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Effects of Low Crude Protein Diets Supplemented with Synthetic Amino Acids on Growth Performance and Blood Biochemical Profile of Growing 20–50 kg Cross-bred (Yorkshire×Zovawk) Pigs

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ABSTRACT

The study was carried out during April–June, 2024 in the livestock farm of the College of Veterinary science and Animal Husbandry, Selesih, Aizawl, Mizoram, to investigate the effect of low crude protein diets supplemented with synthetic amino acids on performance of growing cross-bred (Yorkshire×Zovawk) pigs. Twenty cross-bred pigs of similar age (3–4 months) and average body weight (20–23 kg) were taken for the study period of 60 days and were randomly allocated into 4 groups each with 5 animals. Standard grower ration was prepared as per National Research Council . All the animals were fed isocaloric diet with different protein level with or without amino acid supplementation. The diet was prepared for 20–50 kg bwt pigs in which Group-1 was control group and fed standard grower ration having 18% of crude protein (CP). The rest three groups were fed 15% CP i.e. 3% unit reduction of standard CP level. Group-2 was fed without synthetic amino acids while there was lysine supplementation in Group-3 and there was supplementation of the Lysine, methionine and threonine in Group-4 as per the requirement. During the whole feeding trial of 60 days there was no significant difference (p>0.05) in average dry matter intake, average daily gain and feed conversion ratio among the different treatment groups. A digestibility trial was also conducted which revealed that digestibility coefficient of dry matter, CP, crude fibre, ether extract and nitrogen free extract was not significantly differed (p>0.05) among different treatment groups. Blood biochemical parameters analysis revealed that serum glucose, total protein, albumin, globulin, urea, creatinine, triglycerides, cholesterol and SGOT value was within normal range and no significant difference (p>0.05) were observed among the treatment groups. It was concluded that the reduction of dietary protein by 3% unit of feeding standard in the diet of growing cross-bred (Yorkshire×Zovawk) did not have any adverse effect on the growth performance, nutrient utilization and blood biochemical profile of the pigs.

KEYWORDS: Cross-bred, synthetic amino-acid, growth performance, blood biochemical profile

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1. INTRODUCTION

Mizoram, one of the North Eastern states of India, relies heavily on livestock for its animal husbandry economy, with pig farming being the most common practice among Mizo communities. The state has an estimated pig population of 0.29 million (Anonymous, 2019) reflecting a 19.26% increase from the previous census and accounting for about 82.2% of the total livestock population. The indigenous breed, Zovawk, is widely reared for pork and manure. (Lalmuansangi et al., 2021). Pig farming serves as a major source of income for smallholders and remains a key economic activity. During 2022–23, total meat production from various livestock species in Mizoram was estimated at 15,528 t, of which pork contributed 4,886 t (Anonymous, 2023–2024). In recent years, commercial pig farming has gained popularity due to its profitability, driven by rapid growth rates and high pork demand. Despite its importance, feeding remains a major constraint for pig farmers in Mizoram, largely due to limited availability of feed ingredients and inadequate scientific knowledge of pig nutrition. Feed costs constitute about 75–80% of total production expenses, making efficient feeding practices essential for optimizing growth, reproduction, and profitability. Dietary protein is a critical component, supplying essential amino acids (EAA), but it also significantly influences production costs. Excess dietary protein beyond the animal's requirement is excreted as nitrogenous waste, such as ammonia and amines (Mc Donald et al., 2022), leading to economic losses and environmental concerns, including increased nitrogen emissions (Niyonsaba et al., 2023). Reducing crude protein (CP) levels in pig diets has been identified as an effective strategy to minimize nitrogen excretion and ammonia emissions (Andretta et al., 2021). High protein intake can lead to amino acid catabolism, imposing stress on the liver and kidneys, increasing heat production, reducing feed intake, and ultimately impairing nutrient utilization. It also raises energy expenditure and affects organ size and metabolism (Yen, 1997; Nyachoti et al., 2000). To address this, supplementing low-protein diets with essential amino acids can help maintain an ideal amino acid balance, thereby improving nitrogen utilization and growth performance. (Cappelaere et al., 2021). Recent studies highlight multiple benefits of low CP diets supplemented with amino acids, including improved environmental sustainability, better animal health, and reduced feed costs. Duarte et al., (2024) reported that reducing dietary CP by 2% units with supplementation of lysine, methionine, threonine, tryptophan, and valine improved intestinal health in growing pigs. Similarly, Correia et al. (2023) observed enhanced gut morphology in piglets, including increased villus height, higher goblet cell proportion, reduced crypt depth, and fewer Payer's patches. Niyonsaba et al. (2023) further confirmed that lowering CP levels did not negatively affect growth performance in growing-finishing pigs. Lower dietary protein also plays a crucial role in maintaining gut health in piglets. Excess protein often remains undigested and undergoes fermentation in the colon, producing harmful metabolites and promoting the growth of pathogens such as E. coli, a major cause of diarrhoea. Studies have shown that reduced CP diets decrease diarrhoeal incidence (Ball and Aherne, 1987) and lower the production of toxic compounds like ammonia (Nyachoti et al., 2006). However, there is limited scientific information on the effects of low CP diets supplemented with amino acids on the performance of growing crossbred (Yorkshire×Zovawk) pigs weighing 20–50 kg. Therefore, the present study was undertaken to evaluate the impact of such diets on growth performance and blood biochemical parameters in these pigs.

