PERFORMANCE OF UPGRADED TENYI-VO PIG ON DIET REPLACED WITH DRIED DISTILLERS GRAIN WITH SOLUBLES

ABSTRACT

The present study was conducted to investigate the effect of feeding DDGS as GNC replacement on the body weight, gain in weight, feed intake, feed efficiency and the economics of production of upgraded *Tenyi-Vo* pig (75 per cent). A total number of 20 upgraded Tenyi-Vo pigs of about 3 months old were divided into four treatments groups designated as T_1, T_2, T_3, and T_4 having five animals in each treatment as replicates. The animals were fed with diet containing DDGS at 0, 6, 12 and 18 per cent as GNC replacement. The results revealed that feeding of DDGS-based diet did not have any significant effect on the final body weight, total weight gain and mean feed efficiency. Feed intake was observed to be significantly ($p<0.05$) higher in DDGS based diet group. Total cost of production per kg gain was observed to be maximum at 18 per cent DDGS level. Higher net profit per pig, net profit per kg weight gain and benefit cost ratio was observed in the groups fed with 12 per cent DDGS followed by 6 per cent, 0 per cent and the least at 18 per cent DDGS. Based on the above findings, replacement of GNC with DDGS at the rate of 12 per cent was recommended for upgraded Tenyi-Vo pig (75 per cent) for achieving optimum body weight, weight gain, feed intake, FCE and higher net return.

Key words: Upgraded *Tenyi-Vo* pig, DDGS, body weight, feed efficiency.

INTRODUCTION

Livestock and poultry sectors are important for rural sustenance and are the driving force for the economic development of the country. It contributes significantly to the agricultural gross domestic product of the country. Among the livestock species, the pig is an important animal, particularly for the Northeast region and the tribal-dominated areas of the country. Hence, pig farming is mostly confined to this region and the rural and tribal belt of the country, as is also the consumption. The animal is being reared under poor conditions or allowed to scavenge by itself (Kumaravel and Senthilkumar, 2017) without proper management and healthcare. Pig rearing has been a neglected area as it was tagged as a dirty animal and identified with the lower strata of society. Social and religious prejudices also hindered the progress and development of pig production. It is considered a backward profession, and unorganized rearing largely dominates the sector; it is primarily in the hands of the poor, landless, and weaker sections of society (Prasad *et al*., 2011). Being able to thrive and survive with minimum input and through scavenging, pig rearing fits well with the economies of poor and marginal farmers. However, today, pig rearing has found its niche as an important livestock species that has immense potential for rural livelihood and ensures nutritional security for the weaker sections of society. As such, due emphasis has been given to this sector through various government programs and initiatives. In India and other developing countries, the rearing of pigs holds an important place for the socio-economic up liftmen of poor farmers, providing nutritional and financial benefits. It also allows the efficient conversion of household waste into rich manure for agricultural crops (Chauhan *et al*., 2016; Sultana*et al*., 2017). Pig farming is not only an important backyard venture that assures high-quality protein, prompt cash, and income generation to the pig-rearing community but is also highly viable as a commercial enterprise. This is due to its favorable attributes, such as high prolificacy, faster growth rate, short generation interval, ease of rearing and higher meat yield, better feed conversion efficiency, ability to convert inedible feed into

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highly nutritious meat and valuable by-products, and being ideal for integrated farming, etc. In recent years, owing to the change in consumer preference and lifestyle, the demand for pork and pork products has been continuously increasing, which has encouraged young entrepreneurs to start pig rearing on a commercial scale as an income-generating activity (Kumaravel and Senthilkumar, 2017).

