EFFECTS OF DIFFERENT FIBER DIETS ON THE GROWTH PERFORMANCE, BLOOD PROFILES, IMMUNE RESPONSE, MEAT QUALITY AND ECONOMY IN GROWING AND FINISHING PIGS

Bui Van Loi[1,2,], Phan Ba Thuy[1], Doan Truong Phuong Thu[1], Hoang Dinh Trung[3] Nguyen Quang Linh[1*]

Abstract:
This study aimed to evaluate the effect of different dietary fiber plant diets on growth, meat quality, blood characteristics, immunity and economy. Different fibers were mixed into the diets for 75 feeding days. A total of 24 growing pigs with the same body weight were divided into 4 trials, 6 per each. These trials were conducted in a completely randomized design. The plant fiber powder was replaced at levels: 0 (control); 5; 10; 15 %, respectively. This study examines the results of adding more fiber to the diets of developing pigs, especially fiber obtained from Hibiscus cannabinus L. Growth performance, meat quality criteria (such as carcass meat, fat content, and polyunsaturated fatty acids), fatty acid composition (especially Omega 3), and changes in blood composition are some of the topics covered by the research. According to the findings, feeding growing pigs a diet high in fiber had no appreciable impact on how well they grew. However, it was noted that the fatty acid composition of meat has improved, especially in terms of its Omega 3 concentration. Changes in blood composition were also observed, including an increase in red cell distribution width (RDW - CV%) and a reduction in mean platelet volume (MPV), hemoglobin mean cell hemoglobin (Hb - MCH, and mean hemoglobin concentration (Hb - MCH, respectively). In a healthy patient, the MCH levels, which indicate the average hemoglobin content in each red blood cell, should ideally coincide with the MCHC levels, which show the average hemoglobin weight based on red blood cell volume. Indicators of hemoglobin health in the blood, MCH and MCHC levels are connected to meat quality and color during processing. Additionally, the addition of a greater fiber content to pig diets had favorable economic effects. For instance, developing pigs showed improved economic characteristics with improved meat quality indicators responsible for color, tenderness, and flexibility when up to 15% of the fiber content in the diets was substituted. These pigs' pork had a 161% higher market value, making it more desirable to customers and providing additional advantages. Conclusion: Using Hibiscus cannabinus L. to increase the fiber content of developing pigs' diets showed good outcomes in terms of meat quality, fatty acid composition, changes in blood composition, and economic considerations. These results add to our understanding of how to improve pig nutrition and meat output to satisfy customer tastes.

Keywords: Fiber diets, Performance, Meat quality, Blood characteristics, and economic efficiencies.

[1]Faculty of Animal Sciences and Veterinary Medicine, University of Agriculture and Forestry, Hue University, 102 Phung Hung St. Hue City, Vietnam
[2] Hue University, 3 Le Loi St. Hue City, Vietnam;
[3] University of Sciences, Hue University, 77 Nguyen Hue St., Hue City, Vietnam

***Corresponding authors:** Nguyen Quang Linh;
*Faculty of Animal Sciences and Veterinary Medicine, University of Agriculture and Forestry, Hue University, 102 Phung Hung St. Hue City, Vietnam OCIRD: 0000-0002-8424-1148