2. MATERIALS AND METHODS

2.1. Location and period of study

The study was carried out during April–June, 2024 in the livestock farm of the College of Veterinary science and Animal Husbandry, Selesih, Aizawl, Mizoram. It was conducted from first week of April and the feeding trial was carried out for 60 days.

2.2.1. Approval of institutional animal ethics committee (IAEC)

The study was approved by Institutional Animal Ethics Committee (registered under CPCSEA) of College of Veterinary Science and animal husbandry, Central Agricultural University (Imphal), Selesih, Aizawl, Mizoram (approval reference number CVSC/CAU/IAEC/13-14/R20)

2.2. Animals and experimental design

Twenty crossbred pigs (Large white Yorkshire×Zovawk) of similar age group (3–4 months) and average body weights (20–23 kg) were allocated randomly into 4 treatment groups (G_1, G_2, G_3 and G_4) and housed in a well-ventilated animal shed. A provision for feeding individually twice a day was arranged. Fresh drinking water was provided at all times. The duration of the experiment was 60 days. Body weight and feed intake were determined weekly. Average daily gain (ADG) and Feed conversion efficiency of experimental pigs were also calculated.

2.3. Experimental diets

The feed ingredients used for the preparation of concentrate mixtures were maize, wheat bran, soybean meal, fish meal, Mineral mixture and Salt. A standard concentrate mixture for growing pigs was prepared as per Anonymous, 1998. and fed to control group (G_1). Three rations which were isocaloric to the Standard Concentrate mixture was prepared for feeding to the other three different groups (G_2, G_3 and G_4) of animals The diet prepared for 20–50 kg body weight is presented in Table 1. During the feeding plan, G_1 was control group and fed standard concentrate mixture having 18% of CP. In the diet of G_2, G_3 and G_4, there was 3% unit reduction of CP level i.e 15% of CP. G_2 feed concentrate mixture is having 18% CP without synthetic amino acids. There was lysine supplementation in G_3 and in G_4 there was supplementation of the Lysine, methionine and threonine as per the requirement (Anonymous, 1998).

2.4. Chemical analysis

Representative samples of each of the concentrate feed ingredients and residual feeds were analyzed in the laboratory for proximate principles. Feed samples were analyzed for proximate principles viz., dry matter, crude protein, ether extract, crude fiber, total ash and nitrogen free extract (Anonymous, 2000), calcium (Talapatra et al., 1940) and Phosphorus (Anonymous, 2000).

2.5. Feeding trail

The complete duration of feeding trial was 60 days, during which daily dry matter intake was calculated by recording the daily feed offered and residual feed. These samples were analyzed for dry matter content. The body weight of the animals was taken once before the start of the trial and at 7 days interval during the experimental period.