According to the 19th Livestock Census (2012), the total pig population in the country was 10.29 million, which accounts for 2.01% of the total livestock population. The majority of the pig population consisted of native breeds (76 percent); however, the population of cross-bred and exotic pigs showed an increase of 12.7 percent from the year 2003 to 2012. North East India accounts for 38 percent (3.95 million) of the total pigs in India. For every thousand households, the number of pigs was highest in Arunachal Pradesh (2221), followed by Nagaland (1424), Mizoram (1220), Meghalaya (1124), and Manipur (657), which indicates the importance and acceptance of pigs in the region (Chauhan *et al*., 2016). Some of the exotic breeds available in the country included Hampshire, Large White York Shire, Duroc, Landrace, and Tamworth, while some of the popular indigenous pigs recently recognized were Ghoongroo (West Bengal), Zovawk (Mizoram), NiangMegha (Meghalaya), Tenyi Vo (Nagaland), Agonda Goan (Goa), Nicobari (Andaman and Nicobar), and Doom from Assam (NBAGR, 2018).

In the Northeastern states, almost every household owns a pig, which is commonly reared under the traditional system in the backyard with nil or few inputs in terms of family labor and feed (Patr *et al. 2014).* The animal survives on kitchen waste and forages (Kumaresan *et al*. 2009) from the nearby jungles, which are usually cooked along with a small quantity of rice bran or broken rice. In the state of Nagaland, pigs are reared under a minimum-input production system where non-conventional feed forms the bulk of the feedstuffs offered to the animals (Moanaro *et al*., 2011). North East India has much higher pork consumption than the rest of the country, of which Nagaland is the highest importer of pigs vis-a-vis consumers of pork in the country. Traders in both Assam and Nagaland reported that the demand for pork has been increasing trend so also the price of pork. Nagaland has a pig population of about 5.2 lakh, of which 80 percent cent are produced in rural areas and only 20 per cent in peri-urban areas. Even though the state has a pig-human ratio of 1:4 and the highest per capita concentration of 31 pigs per square km, it still continues to import 40 per cent of its requirements from other states. (State Animal Husbandry Administrative Report, 2016). There is a huge demand for pork in the state, which accounts for 60% of the total meat requirement and is being imported from other states (Government of Nagaland, 2016). Such a huge deficit in pork availability is mainly due to the practice of the traditional system of rearing (Chauhan *et al*., 2016), which is characterized by low producing germplasm, poor feeding, management and health care. Keeping in view the demand and availability, piggery enterprises have occupied a promising sector among various developmental programmes in the state.

Since feed is the single most important factor that determines the productivity and profitability of pig production, identifying and utilizing locally available low-cost feed resources can be well-targeted interventions to improve pig production and bring significant livelihood benefits for tribal and other marginalized pig rearing communities in the region. Hence, constant efforts are being made to explore new and alternative feed resources, which are being evaluated for their optimum inclusion and utilization. Several agro-industrial byproducts are available in large quantities and have considerable nutritional value. The cereal by-products commonly used are rice polish, rice bran, maize gluten meal, dried distillery grains with solubles, etc. Recently, there has been a surge in the use of brewer's spent grains world-wide due to rapid DDGS production and improvements in its quality. DDGS results from the fermentation of cereal starch to produce fuel ethanol and carbon dioxide at new generation ethanol plants. Use of this by-product has great potential in livestock

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feeding to offset high feed costs and increase availability. The new generation of DDGS is golden colored and has a characteristically sweet fermented smell. The nutrient fractions (protein, oil, and fiber) of DDGS are 2–3 times more concentrated in comparison to corn. Shurson and Noll (2005) observed that every 100kg of corn after fermentation results in approximately 36 liters of ethanol, 32kg of DDGS, and 32kg of carbon dioxide. Distillers' wet grains (DWG), distillers' dried grains (DDG), distillers 'wet grains with soluble (DWGS), distillers' dried grains with soluble (DDGS), and condensed distillers' soluble (CDS) are the forms of distillers' grain Hoffman and Baker (2011). DDGS are valuable sources of energy (10 percent), protein (27 percent), amino acids, and phosphorous (0.72 percent) for livestock and poultry (Panda *et al.*, 2006). Due to its high digestibility and rapidly fermentable fiber, it is also being used as a high energy source (Klopfenstein *et al.*, 2008). Distiller grains are alternative feed resources that can be used in animal diets and hence need to be evaluated to explore their usage for economic feeding. Assuming the continual growth in the livestock and poultry sectors, the gap between supply and demand will escalate the prices of feed ingredients further. This rise will in turn increase the cost of production and reduce profitability. Distillers' dried grains with solubles (DDGS) have been widely used to replace corn and soybean meal in livestock and poultry diets to supply energy and protein. Due to its higher fiber level (18 to 19 percent), DDGS can be utilized more efficiently by ruminants as compared to monogastric animals, such as pigs and poultry. DDGS is as rich in energy as corn, with a higher amount of calcium, phosphorus, and sulfur (Hoffman and Baker, 2011). Comparatively, DDGS produced from new-generation ethanol plants is higher in digestibility and metabolizable energy, higher in amino acids, and has more available phosphorous than DDGS produced from traditional ethanol plants. There has been a rise in ethanol production with a simultaneous increase in production of DDGS (Gibson and Karge, 2006), and corn DDGS has become one of the most economically and widely available alternative feed ingredients in swine diets (Shurson et al., 2011). Hence, DDGS can be a suitable alternative feed resource for reducing feed costs by replacing portions of expensive oil cakes such as groundnut cake, whose availability is limited in the region and which is expensive.