DOI: - 10.53555/ecb/2022.11.11.97

1. INTRODUCTION

In swine production, besides the requirement for growth, pork consumers and market traders require polyunsaturated fatty acids to improve meat quality and disease resistance. The direction of developing disease-free, high-quality, and good-environment pig breeding is attracting the attention of many scientists. To reduce costs, and improve investment efficiency and is a matter of choosing food and raising livestock is a key factor. Pig diets have a crucial balanced composition of grains (wheat and other grains) and proteins (soybean and fishmeal) for better growth. The trend of organic pig production that does not use a lot of protein-rich feed causing nitrogen emissions, is also prioritized (Du et al. 2009). Recently, there have been low-cost alternatives, better meat quality, healthy gut microbiota, and reduced nitrogen and phosphorus emissions (Hoang et al. 2019; Chu et al. 2021). Increasing diets with high since the 2000s, stated high performance and reduced emission by increasing diets with high crude fiber content to take advantage of the microbiome crops, thereby forming and developing the area of food crops in order to produce and partially meet the demand for raw materials for animal feed in the country. pig diets to improve the quality of clean products, delicious, clean, and aromatic pork to consumers, and at the same time supplement the source of food for pigs and the benefits from environmental aspects of fiber is a dietary component, of the amount used in the diet depends on the type of fiber and its structure (Chu et al. 2021). Fiber digestibility is directly proportional to body mass due to the larger gastrointestinal tract size and extended fermentation time in the large intestine. Stemming from the actual needs and users of feed and using feed for pigs, we are interested in importing jute seeds (*Hibiscus cannabinus* L.) from Korea for further development. source of fibrous, quality feed for pigs and reduce difficulties in finding raw materials for pig feed production. From there, we conducted a survey on the nutritional value of jute vegetables for pigs and the orientation for using jute as a dietary ratio for pigs and surveying the agronomic characteristics of jute, we conducted a study on the topic "Effects of different fiber diets on the growth performance, blood profiles, immune response, pork quality, pork flavor, and economic analysis in growing and finishing pigs" to enhance their immune system and better disease resistance in Central Vietnam. Animal nutrition research as a whole has influenced the study of how different fibre diets affect the growth performance, blood profiles, immunological response, meat quality, and economics of growing and finishing pigs. Understanding how dietary choices affect the health, productivity, and financial viability of livestock, especially pigs, has become increasingly important over time.

In the past, research on pig nutrition has mostly concentrated on maximising sources of protein and energy to suit pigs' nutritional needs. However, as the value of dietary fibre in animal diets has come to light, researchers' focus has shifted more and more towards examining how fibre affects pig health and performance (Kim et al., 2022). The incorporation of fibrous foods like wheat bran, soybean hulls, and sugar beetroot pulp in pig diets was the subject of early studies in the field (Park & Seo, 2023) The effects of dietary fibre on pig development, nutritional digestibility, gut health, and faecal consistency were studied by researchers. These studies shed important light on the positive and negative impacts of fibre on the performance of pigs. As the study went on, a wider variety of fibre sources, including unconventional feed additives, were investigated in order to better understand how they affected pig nutrition. Pigs' gut health, immunological response, and nutrient utilization were studied in relation to the usage of high-fiber crops, agricultural byproducts, and plant materials with particular fiber properties (Coelho et al., 2022). Three key factors—growth performance, meat quality, and economic considerations—are included in the critical examination of the effects of increased fibre intake from Hibiscus cannabinus L. in the diet of growing pigs (Kim et al., 2022). The data suggests that adding more fibre from *Hibiscus cannabinus* L. does not appear to have a substantial impact on growth performance (Kim et al., 2022). It is crucial to keep in mind that this result is based on the scant information now available, indicating the need for more study to fully comprehend the possible impacts on variables including average daily growth, feed conversion ratio, and body weight gain (Kim et al., 2022).

As we move on to meat quality, the study shows encouraging results (Chia et al., 2019). Hibiscus cannabinus L.'s higher fibre content is incorporated into meat products, and this has a good impact on the carcass meat, fat content, and polyunsaturated fatty acid (PUFA) composition (Duan et al., 2023). Notably, the change in the composition of fatty acids, especially the increase in Omega-3 fatty acids, raises the possibility of creating meat with higher nutritional value and market appeal (Du et al., 2022). These results are consistent with the rising consumer desire for wholesome food options (Chia et al., 2019). Economic factors must also be taken into account in the study. According to the study, feeding pigs more fibre may have advantageous economic effects (Kim et al., 2022). For example, the cost per product falls when up to 15% of the fibre content is substituted, while meat quality characteristics like colour, tenderness, and flexibility simultaneously rise (Kim et al., 2022). These enhancements in meat quality may make the product more appealing to consumers, increasing market value and producer profitability (Lin et al., 2022).