A digestion trial of 5 days was conducted in the last week of feeding trial by selecting 4 animals randomly from each group. Feeds offered and residues left were recorded daily during the digestion trial. Water was made available to all the animals daily. Representative samples of feed offered and residues left over during the digestion trial were collected daily for estimation of dry matter and samples were pooled for 5 days for the further chemical analysis. A suitable aliquot of feces was taken for dry matter estimation and was kept for 5 days and stored in a labeled container for analysis.

2.6. Blood profiles

Blood was collected from the experimental animals on 0 and 30 days. The blood sample was collected directly from anterior vena-cava under aseptic condition. Serum was separated by centrifugation. Estimation of glucose, cholesterol and triglycerides was done by using biochemical diagnostic kit as per the GOD/POD, CHOD/PAP and GPO/PAP method respectively described by Trinder (1969). Estimation of total protein was done using biochemical diagnostic kit as per the biuret method described by Gornall et al. (1949) while estimation of albumin was done by using biochemical diagnostic kit as per the BCG method described by Doumas and Watson (1971). Blood urea was analyzed by using biochemical diagnostic kit. The creatinine and SGOT was measured using biochemical diagnostic kit as per the Alkaline Picrate method described by Bones (1945).

2.7. Statistical analysis

The data obtained from the experiment was subjected for statistical analysis as per standard method, described by Snedecor and Cochran (1994).

3. RESULTS AND DISCUSSION

3.1. Analysed nutrient content of experimental diets

The chemical composition of experimental diets fed to the different groups of experimental animals is depicted in Table 1. As per Anonymous (1998) the protein requirement for

Table 1: Formulas and calculated value of the experimental diets fed for 20–50 kg bwt cross-bred pigs

Ingredients(%)	Group-1	Group-2	Group-3	Group-4
Maize (kg)	64	71.7	71.7	71.7
Soyabean meal (kg)	20	12.3	12.3	12.3
Wheat bran (kg)	10	10	10	10
Fish meal (kg)	4	4	4	4
Mineral mixture (kg)	1.5	1.5	1.5	1.5
Common salt	0.5	0.5	0.5	0.5
Chemical composition (% DM basis)				
Dry matter (%)	86.84	88.27	89.13	89.03
Crude protein (%)	18.58	15.63	15.58	15.28
Ether extract (%)	2.75	3.14	3.17	3.15
Crude fibre (%)	6.00	4.40	4.40	4.80
Nitrogen free extract (%)	64.30	69.67	69.11	69.38
Total ash (%)	8.38	7.16	7.73	7.39
Organic matter (%)	91.62	92.84	92.27	92.61
Phosphorus (g %)	0.63	0.54	0.51	0.53
Calcium (g %)	2.14	1.87	1.87	1.98
Lysine (%)*	0.95	0.67	0.95	0.95
Methionine (%)*	0.25	0.24	0.24	0.25
Threonine (%)*	0.61	0.51	0.51	0.61
DE (kcal kg^{-1})*	3396	3392.15	3392.15	3392.15

*Calculated values

the piglet having body weight 20–50 kg was 18%. In our experiment the same protein level was maintained owing the calculation of protein level before the feeding experiment. The ration for different groups was consisted of different levels of concentrate feed ingredients and synthetic amino acids. After feed is prepared, the CP% in control group i.e G_1 was found to be 18.58%. The protein level was reduced by approximately 3% in G_2, G_3 and G_4 as compared to the control group.

3.2. Feed intake

The average weekly dry matter intake by the experimental animals during the feeding experiment was recorded (Table 2). Statistical analysis revealed that the average DM intake of feed by pigs of different groups over the whole experimental period was not statistically different (p>0.05) among the group. However the piglets in control group fed higher CP had numerically lower feed intake, this finding are consistent with previous finding (Jin et al., 1998). As low protein AA supplemented diets were expected to supply a better balance of amino acids while minimizing the excess supply, it has been argued that limiting dietary protein content while balancing for essential amino acids may boost feed intake in piglets (Le Bellego and Noblet, 2002). The present study was supported by Correia et al. (2023) who observed that there was no significant effect (p>0.05) in the average feed intake of the weanling pigs when fed low-CP diet (18% CP) with or without supplemental NEAA compared to control high-CP diet (24% CP) fed pigs.