Low production of the piggery sector in Nagaland is a result of a lack of scientific breeding programs, low productivity of the local indigenous germ plasma, poor feed supply, and the non-availability of good germ plasma. Moreover, the high cost of concentrated pig feed imported from the neighboring state is another reason for the slow progress in the piggery sector in the state.

MATERIALS AND METHODS

The present study entitled „Performance of upgraded *Tenyi Vo* pig on diet replaced with dried distillers' grains with solubles" was carried out to study the growth pattern, feed intake, feed conversion efficiency and economics of feeding DDGS in upgraded *Tenyi Vo* pig. The research work was carried out at Indian Council of Agricultural Research- All India Coordinated Research Project on Pig farm (ICAR-AICRP on pig), Nagaland centre, School of Agricultural Sciences and Rural development (SASRD), Department of Livestock Production and Management Nagaland University, Medziphema Campus. The farm is located at 93.2^0 E to 95.15^0 E and 25.6^0 N to 27.4^0 N at an elevation of 310 meters above mean sea level.

Experimental animal

A total of 20 three-month-old, 75 percent upgraded *Tenyi-Vo* pigs of uniform size were used to carry out the trial. The genetic composition of the experimental animal was *Tenyi Vo* x Hampshire (25 percent *Tenyi Vo*, 75 percent Hampshire). The animals were reared for a period of 6 weeks (42 days) under standard management practices. The animals were selected from: All India Coordinated Research on Pig Farm (ICAR-AICRP on Pig), Nagaland Centre, School of Agricultural Sciences and

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Rural Development (SASRD), Department of Livestock Production and Management, Nagaland University, Medziphema Campus. Accordingly, the 20 (Twenty) experimental animals were randomly divided into 4 treatment groups with 5 animals in each group in a Random Block Design (RBD). All the experimental animals were ear-tagged for proper identification, weighed, and randomly distributed in four separate, uniform-sized pens.

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Experimental diet

Good quality feed ingredients were procured from reliable source and the feed was prepared as per the requirement laid down by ICAR, (2011) while DDGS was obtained from a distillery plant located at Khatkhati, Assam. The experimental animals grouped as T1 T2, T3 and T4 were allotted with four dietary treatments by replacing 0, 6, 12 and 18 per cent GNC with dried distillers' grains with soluble (DDGS), respectively as described below:

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List 1. Experimental diet list

T_1 (control)	Basal diet
T_2	GNC replaced with 6 per cent DDGS
T_3	GNC replaced with 12 per cent DDGS
T_4	GNC replaced with 18 per cent DDGS

Body weight and weight gain

The initial body weight of the experimental animals was recorded at the start of the experiment, and the weight was taken individually using a digital balance with a maximum capacity of 100 kg and expressed in kg. Before weighing the animals, the ear tag numbers were identified, and accordingly, the body weight recorded was noted against the identification numbers of each animal. Subsequently, body weight was recorded at a weekly interval in order to observe the growth performance on a weekly basis. Weighing of the animals was done in the morning prior to feeding and watering.

