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Effect of substituting concentrate feed with cassava (*Manihot esculenta*) silage on the performance of *Tenyi Vo* pig

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ABSTRACT
The research was carried out on 20 weaned *Tenyi Vo* piglets of 2 months old, which were divided into four different treatment groups i.e. T_1, T_2, T_3 and T_4. The treatment groups T_1,T_2, T_3 and T_4 were fed with 20 % cassava silage + 80 % concentrated feed(T_1), 15 % cassava silage + 85 % concentrate feed (T_2), 10 % cassava silage + 90 % concentrated feed (T_3) and only 100 %concentrated feed in T_4 (control). Analysis of variance showed higher ($P<0.05$) final body weight in T_1 with 7.43 kg followed by T_2, T_3 and T_4. Higher weight gain of 0.64 kg/pig/week and significant difference ($P<0.05$) with T_2, T_3 and T_4 that was 0.53kg, 0.49kg and0.45 kg, respectively. In the final week of the experimental study period, the average feed intake of T_1 treatment group shows higher feed intake with 1.87 kg/pig/week followed by T_2, T_3 and T_4. The overall average feed conversion efficiency of T_1 at the final week shows better FCE as compared to T_2, T_3 and T_4. 10 % morbidity and 10 % mortality was record during the whole experimental study period. Net profit per piglet and net profit per kg live weight showed better return value in T_1 as compared to the other treatment groups followed by T_2, T_3 and T_4, respectively. The overall performance in body weight, gain in body weight, feed intake, feed conversion efficiency and economics of production was better in T_1 (BCR 1.21) as compared to the other treatment groups. Therefore, substitution of 20 % cassava silage into the diet of the *Tenyi Vo* pigs can be recommended for the farmers of Nagaland.

Keywords: *Tenyi Vo* pig, Cassava (Manihot esculenta), Body weight, Feed intake, Feed Conversion Efficiency.

INTRODUCTION

The North Easter Region (NER) of India consisting of Assam, Arunachal, Manipur, Meghalaya, Nagaland, Tripura, and Sikkim are dominated specially by tribal community belonging to same ethnic race and pig keeping is considered integral to the life of the tribal of NER. There is a huge scope in piggery production in the NER as approximately about 80% of the population being non-vegetarian and pork is also considered as one of the most desired meat among the tribal. The pig production is relatively remunerative due to the fast growth rate, high feed conversion ratio, high production potential and highly adaptability to varied environmental condition. The total pig population in the country is 9.06 million and Assam standing in the first position in pig population in the country having a pig population of 2.1 million and Nagaland having 0.40 million according to the 20th livestock census (GoI 2019).

Pig rearing is commonly seen in almost every household in the villages in Nagaland. And rural household rear 2-3 pigs yearly for the community feast and also as a subsidiary source of income for the family. And still it is highly consider that the no. of pigs own by the farmers will often be the deciding factor in a man's social position in the community as the no of pigs is the only practical way of accumulating the wealth in the rural area of Nagaland. However, in Nagaland, pig production system is small scale and backyard system, and no proper large scale production of pig is available. Majority of the pigs available in the state are non- descript type. *Tenyi Vo* pig is a registered Indian breed, indigenous to the state of Nagaland. Breed registration (Patented) by the National Database of ICAR-National Bureau of Animal Genetic Resources, Karnal (Haryana) as the 4th breed of Indian Indigenous pig with the Accession Number INDIA_PIG_1400_TENYIVO_09004 on June 21st 2016.The Native pig Tenyivo is found in the areas of the districts of Kohima, Phek, Peren, Tseminyu and Dimapur in Nagaland and Senapati district of Manipur. It is predominantly black in colour with white markings on the forehead, flanks and legs. The tail is long and usually ends with a white switch. Adult pigs weigh from 35 to 50 kg (Rutsa *et al.,* 2016). It has a good mothering nature. One distinct feature of the indigenous Naga pig (*Tenyi Vo* pig) has the characteristic of wildly nature like most people rearing in open field condition in the rural area where they scavenge for the food in the jungle during day time and return back to its owner by the evening. They can survive without much of the care and disease management. The meat is considered as the best meat from other livestock animal among the rural people of Nagaland. It is still preferred breed during the festivity among the tribal.

