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Tiapenla Amer

M.Sc. Student, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema Campus, Nagaland, India

M Catherine Rutsa

Associate Professor, Department of LPM, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema Campus, Nagaland, India

N Savino

Associate Professor Department of LPM School of Agricultural Sciences & Rural Development Nagaland University, Medziphema Campus, Nagaland, India

Rajan Singh

Ph.D. Scholar, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema Campus, Nagaland, India

Corresponding Author:

M Catherine Rutsa

Associate Professor, Department of LPM, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema Campus, Nagaland, India

Performance of tenyivo pig on diet supplemented with nutgall (*Rhus semialata*) fruit

Tiapenla Amer, M Catherine Rutsa, N Savino and Rajan Singh

Abstract

The present study entitled “Performance of Tenyivo pig on diet supplemented with Nutgall (*Rhus semialata*) Fruit” was carried out to examine the effect of Nutgall Fruit on body weight, gain in weight, feed intake, feed conversion efficiency, morbidity, mortality and economics of production of Tenyivo pigs. The experimental study was carried out with twenty weaned Tenyivo piglets of two-month-old for a period of two months. The experimental animals were randomly selected and divided into four treatment groups namely T₁, T₂, T₃ and T₄ with five piglets in each group irrespective of sex. The treatment groups T₂, T₃ and T₄ were fed with concentrate feed supplemented with Nutgall Fruit at the rate of 1%, 2% and 3% per kg feed; respectively on alternate days whereas the T₁ group was fed with concentrate feed only. Analysis of variance (ANOVA) showed that the final body weight and feed intake were significantly ($p < 0.05$) higher in the T₃ group at 9.15 kg and 1.35 kg, respectively. Moreover, T₃ exhibited better weight gains at 0.48 kg/pig/week. Feed conversion efficiency was unaffected by dietary supplementation of Nutgall (*Rhus semialata*) fruit. There were 40% and 20% morbidity and mortality during the experimental period in the treatment T₄ group. Therefore, Nutgall (*Rhus semialata*) Fruit at a 2% level in the diet of Tenyivo pigs can be recommended for farmers.

Keywords: Tenyivo pig, Nutgall (*Rhus semialata*) fruit, Body weight, feed intake, feed conversion efficiency

1. Introduction

Pig is an important livestock which act as an intrinsic role in improving the economic status of the people of Nagaland as well as the whole of North eastern region of India. In Nagaland, pig production system is mostly small-scale and backyard system. Market-oriented enterprise is rear and majority of pigs available in this region are of non-descript type. Most of the households with small land holdings rear pigs at the backyard that fetch good profit in cash that are utilized to meet the family needs. Pigs are mainly reared on locally available feed resources and vegetation, crop residues and kitchen waste which are low cost and gives better return. Pigs are known for their inherent capacity of converting existing resources and damaged feeds which are either not edible or not very palatable to human beings into highly valuable protein source. The demand for animal protein is high since the food habits of the local inhabitants are mostly of non-vegetarian. However, productivity is low as individual piggeries consist of two to three numbers of pigs that priorities fattening over breeding where marketing of the meat and meat products are still at the state of inception. There is huge bridge between the demand and supply of pork which is contributed by several factors such as lack of superior germplasm, lack of knowledge on scientific methods of pig farming, inbreeding, and lack of balance feeding and high cost of feed.

Nagaland has a pig population of 4.04 lakhs (20th livestock census, 2019) and recorded the highest per capita density of pig and consumption of pork at 24.41 and 9.7 kg respectively. The total state requirement for meat as per projected human population for 2019-20 is 66,700 tons with total internal state production of 32,035 tons, leaving a shortfall of 51%, despite having an exceptional opportunity for development of pig husbandry on commercial scale. Livestock and poultry contribute about 10% to the Primary Sector Gross Domestic Product (GDP) and 2.62% to state GDP and pork meat alone constitute about 60% of the meat consumed in the state. Piggery rearing plays a major role in Nagaland as a potential source of meat production. Faster growth rate, prolificacy, higher fecundity, efficient feed converter, short generation interval and good dressing percentage are some biological advantages of swine over other livestock.