Feed intake and feed conversion efficiency

Feed and water were provided ad libitum to all the groups throughout the experimental period. The amount of feed supplied to the animals and the leftovers following morning and afternoon feeding were recorded daily. Feed intake was calculated by offering a weighed quantity of feeds according to the treatments with the help of a precise digital weighing balance and expressed in kg. The left-over feed was subtracted from the total amount of feed supplied to arrive at the exact quantity of feed consumed by the animals per day. From these data, the average weekly feed consumption was calculated for each animal in each group and expressed in kg. The feed conversion efficiency was calculated by adopting the following formula:

$$\text{Feed conversion efficiency (FCE)} = \frac{\text{Total body weight gain (Kg)}}{\text{Total quantity of feed consumed (Kg)}}$$

Economics of feeding DDGS

The economics of feeding diet supplemented with DDGS was calculated on the basis of overall cost of inputs prevailing in the market i.e. the cost of piglets, feeds, test material, labour, medicines and other miscellaneous cost. The total cost of feed per animal was obtained by considering the total quantity of feed consumed throughout the trial period. The cost of production per kg weight gain was calculated by dividing total cost of production by total weight gain. Final live weight and total weight gain of the pig was considered for calculating the gross return per pig and net profit per kg weight gain.

Statistical Analysis

The experimental data collected was subjected to statistical analysis in order to interpret the results and derive a conclusion. The data was analyzed using one-way analysis of variance (ANOVA) in a random block design as described by Snedecor and Cochran (1994). All statistical analyses were performed using Microsoft Excel. The overall level of statistical significance was defined as $P<0.05$.

RESULTS AND DISCUSSION

Body weight

The observation on variation in weekly body weight and the mean body weight of upgraded Tenyi-Vo pigs are presented in Table 2. The average initial body weight of upgraded *Tenyi-Vo* pigs was recorded as 10.868, 11.151, 11.777 and 10.049 Kg per pig for T_1, T_2, T_3 and T_4, respectively while the corresponding body weight of the treatment groups recorded at the end of the trial period (6 weeks) was 18.675, 19.524, 21.228 and 17.155 Kg per pig. The overall mean body weight was 15.357, 15.712, 17.048, and 13.972 kg per pig for the group T_1, T_2 ,T_3, and T_4 respectively. Though higher body weight was observed in group T_3 (12 per cent) followed by T_2, T_1 and the least in T_4 (18 per cent), statistically there was no significant difference in the mean body weight within the level of DDGS supplemented. It indicated that the inclusion of DDGS up to 18 per cent GNC replacement did not have any adverse effect on the body weight of upgraded *TenyiVo* pigs. The results of the present study was in agreement with the earlier findings of researchers such as Whitney and Shurson (2004) who fed DDGS at the rate of 0, 5, 10, 15 and 25 per cent and observed non- significant difference in body weight among the treatment groups, Spencer *et al.* (2007) also found that there was no effect on growth performance of pigs fed diets containing either 7.5 or 15 per cent DDGS.

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Gain in body weight

The pattern of growth and total average gain in weight during the experimental period are plotted Table no.3. The average gain in weight for the treatment groups T_1, T_2, T_3 and T_4 from the 1st to the 6th week of the trial period was in the range of 0.806 to 2.18, 0.703 to 1.982, 1.276 to 1.762, and 0.717 to 1.646 kg per pig, respectively. The corresponding values for the overall body weight gain in the treatment groups were 7.902, 8.373, 9.293 and 7.086 kg. Statistical analysis revealed that body weight gain from the 1st to the 3rd week and from the 5th to the 6th week was unaffected by the dietary inclusion of DDGS. However, in 4th week, weight gain in the control group T_1 was significantly ($P<0.05$) higher as compared to the groups fed with a DDGS-based diet, though it could not be ascribed to feeding DDGS as its influence was not observed in 5th and 6th weeks. DDGS in the diets of grower pigs (30–60 kg) did not change the performance of pigs. Similarly, Whitney and Shurson (2004) observed a non-significant growth rate when DDGS was included in the diet at a rate of 0, 5, 10, 15, and 25 percent. In addition, Graham *et al*. (2014) also reported a non-significant effect of DDGS on weight gain, neither at a 20 percent nor a 40 percent level of DDGS. Widyaratne and Zijlstra (2007) and Feoli *et al*. (2008) also observed that the growth rate was negatively affected in pigs fed with a DDGS-based diet. Variation in the findings could be due to differences in the age and breed of animals, the quality of DDGS, the nutrient composition of DDGS, the source of DDGS, and other factors such as feed, agro-climatic conditions, etc.