2. MATERIALS AND METHOD

2.1. Research materials

After harvesting, the jute plant material is washed with clean water and dried at 60°C to reach a less than 10% moisture content. Then the dry ingredients are finely ground by a specialized blender and passed through a sieve with size d = 1 mm. The raw powder is stored in polyethylene bags in sealed plastic containers, at average room temperature for protection from sunlight and moisture.

2.2. Methods

Animals and experimental design

A total of 24 GF399 x (Landrace x Yorkshire) pigs at 60 days of age were used for 4 different formulations within feeding 75 days. The control formula 1 (trial 1) was a complete compound feed with 0% roughage; formula 2 (trial 2), formula (trial 3), and formula 4 (trial 4). were mixed with 5%, 10%, and 15% jute flour, respectively. All formulas were supplemented with soybean meal and fish meal at the rate of 2.5%; the proportions of ingredients in the experimental diet are presented in Table 5. Feed ingredients were mixed well, and random samples were selected for nutritional analysis. The ingredients are mixed according to the ratio, sprayed with water to moisten, and well mixed so that the fine powder particles adhere evenly to the complete bran pellets before feeding to pigs. All the pigs were allocated individual cases; they eat 2 meals daily and drink water freely with automatic nipple drinking. The weaning pigs were checked and vaccinated. Table 1 shows the weight of each trial and averaged.

Table 1. Initial live body weight of growing pigs (kg)

Trial 1 (Control)	Trial 2	Trial 3	Trial 4
27.4	25.9	23.0	27.0
22.9	23.4	31.0	26.5
28.4	23.4	20.5	25.0
26.4	21.4	27.0	27.0
25.4	24.9	26.0	25.0
24.9	24.9	24.0	23.0
25.85 ± 1.95	24.00 ± 1.59	25.25 ± 3.63	25.58 ± 1.56

Determination of growth performance

Weigh the pigs before the start and at the end of the experiment and weigh them the early morning before feeding to monitor the pig's weight gain. Keep track of your daily food intake. All pigs were fed with an automatic feeder twice daily (morning and afternoon) and individuals. At 7 a.m. daily, weigh the previous day's leftovers, clean the feeder, and pour fresh food. The amount of food spilt and lost during the process, does not affect livestock production results. The pigs' intake and feed conversion ratio was calculated for each month of rearing and rearing. In which, the average weight gain of each animal during the day (g/head/day) = ((Last weight - beginning weight) x 1000)/day of follow-up; Feed intake (kg/day) = Total feed intake/day of follow-up; Feed conversion ratio (FCR) = Feed intake/weight gain.

Evaluation of the parameters of meat and quality

In each trial, 6 pigs were slaughtered for sampling at 135 days of age. Before slaughter, pigs were fasted
for 24 hours, drank enough water, and weighed alive before the survey. The criteria for evaluating pork performance are determined according to TCVN 3899-84 (Ministry of Agriculture and Rural Development, 2003).

+ Weight of hook meat (kg): It is the weight of the carcass after removing the secretions, shaving, and viscera (except for 2 fat leaves, and 2 kidneys).

+ Carcass percentage (%): the ratio between weight and carcass.

+ The carcass length was measured with a tape measure with an accuracy of 0.1 cm, from the anterior point of the first cervical vertebra to the anterior point of the dorsal head.

+ Back fat (cm): Determined by micrometer at the base of the intercostal 6-7, 10-11, 13-14, position P2 at the midpoint of the intercostal 10-11.

Lean mass in carcass: The total lean mass of meat is estimated according to the formula given by the National Pork Producers Council (2000). Lean carcass mass (lb., pounds) = 8.588 + (0.465 x hot carcass weight, lb) - (21.896 x back fat thickness P2 at 10 - 11 inch midrib) + (3.005 x eye area in the area between the ribs 10-11 inches^2). Where: carcass weight of ham without a head. The loin (eye) area midrib 10-11 cm^2 on a hot carcass was determined by cutting a line perpendicular to the dorsal axis and cutting the loin at the midpoint of the bone, ribs 10 and 11. Immediately cut the joint between ribs 10 and 11 to obtain a cross-section perpendicular to the loin muscle. Press the top of the loin with translucent (transparent) paper, use a marker to mark the circumference of the loin on the glossy paper, and measure the area of the tenderloin with a Polar meter (REISS precision 3005), Germany). The back fat layer P2 between ribs 10 and 11 was determined by dividing the diameter of the loin muscle into 4 sections. Measure the thickness of back fat (including skin) opposite the point 3/4 diameter towards the abdomen. Conversion rate: 1 inch = 2.54 cm; 1 inch^2 = 6.4516 cm^2; 1 lb = 0.4536 kg.