Considering the meat consumption, demand and the threat of losing the purity of the indigenous pig of Nagaland, it is essential to learn and study about the basic information about the productive characteristic of the indigenous pig breed. So to further improve the production of Tenyi Vo pig as well as make the economics cost of production cost effective, cassava (Manihot esculenta), which is root crop that is rich in energy, high calories, is locally available and cultivated by the tribal here in Nagaland. It is consumed by tribal here in Nagaland as well as the surplus of the cassava plant is given

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to the livestock, can be used in the pig feeds, which can reduce the competition between of livestock and human for food-grain and also which easily available. Considering the availability of cassava in the geographical area of Nagaland as well as the benefit of high energy and calories content, the present experimental study research entitled "Effect of substituting concentrate feed with Cassava silage on the performance of Tenyivo pig" was taken up to evaluate and recommend economical pig feeds for the pig farmers of Nagaland.

MATERIAL AND METHOD

Twenty (20) weaned *Tenyi Vo* piglets of two months of age were randomly selected irrespective of sex 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 Agriculture Sciences (SAS), Nagaland University, Medziphema Campus-797106, Nagaland. The experimental piglets were divided into four groups consisting of five piglets in each group. The selected animals were housed in four pens and were reared for the period of nine weeks managed under standard housing and management system. The entire experimental animal was given an ear tag plastic type engraved with number for identification.

Standard conventional feed containing 20 per cent crude protein (CP) was followed as per National Research Council (1998). The concentrated feed composition consisted of feed ingredient viz. wheat bran, grounded maize, groundnut oilcake, fish meal, common salt and mineral mixture was freshly prepared manually in the farm go-down once a week. The experimental animals were allotted with four different dietary treatments by substituting concentrate feeds with cassava (Manihotesculenta) silage in different groups. The following experimental diet as given in the table 1 below was provided:

Table 1: Experimental Diet in different treatment groups.

Group	Total no. of pigs	Quantity of cassava silage substituted
T_1	5	80% Concentrated feed + 20% Cassava silage
T_2	5	85% Concentrated feed + 15% Cassava silage
T_3	5	90% Concentrated feed + 10% Cassava silage
T_4(Control)	5	100% Concentrated feed

The experimental animals were fed twice daily once in the morning at 8:00AM and once in the evening at 3:30PM 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 was made available throughout the day. The initial individual body weight of the all the experimental animal were recorded at the onset of the experiment using a digital weighing balance of 100 kg capacity Weekly body weight of the experimental animals was recorded in the morning hour before feeding for period of nine weeks and average daily gain (ADG) in body weight was calculated for each experimental animals. Utmost care and handling of animals was given to minimized stress to the animal. Weight quantity of conventional feed and cassava silage which were supplied on daily basis was recorded for all the experimental groups. The residue or left over feeds were collected daily and calculated, based on that, the total amount of the feed intake per day by each experimental animal was recorded. Health record of the piglets for all the groups was maintained and recorded from day one till the end of the experimental period by regular monitoring and observation of the animal's feeding behaviour, movement, alertness, defecations-urination, presence of abnormal eye discharges and dead if any was recorded. The overall economic of pig production was calculated by taking into account the total cost of the piglets, total cost of concentrated feed consumed, total cost of cassava tubers, labour charges, electricity, medical and other miscellaneous cost. The total cost concentrated feed per pig was obtained by considering the total quantity of feed consumed throughout the experimental period multiplied by the rate per kg of feed. The cost of production per kilogram weight gain was calculated by dividing total cost of production by total weight gain. Final live weight was taken in account for calculating the gross return per pig and net profit per pig. The experimental data was statistically analysed using one-way Analysis of Variance (ANOVA) in Randomized Block Design for the comparison of different treatment groups as described by Snedecor and Cochran (1994). The difference between treatments was analysed by using one-way analysis of variance (ANOVA) at 5% level of significance to find out the significance and non-significance of the variance due to different treatments. Further, the difference between the treatments was analysed by Duncan's Multiplication Range Test (DMRT) method to find out the difference between the treatments.