Feed Intake

The average weekly feed intake and total feed intake of different experimental groups of upgraded *Tenyi-Vo* pigs during the trial period are presented in Table 4. The total feed intake during the entire trial period for T_1, T_2, T_3 and T_4 groups was 31.154, 34.160, 41.670, and 41.250 kg per pig, respectively, while the mean feed intake was 5.192, 5.693, 6.945, and 6.875 kg/pig for T_1, T_2, T_3 and T_4, respectively. In the first week, feed intake was significantly higher in group T3 followed by T4, T2, and the least in T1. However, the feed intake did not differ significantly between groups T1 and T2. In the 2nd week, feed intake followed a similar trend, with higher feed intake recorded in T3 followed by T4, T2, and the least in T1 and the feed intake varied significantly among the groups except between T2 and T4. Similarly, during the 3rd and 4th weeks, higher feed intake was recorded in T3 However, the feed intake did not vary between treatment groups T1 and T2 and the group T2 and T4 at the 3rd week, while in the 4th week, the difference between the group T1 and T2 and the group T3 and T4 was found to be non-significant.

In the 6^{th} week, the increase in feed intake was not consistent, and was observed to be higher in T4 followed by T2, T1 and T3 However, the variation between T1 and T3 was found to be non-significant. Preference and enhanced palatability of feed due to the inclusion of DDGS could be the reason for increased feed intake in the DDGS-supplemented group. Similar to the present finding, researchers such as Harris *et al*. (2012) had also reported higher feed intake in pigs fed with a DDGS-based diet as compared to the control Abd El-Hack (2015) observed increased feed intake when DDGS was added up to 16.5 percent, and Waxenecker (2008) found that when pigs were fed diets containing DDGS at the rate of 0 and 10 percent, they had higher feed intake than the control group. On the other hand, several researchers, such as Whitney *et al*. (2001); Whitney and Shurson (2004); Greiner *et al.* (2008); and Widmer *et al*. (2008), reported that there was no significant difference in feed intake when swine diet was added with DDGS up to 30 per cent. Variations in the findings could be due to factors such as age, type, and breed of pig, feed composition, level and quality of DDGS, agro-climatic conditions, etc.

Feed conversion efficiency

The average weekly feed conversion efficiency and mean feed efficiency of the different experimental groups of upgraded *Tenyi-Vo* Pig up to six weeks period are depicted in Table 5. As per Table 4, the average feed conversion efficiency (gain: feed) was in the range of 0.122 to 0.455, 0.135 to 0.358, 0.196 to 0.267, and 0.109 to 0.233 in treatment groups T_1, T_2 ,T_3, and T_4 respectively. The mean feed conversion efficiency recorded in different experimental groups of upgraded *Tenyi-Vo* pigs at the end of the sixth week trial period was recorded as 0.263, 0.242, 0.228, and 0.173 for T_1, T_2, T_3 and T_4, respectively.

Except for 4th week, there was no difference in feed efficiency between the treatment groups. In the 4th week, the FCE (gain/feed) value for the control group was observed to be better, and the mean FCE decreased linearly with the increase in DDGS level. Numerically, the overall mean FCE also showed a decreasing trend with the increase in DDGS level. However, statistical analysis revealed that the FCE was unaffected by DDGS. The present findings were in line with the results obtained by Whitney and Shurson (2004), Widmer *et al*. (2008), and Harris *et al.* (2012), who reported that gain: feed was similar and there was a non-significant difference in feed efficiency regardless of the level of DDGS used. The present study disagreed with researchers such as Barbosa *et al. (*2008) who reported that adding DDGS up to 30 percent improved feed efficiency. Variations in the findings could be due to differences in feed consumption, nutritive level of feed and DDGS, breed of pig, source of DDGS, etc.