To improve pig production in rural areas, locally available fodder crops and medicinal plants

available in the state can substitute costly antibiotics, in order to improve the health and growth rate of the livestock. Under Indian traditional system medicinal plants have been used from ancient times for treatment of various diseases, irrespective of the form of existence, from animals to humans and from the common to the eminent. Medicinal plants known for its various therapeutic benefits were used in the Agri-horticulture, pharmaceutical, cosmetic, perfumery and nutraceutical industries (Subhose *et al.* 2005) [34]. Nutgall (*Rhus semialata*) a fruit commonly known as Chinese sumac is a deciduous tree of North Eastern India belonging to anacardiaceous Family, a nutritive plant found in wild and semi wild areas, lowland, hills and mountain forests has nutritive value. The fruits of Nutgall (*Rhus semialata*) are edible with a sharp acidic taste. Traditionally used by the Naga tribes of Nagaland since ancient times as a curative substance against various gastro-intestinal ailments.

Considering the medicinal values of Nutgall fruit and its possible use as an alternative feed additive the present research work entitled "Performance of Tenyivo pig on diet supplemented with Nutgall (*Rhus semialata*) Fruit" was proposed.

2. Materials and Methods

The present study entitled "Performance of Tenyivopig on diet supplemented with Nutgall (*Rhus semialata*) Fruit" was undertaken to examine the effect of dietary supplementation of Nutgall Fruit on the growth pattern, feed intake, feed conversion efficiency, morbidity, mortality and economics of Tenyivopigs following the standard management practices. The experimental research was carried out at the Indian Council of Agriculture Research-All India Coordinated Research Project on Pig (ICAR-AICRP on Pig), Nagaland Centre, Department of Livestock Production and management, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus (Photo plate-1: A and B). The farm is at 93.20°E to 95.15°E longitudes and latitudes between 25.6°NS at an elevation of 310 meter above the mean sea level (MSL).

2.1 Experimental animals

A total of twenty (20) weaned piglets of two-month-old Tenyivo pig were randomly selected from the farm of Indian Council of Agricultural Research-All India Coordinated Research on Pig (ICAR-AICRP on pig), Department of Livestock Production and Management, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus-797106, Nagaland. The experimental animals were divided into four groups consisting of five piglets irrespective of sex in each group. The animals were reared for a period of two months under standard housing and management practices. All the selected experimental animals were given an ear tag plastic type engraved with number for identification (Photo plate 2-A). The initial body weight was recorded and five piglets were placed in each pen of uniform size irrespective of sex. All the identified experimental animals were de-wormed orally with Albendazole Oral suspension Vet@ 2ml per animal per day (Photo plate 2-B and C) for three consecutive days.

2.2 Experimental diet

The experimental animals were fed with concentrate grower ration with 16% Crude Protein as per Bhat *et al.* (2010) [3].

Feed ingredients were purchased from the authorized dealer Animal Feeds and Needs, Medziphema, Dimapur. The concentrated feed composition consisted of feed ingredients *viz.* Wheat bran, grounded maize, groundnut oilcake, fish meal, common salt and mineral mixture as depicted in the table 1. The concentrated ration of 50 kilogram was manually prepared freshly from the feed go-down of the pig farm once a week.