RESULTS AND DISCUSSION

1. Body Weight

The effect of cassava silage on the growth of the *Tenyi Vo* piglets up to ninth weeks on different treatment groups was recorded and presented in the Table 2. The average body weight of weaned *Tenyi Vo* piglets of two-months old of all four experimental groups i.e., T_1, T_2, T_3 and T_4 at the initial period of experimental study was 3.47 kg, 3.48 kg, 3.37 kg and 2.89 kg, respectively. The corresponding average body weight at the end of the experimental study was 7.43 kg, 6.68 kg, 6.39 kg and 6.17 kg, respectively.

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Analysis of Variance (ANOVA) shows no significance difference from initial week till 5th week of the experimental period. During the 6rd week of the experimental period, the average body weight of all the treatment recorded was 5.74 kg, 5.32 kg, 5.16 kg and 4.99 kg for T_1, T_2, T_3 and T_4, respectively. In the final body weight recorded on the 9th week, analysis of variance (ANOVA) showed significant difference between the different treatment groups, higher body weight was observed in T_1 followed by T_2, T_3 and T_4. In agreement with the report given by Missotten *et. al.,* (2010) that using of fermented liquid feed (FLF) showed a better body weight gain with that of dry-feed. However, various studies carried out on cassava root meal as a feed supplement for crossbred pigs as reported by Jimenez *et al.* (2005) recorded no improvement of growth rate on inclusion of cassava root meal in the ration of crossbred pigs. The agreement findings of Amer *et al*. (2023) who reported higher final body weight in pigs fed a diet supplemented with nutgall (Rhus semialata). Sothu *et al*. (2023) the difference between group of T1, T2, and T3 group was non-significant in the seventh, eighth and ninth week, however, T4group which was given 1.5% Roselle calyx powder was significantly different ($p<0.05$).

Table 2. Effect of cassava silage 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	3.47	3.48	3.37	3.29	0.15	**NS**
1st	3.45	3.69	3.58	3.49	0.15	**NS**
2nd	3.79	3.79	3.66	3.77	0.14	**NS**
3rd	4.36	4.25	4.13	4.03	0.17	**NS**
4th	4.82	4.60	4.43	4.34	0.18	**NS**
5th	5.30	4.95	4.80	4.69	0.19	**NS**
6th	5.74[a]	5.32[ab]	5.16[b]	4.99[b]	0.18	0.82
7th	6.24[a]	5.71[ab]	.51[b]	5.33[b]	0.21	0.96
8th	6.79[a]	6.17[ab]	5.92[ab]	5.64[b]	0.71	**NS**
9th	7.43[a]	6.68[b]	6.39[b]	6.17[c]	0.76	3.43

[a, b, c] Means bearing different superscript in row differ significantly ($P<0.05$).

2. Gain in weight

The effect of cassava silage on the gain in body weight of the *Tenyi Vo* piglets up to ninth weeks were recorded and presented in the Table 3. The average gain in weight of weaned *Tenyi Vo* piglets of two-months old of all four experimental groups i.e., T_1, T_2, T_3 and T_4 at the first week of experimental study was 0.27 kg, 0.21 kg, 0.22 kg, and 0.20 kg/pig/week, respectively. Statistical analysis shows no significant difference in week 1st and 2nd, however from the 3rd week till the 9th week of the experimental study period, statistical analysis shows significant different among the different groups of the treatment. In the 3rd week of the experimental study, T_1 group (20% cassava + 80% concentrated feed) showed higher average weight gain with 0.40 kg/pig/week and significant different ($P<0.05$) with the other treatment groups, however no significant different was to be found between T_2, T_3, and T_4 with0.32 kg, 0.31 kg and 0.26 kg/pig/week respectively. In the final week of the experimental study period T_1 shows higher average weight gain with 0.64 kg/pig/week and significant difference ($P<0.05$) with T_2 , T_3 and T_4. Treatment group T_2 differing significantly with treatment T_4, however treatment groups T_3 and T_4 showed no significant difference. In agreement with the findings reported by Ngaon and Ly (2007) that the inclusion of ensiled cassava root in the diet of crossbred pigs improved the average daily gain of the pigs, with the similar finding by Loc *et al.,* (2000) reported that the inclusion ensiled cassava root in the diet of the growing pig recorded an average daily gain of 591 g/day when 20 per cent of ensiled cassava root was included in the diet. The differences may be due to the differences in the pig breed and the variation in management system. However, based on the present experimental findings, inclusion of ensiled cassava with 20 percent substitution can be recommended in the diet to get better body weight gain.