Economics

The economics of feeding diet containing different level of DDGS as GNC replacement in upgraded *Tenyi-Vo* pig are presented in Table 6. The feed cost per pig was 1115.65, 1209.26, 1457.79, and 1425.60 rupees for T_1, T_2, T_3, and T_4 respectively, while the corresponding values for feed cost per kg gain were 142.87, 144.42, 154.25, and 200.62. The total cost of production for T_1, T_2, T_3 and T_4 was 3860.11, 3953.58, 4202.11, and 4169.92 rupees per pig, respectively. The corresponding values for the average cost of production per kg gain in weight of pig were 488.42, 472.18., 444.67., and 586.98 rupees. The net profit per pig was 840.84, 962.82, 1143.79, and 157.53 rupees, respectively, for the T_1, T_2, T_3 and T_4 groups, and the corresponding values for the net profit per kg gain in weight were 107.66, 114.99, 121.02, and 22.168 rupees. The benefit: cost ratio was calculated as 1.217, 1.243, 1.272, and 1.037 for T_1, T_2, T_3, T_4, respectively. The total cost of production per pig was observed to be higher in the treatment groups as compared to the control group, apparently due to higher feed intake, while the cost of production per kg of live weight gain was highest in T4 followed by T1, T2 and the least in T3. The cost of feed per kg of weight gain was observed to be higher in the treatment groups that were provided DDGS, and the percentage of increase over the control was highest in T4, followed by T3 and T2. An increase in feed cost per kg gain might be due to higher feed intake in groups fed with DDGS with poorer feed efficiency.

The net profit per pig, net profit per kg live weight gain of pigs, and benefit-cost ratio followed a similar trend, and they were recorded to be higher in the group fed with 12 percent DDGS (T3) followed by T2 , T1 and the least was observed in the treatment group T4 (18 percent DDGS). As evident, the net income and benefit-cost ratio from upgraded Tenyi-Vo pigs fed with a diet replaced with 12 percent (T3) and 6 percent (T2) DDGS were observed to be better as compared to the control group, while (T4) group showed poor performance in terms of the economy of feeding DDGS. Similar to the present findings, Pharazayn *et al.* (2008) observed a higher net return from feeding DDGS up to 15 percent. The results of the present study were contradictory to the findings of Skinner *et al.* (2012), who observed a significant decrease in feed cost per kg when DDGS was, added up to 20 percent in the diet. As evident from Table 6, the feed cost per kilogramme of weight gain over the control was increased by 1.08, 7.96, and 40.42 percent for T2, T3, and T4 respectively. Statistical analysis revealed that feed cost per pig was significantly higher in groups fed DDGS-based diets compared to the control group, but feed cost per kg gain was non-significant in the treatment group regardless of DDGS level.

CONCUSION

Based on the results of the present study, the following conclusions have been drawn: There was a non-significant difference in body weight within the level of DDGS used to replace GNC. Except for the 4th week, body weight gain was unaffected by the dietary inclusion of DDGS. In the 4th week, weight gain in control group T_1 was significantly ($P<0.05$) higher as compared to the groups fed with a DDGS-based diet. There was a significant ($P<0.05$) difference in feed intake between the control and treatment groups. From the 1st to the 4th week, feed intake was significantly higher in groups fed with 12 percent DDGS (T_3) in the diet; meanwhile, in the 5th and 6th weeks, feed intake was significantly higher in the group fed with 18 percent DDGS (T_4). Except for at4th week, feed conversion efficiency was non-significant among the treatment groups. During the 4th week, better FCE (gain/feed) was observed in the control group as compared to the DDGS-based diet group. A higher total cost of production per pig was observed in groups fed with DDGS as compared to the control group. The cost of production per kg gain in weight was maximum in T_4 and the least in T_3. Feed cost per kg gain was highest in T_4 (18 percent), and the least in control T_1. Higher net profit per pig and net profit per kg gain were observed in the groups fed with 12 percent DDGS (T_3), followed by T_2, T_1 and the least was in T_4 group (18 percent DDGS). The benefit-cost ratio followed a similar trend.