Table 1: Composition of Ingredient concentrated ration with 16% Crude Protein (Bhat *et al.* 2010) [3]

SL. No.	Ingredient	Quantity (kg)
1.	Maize	30
2.	Groundnut cake	20
3.	Wheat Bran	40
4.	Fish Meal	7.5
5.	Mineral Mixture	2.5
6.	Vitamin Supplement	10g
	Total	100

2.3 Preparation of Nutgall fruit powder

The fresh fruits of the Nutgall plant were collected directly from the tree during early part of December month 2021 from the wild forest of Kohima District, North Eastern India. The collected weight of the fruits along with the branches was 10 kg which after preparing weight 7 kg. The fruit was sun dried for a week to remove excess moisture (Photo plate 3-A and B). After drying, the fruit was separated from the stems (Photo plate 4-A) and pounded into powder manually by using traditional pestle and mortar (Photo plate 4-B). The pounded fruit was then sieved to discard the seeds using a fine traditional bamboo sieve. The powdered fruit was stored in a clean sterile container (Photo plate 4-C) free from dust and moisture.

Table 2: Chemical composition of concentrate mixture of Nutgall (*Rhus semialata*)

Ingredients	Concentrated/kg.
Moiture	83-85%
Ash	4%
Crude fat	0.8-0.9%
Fibre	2-3%
Protein	2-3%
Carbohydrate	89% Dry weight
Ascorbic acid	5.35 mg/100 Gramm
Phosphorus	34-37 mg/100 Gramm
Sodium	83-85 mg/100 Gramm
Potassium	956-966 mg/100 Gramm
Calcium	263-279 mg/100 Gramm
Magnisium	137-140 mg/100 Gramm
Iron	15.5 -15.8 mg/100 Gramm
Manganese	18.2-18.3 mg/100 Gramm
Copper	0.43-0.48 mg/100 Gramm
Zinc	5.6-5.7 mg/100 Gramm

2.4 Treatment and feeding

The experimental animals were allotted with four dietary treatments by supplementing concentrate feeds with Nutgall (*Rhus semialata*) Fruit in different concentration. (Photo Plate 5-A and B)g.

The identified experimental animals kept in the four pens marked as treatment T₁, T₂, T₃ and T₄ were provided with the following experimental diet as given in the table below:

Table 3: Experimental Diet in different treatment groups

Group	Total no. of pigs	Quantity of Nutgall Fruit supplemented
T ₁ (Control)	5	Concentrate feed
T ₂	5	Concentrate feed + 1% Nutgall Fruit on alternate days
T ₃	5	Concentrate feed + 2% Nutgall Fruit on alternate days
T ₄	5	Concentrate feed + 3% Nutgall Fruit on alternate days

The animals were fed twice daily once in the morning at 8:00 am and evening at 3:30 pm (Photo plate6-A) at the rate of 1kg per treatment per day initially and steadily increased as per the quantity consumed by each group/each pen. Adequate clean drinking water was made available throughout the day (Photo plate 6-B).

Statistical Analysis

All the data obtained were analyzed by Completely Randomized Design (CRD) using one-way analysis of variance (ANOVA) given by Snedecor and Cochran (1994)^[32]. The differences between treatments were analyzed by using one-way analysis of variance (ANOVA) at ($p < 0.05$) level of significance to find out the significance and non-significance of the variance due to different treatments. Further, the differences between the treatments were analyzed by Duncan’s Multiple Range Test (DMRT) method to find out the difference between the treatments.

3. Results and Discussion



Fig 1: Fresh Nutgall Fruit



Fig 2: Sun drying of Fresh Nutgall Fruit



Fig 3: Pounding of Nutgall Fruit into powder using traditional pestle and mortar



Fig 4: Nutgall Fruit powder



Fig 5: Different treatment levels of Nutgall fruit



Fig 6: Feeding of Pigs

3.1 Body weight

The average body weight of *Tenyivo* pig of all the four experimental groups i.e., T₁, T₂, T₃ and T₄ at the initial period of experiment was 4.23 kg, 4.30 kg, 4.80 kg and 4.75 kg, respectively. The corresponding average body weight at the

end of the experimental study was 7.79 kg, 8.60 kg, 9.15 kg and 7.36 kg, respectively. The overall mean body weight of T₁, T₂, T₃ and T₄ were 5.78 kg, 6.49 kg, 6.67 kg and 5.61 kg, respectively.