Table 3. Effect of cassava silage on the weekly weight gain of Tenyivo pigs (kg/pig/week).

WEEKS	T_1	T_2	T_3	T_4	SEm±	CD (P=0.05)
1st	0.27	0.21	0.22	0.20	0.04	**NS**
2nd	0.26	0.26	0.22	0.27	0.04	**NS**
3rd	0.40[a]	0.32[b]	0.31[b]	0.26[b]	0.02	0.11
4th	0.46[a]	0.35[b]	0.30[b]	0.31[b]	0.03	0.14
5th	0.48[a]	0.35[b]	0.37[b]	0.35[b]	0.02	0.11
6th	0.43[a]	0.37[b]	0.34[bc]	0.30[c]	0.02	0.11
7th	0.51[a]	0.39[b]	0.35[b]	0.34[b]	0.03	0.13
8th	0.55[a]	0.46[b]	0.41[b]	0.40[b]	0.06	0.28
9th	0.64[a]	0.53[b]	0.49[bc]	0.45[c]	0.07	0.31

[a, b, c] Means bearing different superscript in row differ significantly ($P<0.05$).

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3. Feed intake

The effect of cassava silage on the feed intake of the *Tenyi Vo* piglets up to ninth weeks were recorded and presented in the Table 4. The average feed intake of weaned *Tenyi Vo* piglets of two-months old of all four experimental groups i.e., T_1, T_2, T_3 and T_4 at the first week of experimental study was 0.77 kg, 0.68 kg, 0.81 kg and 0.71kg/pig/week, respectively. The corresponding average feed intake at the end of the experimental study was 1.87 kg, 1.66 kg 1.55 kg and 1.35 kg/pig/week, respectively. Feed intake increased gradually till the final week of the experimental study period; however, statistical analysis shows no significant differences till the 3rd week of the experimental study period. In 4th week of the experimental study, analysis of variance (ANOVA) shows T_1 significant difference ($P<0.05$) from the other treatment group, however no significant difference was observed among the treatment groups T_2, T_3 and T_4. In the final week of the experimental study period, the average feed intake of T_1 treatment group shows higher feed intake with 1.87 kg/pig/week followed by T_2, T_3 and T_4. T_3 and T_4 show no significant difference and also T_2 and T_3. However T_2 and T_4 shows significant difference with T_2, the average feed intake per week was 1.66 kg/pig/week and T_4 with 1.40 kg/pig/week. Analysis of variance shows significant difference with the other treatment groups, in agreement with the experimental study conducted by Chou *et al.* (1975) that the inclusion of cassava root meal in the diet increased feed intake of the pigs, however, the present study findings contradict to the findings recorded by Tewe *et al*. (1983) that inclusion of cassava roots in the diet did not affect the feed intake of the pig.

Table 4: Effect of cassava silage on the feed intake of Tenyivo pigs (kg/pig/week).

