.00</b>
Feed Consumed (kg)	4.36	4.39	4.54	3.85	4.21
Price of Feeds per kilogram	35.44	35.16	35.93	33.55	32.90
Price of Bunnies	300.00	300.00	300.00	300.00	300.00
Cost of Feed consumed	154.52	154.35	163.12	129.17	138.51
<b>Total cost</b>	<b>454.52</b>	<b>454.35</b>	<b>463.12</b>	<b>429.17</b>	<b>438.51</b>
<b>Net Income</b>	<b>37.48</b>	<b>65.65</b>	<b>32.88</b>	<b>58.83</b>	<b>33.49</b>
<b>R.O.I</b>	<b>8.25</b>	<b>12.63</b>	<b>7.10</b>	<b>13.71</b>	<b>7.09</b>

*Price of Rabbit per/kilogram- 400.00*

### Conclusion

The inclusion of 5, 10, 15 and 20% SMS to the feeds of growing New Zealand White rabbits for seven (7) weeks showed no significant differences on the compared to the control groups with no spent mushroom substrates (SMS) inclusion. Therefore, it is concluded that the utilization of spent mushroom substrates as alternative feed for rabbits has no detrimental effect on the growth performance of rabbits.

### Recommendations

Based on the above mentioned results of the study even though most of the parameters observed in the study it is recommended to use spent mushroom substrates as alternative feed ingredients for rabbits without adverse effect on the overall performance of rabbits. However, it is recommended to use 15% inclusion of spent mushroom substrates for better return on investment.

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