Table 4: Effect of Nutgall (*Rhus semialata*) Fruit on the body weight of *Tenyivo* pigs (kg/pig/week)

Weeks	T ₁	T ₂	T ₃	T ₄	SEm±	CD (P=0.05)
Initial	4.23 ^b	4.30 ^{ab}	4.80 ^a	4.75 ^a	0.16	0.47
1 st	4.58 ^b	4.86 ^{ab}	5.12 ^a	5.28 ^a	0.16	0.48
2 nd	4.76 ^b	5.23 ^{ab}	5.27 ^a	5.45 ^a	0.16	0.65
3 rd	5.05 ^b	5.76 ^a	5.72 ^a	5.70 ^a	0.19	0.56
4 th	5.25 ^b	6.05 ^a	6.05 ^a	5.00 ^b	0.22	0.66
5 th	5.63 ^{ab}	6.58 ^a	6.56 ^a	4.63 ^b	0.44	1.31
6 th	6.20 ^b	7.23 ^a	7.25 ^a	6.08 ^b	0.27	0.80
7 th	6.86 ^{ab}	8.00 ^a	8.22 ^a	4.66 ^b	0.88	2.64
8 th	7.47 ^{bc}	8.24 ^{ab}	8.58 ^a	7.20 ^c	0.31	0.93
9 th	7.79 ^b	8.60 ^{ab}	9.15 ^a	7.36 ^b	0.40	1.20
Total	57.82	64.85	66.72	56.11		
Mean	5.78	6.49	6.67	5.61		

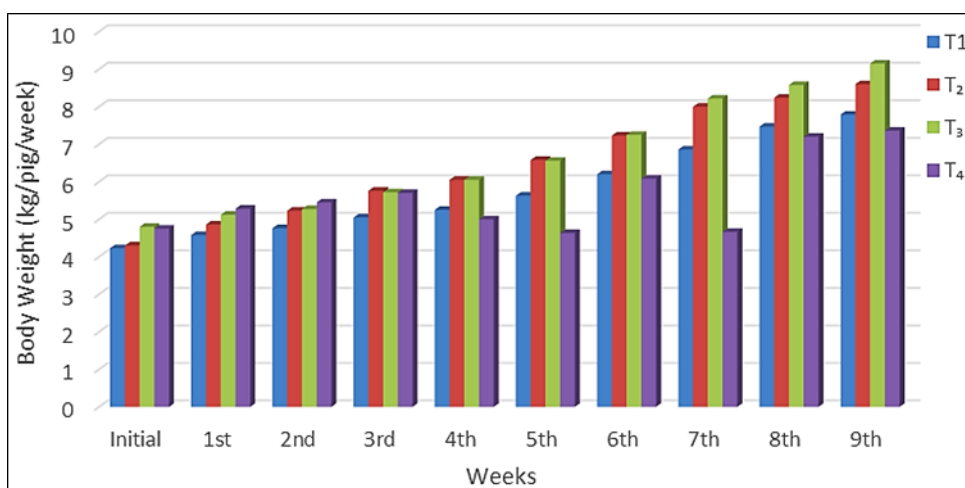


Fig 7: Effect of Nutgall (*Rhus semialata*) Fruit on the body weight of *Tenyivo* pigs (kg/pig/week)

Presence of active materials such as Phenolic compounds, organic acids, B vitamins, ascorbic acids, anthocyanins etc. in Nutgall fruit maybe the reason for the improvement in body weight gain leading to better efficiency in feed intake, resulting in enhanced growth. Analysis of variance (ANOVA) showed that the final body weight was significantly ($p < 0.05$) higher in T₃ group followed by T₂, T₁ and T₄. However, the difference between the groups T₁ and T₂, T₁ and T₄, T₂ and T₃, T₂ and T₄ were non-significant. In agreement with the result, Xin *et al.* (2018) [35] also reported that pigs supplemented with natural and fermented herb (*Artemisia capillaris* and *Acanthopanax senticosus*) in their diet had greater final body weight. However, the result contradicts with the findings of Oanh *et al.* (2021) [25] who reported that supplementation of medicinal plant mixture (60% *Bidens pilosa* L., 15% *Urena lobata* L., 15% *Pseuderanthemum palatiferrum*, 5% *Ramulus cinnamomi* and 5% *Star anise*) in the diet of growing pigs showed no significant differences. Similarly, Adebisi *et al.* (2014) [1] also reported that inclusion of 2g/kg each of turmeric, ginger and garlic extract on the diet of weaned pigs showed no significant differences. This may be due to the differences in the test materials.