Results from the present study indicated that the inclusion of DDGS up to 18 percent did not have an adverse effect on body weight, weight gain, FCE, or feed intake. A DDGS-based diet at 12 percent was more economical in terms of net profit per pig and benefit-cost ratio as compared to the control group. Based on the above findings, it was concluded that GNC could be replaced with DDGS in the diet of an upgraded *Tenyi-Vo* pig (75 percent) at a rate of 12 percent without affecting its body weight, weight gain, feed intake, or FCE for a higher net return.

Highlights

1. Upgraded Tenyi-Vo pigs were fed with diet containing DDGS @ 0, 6, 12 and 18 per cent as GNC replacement.
2. Performance in terms of body weight and weight gain was unaffected by the treatment.
3. DDGS based diet resulted in higher feed intake however, FCE was observed to be non-significant.
4. From 1st to the 4th week, groups fed with 12 percent DDGS (T3) had significantly higher feed intake while at 5th and 6th weeks, feed intake was significantly higher at 18 percent DDGS.
5. Higher net profit per pig and net profit per kg weight gain and benefit-cost ratio were recorded in the group fed with 12 percent DDGS with the least in groups fed with diet containing 18 percent DDGS.
6. Replacement of GNC with 12 percent of DDGS in the diet of upgraded *Tenyi-Vo* pig (75 percent) was recommended for higher net return.

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Table.1 Composition of the experimental diet

Ingredient	Diet(kg)			
	DDGS			
	Control	6%	12%	18%
Maize	60	60	60	60
Rice polish	10	10	10	10
Wheat bran	5	5	5	5
GNC	18	16.92	15.84	14.76
Fish meal	5	5	5	5
Vitamin & mineral mixture	1.5	1.5	1.5	1.50
Salt	0.5	0.5	0.5	0.5
DDGS	-	1.08	2.16	3.24
Total	100	100	100	100

Table 2: Body weight (Kg/pig/week) of Upgraded *Tenyi-Vo* Pigs in different treatment groups.

Treatments	Body Weight							Over all
	Initial	1st	2nd	3rd	4th	5th	6th	
T_1	10.86±0.74	11.73±0.65	12.95±0.64	14.31±1.25	16.49±0.90	17.97±1.01	18.67±1.21	15.4
T_2	11.15±0.56	12.99±0.72	13.70±0.66	14.58±0.86	15.93±1.06	17.54±2.86	19.52±1.10	15.8
T_3	11.77±0.78	13.05±1.22	14.35±1.39	16.16±1.93	17.92±2.09	19.56±2.72	21.22±2.94	17.1
T_4	10.04±0.39	11.23±0.37	12.55±1.02	13.29±1.24	14.11±1.19	15.50±1.64	17.15±1.68	13.9

a,b,c Means bearing different superscript in a column differ significantly ($P<0.05$)

Table 3: Gain in body weight (kg/pig/week) of Upgraded *TenyiVo* Pig in different treatment groups.

Treatment	Weight gain						Total Gain
	1st	2nd	3rd	4th	5th	6th	
T_1	0.86± 0.03	1.22± 0.11	1.34± 0.30	2.18^{a}± 0.19	1.47± 0.25	0.80± 0.27	7.902
T_2	1.84± 0.52	0.70± 0.23	0.87± 0.21	1.35^{bc}± 0.26	1.61± 0.20	1.98± 0.27	8.373
T_3	1.27± 0.27	1.29± 0.29	1.65± 0.75	1.76^{ab}± 0.21	1.63± 0.70	1.66± 0.46	9.293
T_4	1.18± 0.27	1.32± 0.61	0.71± 0.20	0.82^{c}± 0.15	1.39± 0.43	1.64± 0.23	7.086
SEm	0.33	0.28	0.37	0.23	0.42	0.31	
CD(P=0.05)	1.01	0.87	1.16	0.70	1.30	0.95	

a,b,c Means bearing different superscript in a column differ significantly ($P<0.05$)

Table 4: Feed intake (kg/pig/week) of Upgraded *Tenyi-Vo* Pigs in different treatment groups.