Table 2: Weekly dry matter (DM) intake (g head^{-1} day^{-1}) by the experimental animals of different group

Week	Attributes	Group-1	Group-2	Group-3	Group-4	P
1st	DMI	993.6±120.86	1060.1±91.51	1149.80±65.34	1077.10±134.63	0.788^{NS}
2nd	DMI	1058.7±84.76	1129.8±81.06	1273.80±71.12	1105.20±135.82	0.456^{NS}
3rd	DMI	1169.1±66.71	1259.3±79.28	1309.70±151.16	1242.50±113.15	0.799^{NS}
4th	DMI	1283.2±67.63	1387.4±61.14	1337.10.4±188.51	1349.40±95.72	0.905^{NS}
5th	DMI	1429.5±55.01	1507.60±51.75	1456.70±161.50	1461.70±80.37	0.931^{NS}
6th	DMI	1476.8±76.87	1600.2±46.13	1581.30±132.99	1552.00±79.92	0.722^{NS}
7th	DMI	1567.4±101.88	1731.0±35.60	1697.60±129.35	1668.20±76.94	0.578^{NS}
8th	DMI	1687.94±94.36	1831.6±42.04	1796.30±116.52	1780.20±61.44	0.613^{NS}
9th	DMI	1749.4±84.95	1894.9±38.01	1841.20±103.69	1853.90±59.74	0.536^{NS}
10th	DMI	2201.1±257.14	2307.2±174.07	2557.80±331.81	2310.70±245.66	0.793^{NS}

DMI: Dry matter intake; NS: Non-significant

3.3. Growth performance

Many experimental studies have shown that reduction in dietary crude protein level do not have adverse effect on the growth performance of the growing pigs. From the perusal of Table 3, it was observed that the weekly body weight (kg animal^{-1}) of the four groups showed non-significant differences (p>0.05) among the treatment groups during the feeding trail. Our statistical analysis revealed that the average daily gain by the pigs of different groups did not differ significantly (p>0.05) during 60 days feeding trial (Table 4). In agreement to our present observation Wellington et al. (2023) also observed that there was no significant impact on growth performance on supplementation of EAA in combinations with low crude protein diet in weanling pigs. This study was also supported by Peng et al. (2016) who showed that pig performance was similar when dietary CP level was reduced from 20% to 15.3%. On statistical analysis there was no significant (p>0.05) difference observed among the groups in respect of feed conversion efficiency. Similarly, Zhao et al. (2019) showed no effects on growth performance and carcass characteristics of growing-finishing pigs when fed low-CP diet. Recently, Le Dinh et al. (2022) found that reducing CP with EAA supplementation increased ADG and ADFI but also reduced muscle thickness. Conversely, Correia et al. (2023) observed that high-CP diet (24% CP) improves the feed conversion efficiency of piglets in the first 2 weeks after weaning compared to the low-CP diet (18% CP) supplemented or not with non-EAA.

3.4. Nutrient utilization

Statistical analysis revealed that no significant difference (p>0.05) in digestibility coefficient of dry matter, crude protein, crude fibre, ether extract and nitrogen free extract was observed among the different treatment groups (Table 5). The result observed in this study are consistent with findings reported in previous studies evaluating the effects of low crude protein diet supplemented with synthetic amino acid on nutrient utilization in pig. Lee et al. (2001) and Kumar et al. (2012) observed that there was no significant difference (p>0.05) in the dry matter,

Table 3: Weekly body weight (kg animal^{-1}) of experimental pigs of different group