3.2 Gain in weight

The average gain in weight of *Tenyivo* pig for first week was 0.35, 0.56, 0.32 and 0.53 kg/pig for T₁, T₂, T₃ and T₄, respectively. The corresponding mean weight gain for the final week was 0.52, 0.39, 0.38 and 0.28 kg/pig. The overall mean gain in weight was 0.39, 0.48, 0.48 and 0.46 kg/pig/week in T₁, T₂, T₃ and T₄, respectively.

Table 5: Effect of Nutgall (*Rhus semialata*) Fruit on weekly weight gain of *Tenyivo* pigs (kg/pig/week)

Weeks	T ₁	T ₂	T ₃	T ₄	SEm±	CD (P=0.05)
1 st	0.35 ^{bc}	0.56 ^a	0.32 ^c	0.53 ^{ab}	0.06	0.19
2 nd	0.18 ^b	0.37 ^a	0.16 ^b	0.24 ^b	0.04	0.12
3 rd	0.29	0.52	0.45	0.37	0.10	NS
4 th	0.20 ^b	0.28 ^b	0.30 ^b	0.47 ^a	0.05	0.14
5 th	0.38 ^c	0.53 ^a	0.50 ^{ab}	0.43 ^{abc}	0.04	0.11
6 th	0.58	0.65	0.69	0.64	0.10	NS
7 th	0.66 ^b	0.77 ^b	0.97 ^a	0.67 ^b	0.05	0.16
8 th	0.38 ^{ab}	0.23 ^b	0.55 ^a	0.49 ^a	0.06	0.17
9 th	0.52 ^a	0.39 ^{ab}	0.38 ^{ab}	0.28 ^b	0.06	0.19
Total	3.54	4.30	4.43	4.12		
Mean	0.39	0.48	0.48	0.46		

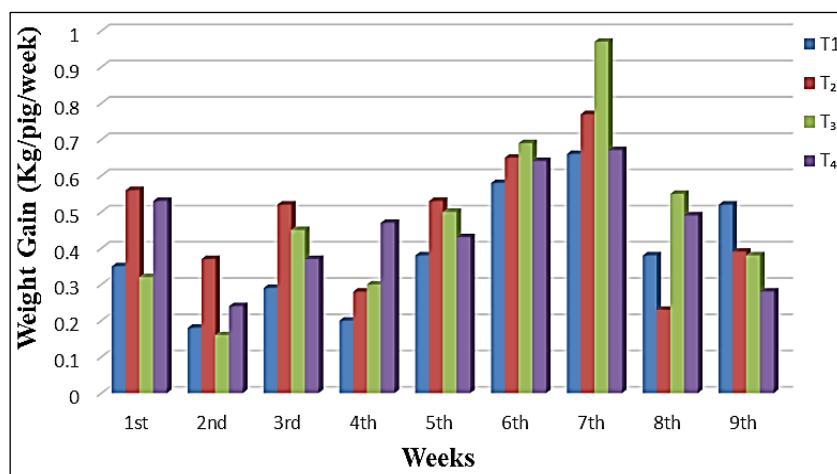


Fig 8: Effect of Nutgall (*Rhus semialata*) Fruit on weekly weight gain of *Tenyivo* pigs (kg/pig/week)