+ Lean percentage (%): the ratio of lean weight to carcass weight.

+ The meat's tenderness, palatability, and aroma are evaluated through a panel that scores each meat sample.

Nutritional value analysis

Total Minerals (Ash): Total minerals were determined by AOAC Official Method 942.05. (AOAC, 2005), using furnace equipment Nabertherm (Germany); Raw fiber (CF): Determination by the method: Ankom Technology Method by Ankom device (A200). Lipids (EE): Determined by the method of AOAC Official Method 920.39, device use: SoxtecTM2055 (Foss, Sweden) (AOAC, 2005). The method for determination of crude protein (CP) was determined by AOAC Official Method 984.13, using the Buchi K-350 device; ADF: Determined by Ankom technology method (AOAC, 2005). Use Ankom device (A200) and moisture (dry matter) according to AOAC (1996), moisture in Animal Feed, Method 930.15. Use a Binder oven device. The total energy was estimated according to Nobllet and Perez, (1993).ME (kcal/kg) = 4194 – 9.2 x Ash + 1.0 x CP + 4.1 x EE – 3.5 x NDF. With, CP – Crude protein (%DM); EE – crude fat (%DM); Ash - Ash total (%DM); CF – crude fiber (%DM); NDF – Fiber insoluble in neutral detergent (% DM).

Table 2. Chemical composition of diets in phase I (60-105 days)

Diets	DM	CP	NDF	ADF	CF	EE	Ash	ME
1	88.43	19.00	7.51	7.01	5.17	4.27	4.50	4162.82
2	88.62	19.70	9.62	9.10	7.60	4.10	5.57	4145.60
3	88.64	19.49	10.54	10.04	9.52	4.00	6.05	4137.34
4	88.69	19.20	13.61	13.06	10.77	3.99	6.02	4126.54

Table 3. Chemical composition of diets in phase II (105-135 days)

Trials	DM	CP	NDF	ADF	CF	EE	Ash	ME
1	89.75	17.21	15.83	8.54	7.59	4.38	7.00	4109.36
2	89.66	18.17	15.92	9.49	8.89	4.32	7.86	4101.85
3	89.71	17.96	17.07	11.55	10.14	4.22	7.86	4097.21
4	89.60	17.90	18.17	11.74	11.70	4.23	8.02	4091.86

Note: *DM (%): Dry matters. CP (%DM): Crude protein. NDF (%DM): Neutral* detergent *fiber. ADF (%DM): acid detergent fiber. CF (%DM): crude fiber. EE (%DM):* crude *fat. Ash (%DM): A total of minerals. and ME* (Kcal/kg DM)

Table 4& 5. Experimental setting-up and diets

Trials	1	2	3	4		1	2	3	4
Pigs (n)	6	6	6	6	Diet (%)	100	90	85	80
Initial age (days)	60	60	60	60	Soybean meal (%)	0	2.5	2.5	2.5
Final age (days)	135	135	135	135	Fish meal (%)	0	2.5	2.5	2.5
Fiber powder (%)	0	5	10	15	Jute stem and leaf meal (%)	0	5	10	15
Slaughter pigs (n)	6	6	6	6	Total (%)	100	100	100	100
Fatty tissue (n)	6	6	6	6					

Blood samples

Blood samples were collected after weaning before the pigs were introduced to the experimental diets and at the end of the experiment. Blood is collected from the ear vein (large pigs) or neck veins (miniature) in the early morning before feeding to pigs. After collecting blood, it was quickly placed into an EDTA anticoagulation tube, shaken gently, and stored in a cold bottle at 2-8°C, Adnan et al. (2020). Technical analysis of blood cell parameters: Red blood cell count, white blood cell count, platelet count, Hb content, average haemoglobin, mean haemoglobin concentration, and red blood cell distribution. The platelet distribution was determined based on the impedance principle on the BC 2800 VET haematology analyzer system at Medlatec Hanoi Testing Center.