Week	Group-1	Group-2	Group-3	Group-4	SEM	P
1st	21.00±2.46	20.90±2.26	23.50±2.02	23.12±3.64	1.223	0.84^{NS}
2nd	24.40±2.73	24.26±2.42	26.65±2.15	25.25±3.72	1.285	0.92^{NS}
3rd	27.76±2.35	27.60±2.71	29.25±2.78	28.50±3.59	1.295	0.97^{NS}
4th	30.60±2.37	30.40±3.04	31.75±3.56	32.25±3.63	1.424	0.96^{NS}
5th	33.20±2.70	33.80±3.33	34.75±4.23	35.25±3.63	1.570	0.97^{NS}
6th	35.80±2.74	36.00±3.01	36.75±4.90	38.75±3.81	1.636	0.93^{NS}
7th	38.30±2.34	39.00±3.20	40.50±4.94	42.25±4.00	1.658	0.87^{NS}
8th	41.10±2.05	41.96±3.40	44.30±4.99	45.87±4.21	1.707	0.78^{NS}
9th	44.10±2.18	44.80±3.24	48.00±5.58	49.50±4.25	1.794	0.71^{NS}
10th	47.20±2.35	47.70±3.28	51.50±6.22	52.80±4.16	1.897	0.70^{NS}
11th	52.20±2.83	51.80±3.10	56.75± 7.52	58.12±4.18	2.12	0..68^{NS}

NS: Non-significant

Table 4: Effect of feeding low protein and amino acid supplementation on feed intake average daily gain and feed conversion efficiency during experimental period (60 days)

	Group-1	Group-2	Group-3	Group-4	P
Initial body wt (kg)	21.00±2.46	20.90±2.66	23.50±2.02	23.13±3.64	0.845^{NS}
Final body wt (kg)	52.20±2.83	51.80±3.10	56.75±7.52	58.12±4.18	0.68^{NS}
Body weight gain (kg)	31.20±2.74	30.90±0.85	33.25±5.72	35.00±0.79	0.756^{NS}
Average daily gain (kg day^{-1})	0.445±0.04	0.441±0.01	0.475±0.09	0.500±0.01	0.756^{NS}
Total dry matter intake (kg)	102.31±5.50	109.96±4.24	112.01±9.69	107.81±4.06	0.690^{NS}
Feed conversion efficiency	3.36±0.30	3.55±0.06	3.56±0.38	3.07±0.06	0.509^{NS}

NS: Non-significant

Table 5: Effect of synthetic amino acid supplementing to the low protein diet on nutrient digestibilities in growing pigs.

Attributes	Group-1	Group-2	Group-3	Group-4	P
Dry matter					
Digestibility coefficient (mean±SE)	85.53±0.92	85.91±1.18	88.32±0.51	86.21±0.39	0.127^{NS}
Crude protein					
Digestibility coefficient (mean±SE)	86.04±1.45	84.15±1.82	86.35±0.74	85.42±0.64	0.633^{NS}
Crude fibre					
Digestibility coefficient (mean±SE)	63.79±1.61	61.07±2.70	62.98±0.61	59.66±2.41	0.486^{NS}
Ether extarct					
Digestibility coefficient (mean±SE)	56.87±3.69	60.28±2.02	60.36±1.94	59.66±4.15	0.840^{NS}
Nitrogen free extarct					
Digestibility coefficient (mean±SE)	91.25±0.49	91.69±0.99	93.65±0.38	92.22±0.67	0.123^{NS}

NS: Non-significant

crude protein, crude fibre and ether extract digestibility among the different treatment groups. However, Jin et al. (1998) observed that dry matter digestibility was improved in 15% CP+lysine+methionine+threonine and 15% CP+lysine+methionine+threonine groups (p<0.05) compared to the control group fed with 18% CP. Jin et al. (1998) reported that nitrogen digestibility was improved in pigs fed 15% CP with lysine, methionine, threonine

(p<0.05) compared to the control group fed with 18% CP. In contrast to our present observation Kerr and Easter (1995) found an increased nitrogen digestibility with supplemented lysine, threonine, tryptophan and dispensable amino acids to the low protein diet. Just (1982) reported that the digestibility of CP increased with increasing percentages in the diet when they examined the range of CP from 13% CP to 29.4% crude protein. Leibholz et al. (1986) and Izquierdo et al. (1988) reported that feeding a low CP diet with supplemental AA could improve N digestibility compared with feeding high CP diet without supplemental AA due to the greater digestibility of crystalline AA in comparision with protein-bound AA. Correia et al. (2023) also indicated that the low-CP+NEAA diet improves N utilization efficiency and intestinal architecture and modulates the response expression of genes related to the immune system and antioxidant capacity in piglets.