WEEKS	T_1	T_2	T_3	T_4	SEm±	CD (P=0.05)
1st	0.77	0.68	0.81	0.71	0.05	**NS**
2nd	0.90	0.91	0.92	0.82	0.03	**NS**
3rd	1.27	1.12	1.07	1.07	0.06	**NS**
4th	1.35^{a}	1.15^{b}	1.15^{b}	1.13^{b}	0.05	0.24
5th	1.41^{a}	1.15^{b}	1.15^{b}	1.25^{b}	0.06	0.25
6th	1.35^{a}	1.22^{b}	1.20^{b}	1.21^{b}	0.03	0.16
7th	1.52^{a}	1.33^{b}	1.36^{b}	1.34^{b}	0.04	0.17
8th	1.74^{a}	1.73^{a}	1.66^{a}	1.35^{b}	0.17	0.78
9th	1.87^{a}	1.66^{b}	1.55^{bc}	1.40^{c}	0.17	0.77

[a, b, c]Means bearing different superscript in row differ significantly ($P<0.05$).

4. Feed conversion efficiency

The effect of cassava silage on the feed conversion efficiency of the *Tenyi Vo* piglets up to ninth weeks on the different treatment groups were recorded and presented in the Table 5. The average feed conversion efficiency of weaned *Tenyi Vo* piglets of two-months old of all four experimental groups i.e., T_1, T_2, T_3 and T_4 at the first week of experimental study was recorded 3.25 kg, 3.42 kg, 3.78 kg and 3.63 kg, respectively. Correspondingly, the average feed conversion efficiency at the end of the experimental study was recorded to be 2.95kg, 3.29 kg, 3.35 kg and 3.09 kg, respectively. Statistical analysis (ANOVA) showed no significant difference till 3rd week of the experimental study. However, statistical analysis (ANOVA) showed significant difference from 4th week till the final week of the experimental study, the average feed conversion efficiency of $T_1$and T_4 at the final week shows better FCE as compared to T_2 and T_3. In agreement with the experimental study conducted by Soniaya and Omole (1982) reported that the effect of inclusion of tapioca root meal in the diets of pigs showed improvement in feed conversion efficiency, and with similar finding, research conducted by Tewe *et al.* (1983) reported that the inclusion of cassava root in the diets of growing pigs showed good feed conversion efficiency in comparison with that of the control group.

Table 5. Effect of cassava silage on the feed conversion efficiency of *Tenyi Vo* pigs (kg/pig/week).

WEEKS	T_1	T_2	T_2	T_4	SEm±	CD (P=0.05)
1st	3.25	3.42	3.78	3.63	0.42	**NS**
2nd	3.55	3.37	4.56	3.06	0.42	**NS**
3rd	3.49	3.81	3.48	4.15	0.17	**NS**
4th	2.96^{b}	3.36^{ab}	3.89^{a}	3.72^{a}	0.21	0.93
5th	2.96^{c}	3.31^{ab}	3.09^{bc}	3.56^{a}	0.12	0.54
6th	3.15^{b}	3.34^{b}	3.34^{b}	4.07^{a}	0.18	0.81
7th	3.05^{b}	3.44^{ab}	3.91^{a}	4.03^{a}	0.22	1.01
8th	3.18^{ab}	3.78^{a}	4.11^{a}	3.35^{ab}	0.49	**NS**
9th	2.95^{ab}	3.29^{a}	3.35^{a}	3.09^{ab}	0.37	1.66

[a, b, c] Means bearing different superscript in row differ significantly ($P<0.05$).

5. Morbidity and mortality

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The morbidity and mortality percentage for different treatment groups were recorded. During the 8th week of the experimental study period, two pigs were observed to be inactive showing signs of weakness such as loss of appetite, watery eye discharge, diarrhoea and laboured breathing. Rectal temperature during that time was recorded to be 104-105° F, the sick animal were observed to be laying down most of the time and feed intake by those two sick animals was reduced. Glucose water was given orally; however, the two experimental animals succumbed to death giving an overall morbidity rate of 10 %, and mortality of 10%. The suspected cause of death may be due to pneumonia and cold climatic condition since the experimental study was carried out during the coldest month (Dec. and Jan.) of the year which in agreement with the study recorded by Gopinathan *et al*. (2011) that the major cause of indigenous pig during pre-weaning and post-weaning was pneumonia. However the treatment group T_1, T_2 and T_3 treated with cassava silage did not have any signs of morbidity or mortality which is in agreement with the study reported by Ly (2006) stated that inclusion ensiled cassava leaf up to 20 per cent in the diet of growing pigs did not affect animal's heath and other performance.