Treatment	Feed intake (kg/pig/week)						Total feed Intake	Mean
	1st	2nd	3rd	4th	5th	6th		
T_1	4.85^{c}±0.14	4.18^{c}±0.15	4.88^{c}±0.10	4.79^{b}±0.20	5.93^{d}±0.17	6.57^{c}±0.09	31.154	5.192
T_2	5.17^{c}±0.09	5.19^{b}±0.02	5.02^{bc}±0.01	5.25^{b}±0.08	6.45^{c}±0.11	7.04^{b}±0.01	34.160	5.693
T_3	6.29^{a}±0.03	6.74^{a}±0.19	6.86^{a}±0.07	7.94^{a}±0.15	7.30^{b}±0.07	6.52^{c}±0.14	41.670	6.945
T_4	5.61^{b}±0.05	5.68^{b}±0.24	5.53^{b}±0.25	7.50^{a}±0.16	8.14^{a}±0.15	8.76^{a}±0.08	41.250	6.875
SEm	0.11	0.15	0.16	0.17	0.12	0.10		
CD(P=0.05)	0.35	0.48	0.52	0.55	0.37	0.32		

a,b,c Means bearing different superscript in a column differ significantly ($P<0.05$)

Table 5: Feed conversion efficiency (gain/feed) of Upgraded *TenyiVo* Pigs in different treatment groups.

Treatment	Weeks						Mean
	1st	2nd	3rd	4th	5th	6th	
T_1	0.17± 0.02	0.29± 0.02	0.28 ± 0.03	0.45^{a} ± 0.19	0.24± 0.01	0.122± 0.04	0.263
T_2	0.35± 0.10	0.13± 0.04	0.17 ± 0.04	0.24^{b}± 0.09	0.25± 0.03	0.280± 0.03	0.242

T_3	0.20± 0.04	0.19± 0.04	0.26 ± 0.11	0.21^{b}± 0.02	0.22± 0.09	0.267± 0.05	0.228
T_4	0.21± 0.04	0.22± 0.02	0.12±0.03	0.19^{c} ± 0.01	0.17± 0.06	0.188± 0.02	0.173
SEm	0.06	0.05	0.05	0.03	0.05	0.04	
CD(P=0.05)	0.19	0.16	0.18	0.12	0.16	0.13	

a,b,cMeans bearing different superscript in the column differ significantly (P<0.05)

Table 6: Economics of production of Upgraded *Tenyi-Vo* Pigs in different treatment groups (Rs/Pig).

ITEMS	Treatment Groups			
	T_1	**T_2**	**T_3**	**T_4**
Cost of pig	2500.00	2500.00	2500.00	2500.00
Cost of feed	1115.65^{c}	1209.26^{b}	1458.02^{a}	1425.68^{a}
Cost of labour	229.32	229.32	229.32	229.32
Miscellaneous cost	15.00	15.00	15.00	15.00
Total cost of production	3860.11	3953.58	4202.11	4169.92
Final body weight (Kg)/pig	18.675	19.52	21.228	17.155
Average weight gain (Kg/pig)	7.81	8.373	9.450	7.105
Cost of production per Kg weight gain(Rs)	488.42	472.18	444.67	586.98
Cost of feed per Kg gain (Rs)	142.87^{a}	144.42^{a}	154.25^{a}	200.62^{a}
Increase in feed cost over control (%)	-	1.08	7.96	40.42
Receipt through sale of pig @Rs.250 per Kg live weight (Rs)	4668.75	4880.00	5307.00	4288.75
Sale of gunny bags @Rs.5/bag(Rs)	7.20	11.40	13.90	13.70
Sale of manure (Rs)	25.00	25.00	25.00	25.00
Total receipt	4700.95	4916.40	5345.90	4327.45
Profit per pig	840.84	962.82	1143.79	157.53
Net profit per Kg weight gain (Rs)	107.66	114.99	121.02	22.168
Benefit : cost ratio	1.217	1.243	1.272	1.037

a,b,c, Means bearing different superscript in column differ significantly (P<0.05)