3.5. Blood biochemical profiles

There was no significant difference (p>0.05) in the blood glucose, total protein, globulin, creatinine, triglycerides, cholesterol and SGOT level among the different treatment groups (Table 6) which was similar to the findings of other worker who had shown that supplementation of low CP diet in growing-finishing pig did not have significant difference (p>0.05) in the blood total protein, glucose, albumin, globulin and creatinine level (Li et al., 1998; Toledo et al., 2014; Niyonsaba et al., 2023). It was also observed that the serum urea concentration decreased numerically as dietary protein concentration decreased which supported the previous study conducted by Figueroa et al., 2002 and Niyonsaba et al., 2023

Table 6: Effect of low protein amino acid supplemented diets on blood biochemical profile in growing pigs

Glucose (mg dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	87.98±2.20	98.09±6.37	89.27±1.08	97.75±0.64	93.27±1.95	0.112NS
60 Days	89.06±2.04	99.72±7.06	92.28±6.48	97.15±1.70	94.55±2.46	0.458NS
Total protein (g dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	6.62±0.17	6.72±0.25	6.64±0.19	7.35ac±0.05	6.84±0.12	0.068NS
60 Days	7.95±0.24	8.13±0.35	8.29±0.37	8.16bcd±0.31	8.13±0.14	0.903NS
Albumin (g dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	4.41±0.09	4.37±0.18	3.84±0.21	3.79±0.39	4.10±0.13	0.226NS
60 Days	4.79±0.08	3.88±0.17	4.57±0.39	4.72±0.11	4.49±0.14	0.078NS
Globulin (g dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	2.21±0.20	2.35±0.34	2.79±0.39	3.56±0.42	2.73±0.21	0.094NS
60 Days	3.16±0.30	4.24±0.47	3.72±0.25	3.43±0.21	3.63±0.18	0.197NS
Urea (mg dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	36.03±0.91	33.87±5.60	36.76±3.88	33.38±1.68	35.01±1.56	0.884NS
60 Days	32.26±4.28	30.64±4.15	31.52±4.08	30.82±4.57	31.31±1.83	0.993NS
Creatinine (mg %)						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average ± SE	P
Innitial	1.07±0.14	1.14±0.15	1.07±0.11	1.10±0.03	1.09±0.05	0.972NS
60 Days	1.33±0.23	1.04±0.10	1.02±0.09	1.00±0.05	1.10±0.07	0.373NS
Triglycerides (mg dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	107.07±5.20	122.83±11.82	108.70±6.08	119.57±4.06	114.54±3.75	0.382NS
60 Days	116.85±2.99	132.61±13.31	117.93±6.42	124.46±2.99	122.96±3.80	0.474NS

Table 6: Continue...

Cholesterol (mg dl^{-1})						
Period/Group	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	81.78a±2.57	86.31±60.5	77.19a±3.54	79.99±3.38	81.31±2.02	0.483NS
60 Days	98.47b±2.96	104.18±7.84	105.56b±6.8	88.14±6.91	99.09±3.32	0.246NS
SGOT						
Group±period	Group-1	Group-2	Group-3	Group-4	Average±SE	P
Innitial	38.66±4.05	38.33±13.37	42.50±6.50	42.00±8.09	40.37±3.75	0.978NS
60 Days	54.66±8.06	49.50±13.25	57.33±7.52	50.83±4.53	53.08±3.91	0.919NS

NS=Non-significant

4. CONCLUSION

The reduction of dietary protein by 3% unit from standard feeding levels in the diet of growing 20–50 kg cross-bred (LWY×Zovawk) did not have any adverse effect on the growth performance and blood profile of pigs. Supplementation of limiting synthetic amino acids to the low crude protein diet of growing cross-bred (LWY×Zovawk) pigs did not significantly improved the performance.

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