There was significant difference ($p < 0.05$) in body weight gain in T₁, T₂, T₃ and T₄ in first, second, fourth, fifth, seventh, eighth and ninth week but no significant difference was found in third and sixth week. Analysis of variance (ANOVA) showed that gain in body weight was significantly ($p < 0.05$) higher in T₂ and T₃ group as compared to T₁ and T₄. However, the difference between T₁ and T₂, T₁ and T₃, T₂ and T₃, T₂ and T₄, T₃ and T₄ was non-significant ($P > 0.05$). Presence of active materials such as Phenolic compounds, organic acids, B vitamins, ascorbic acids, anthocyanins etc. in Nutgall fruit maybe the reason for the improvement in body weight gain leading to better efficiency in feed intake, resulting in enhanced growth. The result from the present study was in agreement with Kwon *et al.* (2005) [20] who reported that supplementation of medicinal plant mixture (Artemisia, Acanthopanax and Garlic) in the diet of growing-finishing pigs showed better average daily gain. Similarly, Kim *et al.* (2006) [18] reported that supplementation of fresh leaves or

leaf-powder of new medicinal plant *Pseuderanthemum palatiferum* in the diet of weaned piglets recorded better average daily weight gain as compared to control group. However, the result was not in conformity with the findings of Cullen *et al.* (2005) [7] who reported that supplementation of garlic (*Allium sativum*) and rosemary (*Rosmarinus officinalis*) in the diet of grower-finisher pig resulted in no significant differences.

3.3 Feed intake

The total feed intakes during the entire trial period for the treatment group were 9.58, 10.55, 12.13 and 11.80 kg/pig, respectively. The corresponding mean feed intake during the experimental period was recorded as 1.06, 1.17, 1.35 and 1.31 kg/pig/week. Statistical Analysis (ANOVA) showed significant differences ($p < 0.05$) among the treatments. The average feed intake was recorded higher in T₃ group followed by T₄, T₂ and T₁.

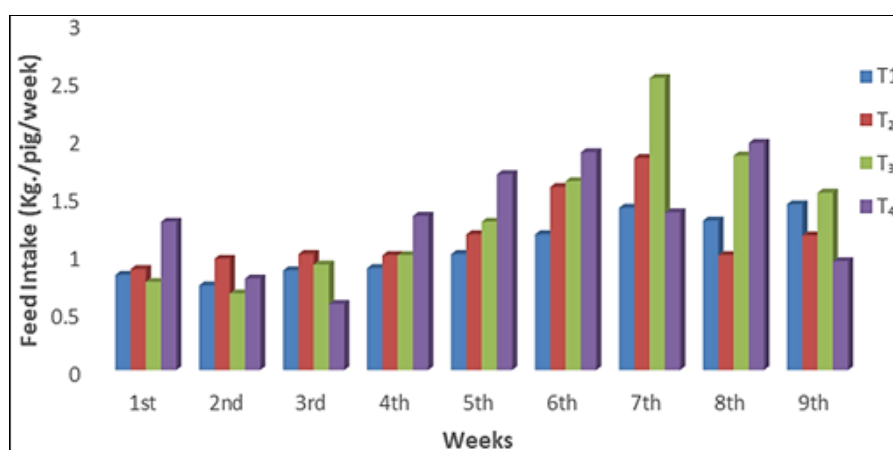


Fig 3: Effect of Nutgall (*Rhus semialata*) Fruit on Feed intake of *Tenyivo* pigs (kg/pig/week)

There was no significant differences ($P > 0.05$) between treatment T₁ and T₂, T₁ and T₃, T₂ and T₃, T₂ and T₄. The result from the present study was in agreement with the findings of Yan *et al.* (2013) [36] who reported that supplementation of fermented garlic powder in the diet of weanling pig's improved average daily feed intake. Similarly, Xin *et al.* (2018) [35] recorded improved average daily feed intake of grower-finisher pigs with diet supplemented with natural and fermented herbs (*Artemisia capillaris* and

Acanthopanax senticosus). However, the result contradicted with the findings of Lee *et al.* (2010) [21] who reported that addition of dietary tannic acid in the diet of weanling pigs showed no effect on feed intake.