Statistical analysis

The data is recorded and saved using Excel 2019 software. Research data were processed by biological statistics on Minitab 20 program, comparing the difference with statistical significance with $P < 0.05$. The parameters mean (M), and standard deviation (m) is used in the report.

3. RESULTS

3.1. Effects of juice powder made from stock and leaf in the diet on growth performance

Table 6 shows that the average weight of pigs at final, pig weight in trials 1, 2, 3, and 4 are 87.33 ± 7.26; 79.17 ± 2.42; 79.92 ± 4.12; and 82.00 ± 6.16 kg/head, respectively however this difference is also no significantly ($P > 0.05$). However, FCR is an indicator of the economy. The smaller the FCR, the more efficient, because the fiber is much cheaper than others. Feed accounts for 65-70% of the cost of livestock production, so farmers need to underfeed conversion efficiency.

3.2. Effects of juice powder made from stock and leaves diets on performance

Table 7 shows the differences between slaughter weights of 4 trials, i.e. 87.33; 79.25; 79.92; and 82.00 kg/head for trials 1, 2, 3, and 4, respectively, and these values were no statistical differences. The area of loin muscle and thickness of the back fat in trial 1 was always higher than in the others. However, no statistically significant difference ($P > 0.05$) was reported. The results of the loin eye obtained, trails: 1; 2; 3, and 4 are 50.92 ± 2.67 cm^2, respectively; 50.24 ± 3.97 cm^2; 51.88 ± 5.41 cm^2 and 53.14 ± 6.65 cm^2. and backfat at different ribs were significant differences between trial 1, 2 and 3, 4, and 4 with $P < 0.05$.

Table 6. Growth parameters of experimental pigs

Trials	1 (n=6)	2 (n=6)	3 (n=6)	4 (n=6)	P-value
	M ± m	M ± m	M ± m	M ± m	
Initial weight (kg)	25.83 ± 1.92	24.00 ± 1.64	25.25 ± 3.63	25.58 ± 1.56	0.550
Final weight (kg)	87.33 ± 7.34	79.17 ± 2.42	79.92 ± 4.12	82.00 ± 6.16	0.062
Feeding period (d)	75	75	75	75	-
Feed intake (kg)	2.13	1.84	1.91	2.08	0.478
Daily gain (g/d)	820.00 ± 87.64	735.56 ± 19.17	728.89 ± 35.69	752.22 ± 66.19	0.052
FCR (kg)	2.62	2.50	2.62	2.79	0.175

Table 7. Performance of growing pigs

Variables/trails	1 (n = 6)	2 (n=6)	3 (n=6)	4 (n=3)	P-value
	M ± m	M ± m	M ± m	M ± m	
Final live weight (kg)	87.33 ± 8.50	79.25 ± 2.44	79.92 ± 4.12	82.00 ± 6.16	0.172
Carcass (kg/head)	65.99 ± 6.48	60.71 ± 2.18	60.13 ± 2.05	62.27 ± 3.92	0.132
Carcass rate (%)	75.48 ± 0.48	76.67 ± 0.49	75.34 ± 2.90	76.03 ± 2.30	0.692
Meat Length (cm)	84.33 ± 5.13	84.67 ± 1.51	84.00 ± 4.60	84.67 ± 1.63	0.982
Wide front body (cm)	38.00 ± 1.73	36.50 ± 1.57	35.67 ± 3.01	37.00 ± 0.89	0.442
Wide the behind body (cm)	35.53 ± 0.58	33.50 ± 2.51	32.17 ± 2.71	33.67 ± 0.82	0.220
Loin eye (cm^2)	**50.92 ± 2.67^a**	**50.24 ± 3.97^a**	**51.88 ± 5.41^b**	**53.14± 6.65^c**	**0.048**
Lean meat weight (kg)	39.08 ± 5.34	37.75 ± 3.36	37.46 ± 2.57	38.69 ± 2.89	0.865
Lean meat rate (%)	**59.06 ± 2.30^a**	**62.20 ± 5.36^b**	**62.28 ± 3.37^b**	**62.15 ± 2.95^c**	**0.043**
Backfat Rib. 6-7 (cm)	**1.64^a ± 0.37**	**1.38^b ± 0.32**	**1.24^b ± 0.21**	**1.21^c ± 0.46**	**0.039**
Backfat Rib.10-11 (cm)	**1.71^a ± 0.26**	**1.18 ± 0.41^b**	**1.05 ± 0.41^b**	**1.00^c ± 0.25**	**0.045**
Backfat Rib.13-14 (cm)	**1.88^a ± 0.37**	**0.92^b ± 0.44**	**1.10^c ± 0.50**	**0.88^d ± 0.24**	**0.046**