6. Economic of production

The detailed economic of production for all the treatment groups are been presented in the Table 6. The total cost of production per piglet was recorded as Rs. 3608.8, Rs.3553.6, Rs.3542.6, and Rs.3503.96 for treatment groups T_1, T_2, T_3 and T_4 respectively. The total cost of production per kg live weight was Rs. 485.70, Rs. 531.967, Rs. 554.37 and Rs. 567.90 for T_1, T_2, T_3, and T_4, respectively. Cost of production for T_1 was lower as compare to the other treatment group. Total receipt through the sale of piglet was recorded as Rs. 4375.40, Rs. 3940.40, Rs. 3772.20 and Rs. 3644.60 for T_1, T_2, T_3 and T_4, respectively, T_1 treatment group show higher return value followed by T_2, T_3 and T_4. Net profit per piglet and net profit per kg live weight showed better return value in T_1 as compared to the other treatment groups followed by T_2, T_3 and T_4, respectively which is in agreement with the study recorded by Ly *et al.* (2001), Ly (2006), Silva *et al*. (2008) and Singh *et al*. (2008) that the inclusion of Cassava silage in the diet of pigs was economically feasible.

Table 6. Economic of *Tenyi Vo* pigs for different treatment groups.

Particular	**T_1**	**T_2**	**T_3**	**T_4**
Cost of piglets (Rs.)	3000	3000	3000	3000
Cost of feed (Rs. /piglet)	312	297.6	312.96	328.96
Cost of cassava silage @ Rs. 50/kg (Rs. piglet)	121.8	81	54.50	0
Cost of labor	150	150	150	150
Miscellaneous cost (Rs. /piglet)	25	25	25	25
Total cost of production(Rs./piglet)	**3608.8**	**3553.6**	**3542.46**	**3503.96**
Average weight of pigs (kg)	7.43	6.68	6.39	6.17
Cost of production per kg live weight (Rs.)	485.70	531.97	554.37	567.90
Receipt through sale of live pigs (Rs.580)/kg	4309.4	3874.4	3706.2	3578.6
Sale of gunny bags (Rs.8/bag)	16	16	16	16
Manure (Rs.5/kg)	50	50	50	50
Total receipt (Rs.)	4375.40	3940.40	3772.20	3644.60
Profit per piglet (Rs.)	766.6	386.8	229.74	140.64
Net profit per Kg live weight (Rs.)	103.18	57.90	35.95	22.79
Benefit cost ratio (BCR)	1.21	1.10	1.06	1.04

CONCLUSIONS

The effect of substituting cassava silage in the diet of the *Tenyi Vo* pig showed ($P<0.05$) significantly higher in T_1 as compared to the other treatment followed by T_2, T_3 and T_4. The average daily gain in body weight showed T_1 significant higher ($P<0.05$) and better gain as compared to the other treatment groups. Better feed intake was recorded in T_1 with 1.87 kg/pig/week in the final week of the experimental study and significantly higher ($P<0.05$) as compared to the other treatment groups. The overall feed conversion efficiency was observed to be better in treatment group T_1 with 2.95 lowest among the other treatment groups. Morbidity and mortality of 10% was recorded among the experimental animal during the whole experimental study period. The profit per piglet as well as per kg live weight was observed maximum in T_1 followed by T_2, T_3 and T_4. Higher benefit cost ratio was in T_1 of 1.21.From the present experimental study research, it can be concluded that the effect of substitution of 20 % cassava silage in the diet of Tenyi Vo pig feed had a better overall performance in term of final body weight, gain in body weight, feed intake, and feed conversion ratio. No morbidity or mortality was observed when 20% of cassava was substituted in the feeds. And moreover good economics of production was indicated in T_1.

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