3.4 Feed conversion efficiency

The overall mean feed conversion efficiency of *Tenyivo* pigs from first to ninth week of experimental period was 3.52, 3.07, 3.37 and 2.89 for T₁, T₂, T₃ and T₄, respectively.

Table 6: Effect of Nutgall (*Rhus semialata*) Fruiton Feed intake of *Tenyivo* pigs (kg/pig/week)

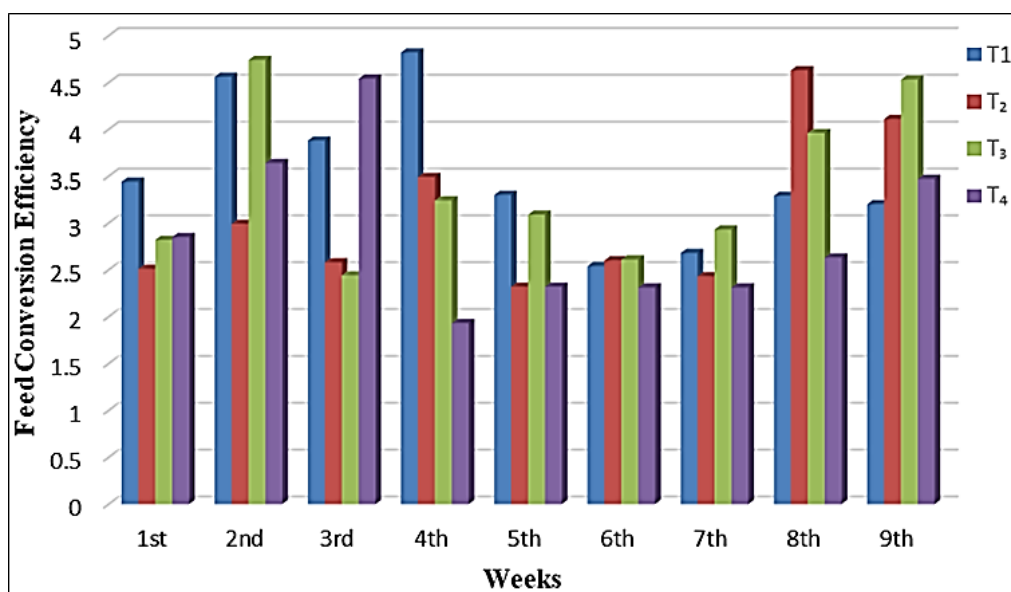
Weeks	T ₁	T ₂	T ₃	T ₄	SEm±	CD (P=0.05)
1 st	0.82 ^b	0.87 ^b	0.76 ^b	1.28 ^a	0.17	0.51
2 nd	0.73 ^{ab}	0.96 ^a	0.66 ^b	0.79 ^{ab}	0.07	0.22
3 rd	0.86 ^a	1.00 ^a	0.91 ^a	0.57 ^b	0.09	0.27
4 th	0.88 ^b	0.99 ^b	0.99 ^b	1.33 ^a	0.10	1.31
5 th	1.00 ^b	1.17 ^b	1.28 ^{ab}	1.69 ^a	0.16	0.47
6 th	1.17 ^b	1.58 ^{ab}	1.63 ^{ab}	1.88 ^a	0.16	0.49
7 th	1.40 ^b	1.83 ^b	2.52 ^a	1.36 ^a	0.17	0.50
8 th	1.29 ^{bc}	0.99 ^c	1.85 ^{ab}	1.96 ^a	0.20	0.61
9 th	1.43 ^a	1.16 ^{ab}	1.53 ^a	0.94 ^b	0.13	0.39
Total	9.58	10.55	12.13	11.80		
Mean	1.06	1.17	1.35	1.31		

^{a,b,c}Means bearing different superscript in a row differ significantly ($p < 0.05$)

Table 7: Effect of Nutgall (*Rhus semialata*) Fruit on Feed Conversion Efficiency of *Tenyivo* Pigs