Means marked with letters $^{a,b,c,\text{ and } d}$ in each row are statistical differences ($P < 0.05$).

3.3. Effects of jute powder made from the stem and leaf in food on meat quality

Sensory properties of meat quality

Pork quality was assessed by the meat's color, tenderness, and elasticity immediately after slaughter. The scale selected for the sensory evaluation of meat is 1 to 5 points. Results of the sensory evaluation of meat quality are presented in Table 8.

The obtained sensory evaluation results are presented in Table 8 and revealed that the color, tenderness, and elasticity of meat between the trials increased from trials: 1 to 4. Specifically, meat color increased, respectively, 3.83; 4.00; 4.25; 4.67 but no statistically significant difference ($p < 0.05$). Tenderness and elasticity of meat after slaughter are important sensory indicators to assess water retention and meat toughness. Meat tenderness in the experiment had the highest statistically significant differences($p < 0.05$) in trial 4 with an average of 4.60 points, followed by trials 3, 2, and 1 with average scores of 4.25, 4.17, and 4.00. The elasticity of meat tends to increase gradually in the trials, and this difference is significant ($P < 0.05$); the results obtained in trials: 1; 2; 3; and 4 are 3.90, 4.00, 4.17, and 4.67, respectively.

Table 8. Sensory evaluation of experimental pork quality

Variables/Trials	1 (Control) (n=6)	2 (n=6)	3 (n=6)	4 (n=6)	P-value
Color	$3.83^{a} \pm 0.29$	$4.00^{b} \pm 0.55$	$4.25^{c} \pm 0.69$	$4.67^{d} \pm 0.38$	0.013
Tenderness	$4.00^{b} \pm 0.50$	$4.17^{ab} \pm 0.26$	$4.25^{ab} \pm 0.27$	$4.60^{a} \pm 0.22$	0.034
Elasticity	$3.90^{b} \pm 0.17$	$4.00^{b} \pm 0.32$	$4.17^{b} \pm 0.26$	$4.67^{a} \pm 0.26$	0.001

Means marked with letters a,b,c, and d in each row are statistical differences ($P < 0.05$).

Thus the results of color, tenderness, and meat toughness through objective assessment gave good results. The meat had a fresher color, softer, and had better elasticity in the jute meal trials.

Indicators of fatty acids in fat

The results in Table 9 show the ratio of unsaturated fatty acids/total fatty acids in trials: 1; 2; 3; and 4 were 66.95%; 66.35%; 63.29%, and the highest was 68.61%. The results showed no significant difference between the groups but for GLA and LA, with $P < 0.01$; for ALA and EPA ($p > 0.05$). Results obtained for ALA in trials: 1; 2; 3; and 4 are 1.01; 0.98; 0.86, and 0.88 g/100g fat; these results were lower than the results of Nguyenet al. (2004) in the diets supplemented with morning glory and sweet potato by 1.33 and 1.37. However, EPA in trials 2 and 3 had better results than in trials: 1 and 4, the results in trial 2 respectively; 3 is 0.039 g/100g fat; 0.031 g/100g fat, and trials 1; 4 had the same result of 0.017 g/100g fat; while Nguyen at el. (2004), reported that no EPA was detected when adding spinach and sweet potato, there were significant differences ($P < 0.01$) in DHA composition in trials 2 and 3 of 0.119 and 0.107 g/100g of fat, which was higher than that of trials: 1 and 4 were 0.043 and 0.055 g/100g fat. Our results on DHA are higher than those of Nguyen et al. (2004) when water spinach in the diet is 0.22, and sweet leaf is 0.17.