Weeks	T ₁	T ₂	T ₃	T ₄	SEm±	CD (P=0.05)
1 st	3.44	2.51	2.82	2.85	0.62	NS
2 nd	4.56	2.99	4.74	3.64	0.53	NS
3 rd	3.88	2.58	2.44	4.54	0.63	NS
4 th	4.82 ^a	3.49 ^{ab}	3.24 ^{bc}	1.93 ^c	0.47	1.39
5 th	3.30	2.32	3.09	2.32	0.50	NS
6 th	2.54	2.60	2.61	2.31	0.33	NS
7 th	2.68	2.43	2.93	2.31	0.46	NS
8 th	3.29 ^{bc}	4.63 ^a	3.96 ^{ab}	2.63 ^c	0.35	1.05
9 th	3.20	4.11	4.53	3.47	0.53	NS
Total	31.71	27.66	30.36	26		
Mean	3.52	3.07	3.37	2.89		

^{a,b,c}Means bearing different superscript in a row differ significantly ($p < 0.05$)

**Fig 4:** Effect of Nutgall (*Rhus semialata*) Fruit on Feed

Conversion efficiency of tenyivo pigs

Statistical analysis had revealed that there were no significant ($P > 0.05$) differences among the treatments. Except at 4th and 8th week, feed conversion efficiency among the treatments were significant ($p < 0.05$). The findings were akin with the results of Lee *et al.* (2010) ^[21] who reported that addition of dietary tannic acid in the diet of weanling pigs showed no effect on feed conversion efficiency. Similarly, Oanh *et al.* (2021) ^[25] reported that the feed conversion efficiency of growing pigs on diet supplemented with medicinal plant mixture (60% *Bidens pilosa* L., 15% *Urena lobata* L., 15% *Pseuderanthemum palatiferum*, 5% *Ramulus cinnamomi* and 5% *Star anise*) resulted in no significant effect. However, the

result contradicts with the findings of Cullen *et al.* (2005) ^[7] who reported that supplementation of garlic (*Allium sativum*) in the diet of 21-week-old male (Large White × Landrace) pigs showed better feed conversion efficiency. Similarly result found to be Jeong *et al.* (2015) ^[15] reported that supplementation of Fermented Medicinal plants (*Gynura procumbens*, *Rehmannia glutinosa*, *Scutellaria baicalensis*) in the diet of growing pigs improved overall feed conversion efficiency as compared to control group.

4. Conclusion

Based on the findings on the overall performance with respect to various parameters till the completion of the experimental

period, it was concluded that: the effect of Nutgall Fruit on the average final body weight was recorded to be significantly ($p < 0.05$) higher in T3 at 6.67 kg, followed by T2, T1, and T4 at 6.49, 5.78 and 5.61 kg, respectively. The average gain in body weight was significantly ($p < 0.05$) higher in the T2 and T3 groups at 0.48 and 0.48 kg, as compared to T1 and T4, which recorded 0.39 kg and 0.46 kg, respectively. The average feed intake was recorded to be significantly ($p < 0.05$) higher in the T3 group at 1.35 kg as compared to the T4, T2, and T1 groups at 1.06, 1.17, and 1.31 kg, respectively. Analysis by ANOVA showed that there was no significant ($P > 0.05$) effect on feed conversion efficiency among treatments. There was 40% morbidity and 20% mortality among the piglets during the experimental period of treatment T4. Four piglets showed signs of sickness, of which two recovered and two died. The benefit cost ratio was recorded as being higher in T3 at 1.28. From the present study, it can be concluded that the overall performance in terms of body weight, weight gain, feed intake, net profit, and benefit cost ratio (BCR) was better in the treatment group T3. Farmers should therefore feed Nutgall (*Rhus semialata*) fruit to Tenyivo pigs at a rate of 2%.

5. Acknowledgement

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6. Conflict of Interest

The authors declare that they have no conflict of interest.

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