Table 9. Results of analysis of fatty acid composition in fat

Variables/Trials	UI	Trial 1 (M ± m)	Trial 2 (M ± m)	Trial 3 (M ± m)	Trial 4 (M ± m)	P-value
Total fatty acid	g/100 fat	**$94.50^{a} \pm 1.05$**	**$95.75^{a} \pm 1.19$**	**$95.67^{a} \pm 0.43$**	**$74.77^{b} \pm 4.25$**	**0.000**
Total Saturated fatty acids		**$30.53^{ab} \pm 1.19$**	**$32.25^{ab} \pm 1.04$**	**$35.12^{a} \pm 2.22$**	**$22.88^{c} \pm 2.11$**	**0.000**
Unsaturated fatty acid		**$63.27^{a} \pm 0.91$**	**$63.53^{a} \pm 1.59$**	**$60.55^{a} \pm 1.97$**	**$51.30^{b} \pm 2.66$**	**0.000**
Stearic acid (C18:0)		**$8.987^{ab} \pm 0.75$**	**$8.422^{ab} \pm 0.61$**	**$10.107^{a} \pm 1.66$**	**$6.870^{b} \pm 0.93$**	**0.001**
Gamma Linoleic acid (C18:3 n-6)		**$0.081^{a} \pm 0.01$**	**$0.068^{a} \pm 0.01$**	**$0.053^{b} \pm 0.01$**	**$0.050^{b} \pm 0.01$**	**0.000**
Linoleic acid (LA) (C18:2 n-6)		**$24.467^{a} \pm 1.03$**	**$23.417^{a} \pm 1.09$**	**$21.050^{b} \pm 1.83$**	**$17.400^{c} \pm 1.24$**	**0.000**
Alpha Linolenic acid (ALA) (C18:3 n-3)		**1.01 ± 0.03**	**0.98 ± 0.05**	**0.86 ± 0.40**	**0.88 ± 0.06**	**0.049**
Eicosapentanoic acid (EPA) (C20:5 n-3)		**0.017 ± 0.01**	**0.039 ± 0.02**	**0.031 ± 0.010**	**0.017±0.01**	**0.034**
Docosahexaenoic acid (DHA) (C22:6 n-3)		**$0.043^{b} \pm 0.006$**	**$0.119^{a} \pm 0.02$**	**$0.107^{a} \pm 0.033$**	**$0.055^{b} \pm 0.01$**	**0.000**
Saturated fatty acids /Total of fatty acids (%)		66.95	66.35	63.29	68.61	-

Note: *Means marked with different letters ab in each row are statistically different ($P < 0.05$).*

PUFAs such as ALA, EPA, and DHA (Omega – 3) received the most research attention because of their positive effects on meat quality and animal health. Animals cannot synthesize the fatty acids ALA, EPA, and DHA independently, but they can obtain the short-chain from the diet and use it to synthesize the more critical long-chain omega-3 fatty acids, EPA and DHA, and then from EPA synthesize DHA. The results of the quantitative analysis of fatty acid compositions are presented in Table 9, and differences in total fatty acids, total unsaturated fatty acids, and total saturated fatty acids between experimental groups ($p < 0.001$). Results of unsaturated fatty acids in trials: 1; 2; 3, and 4 were 63.27; 63.53; 60.55, and 51.30 g/100g fat were consistently higher than saturated fatty acids in 1; 2; 3; and 4 were 30.53, respectively; 32.25; 35.12 and 22.88 g/100g fat. So, our analysis of fatty acid fractions in fat obtained good results.

The values obtained turn in trials 1; 2; 3; and 4 are 24.467; 23.417; 21.050 and 17.400 g/100g fat respectively; this means that gradually replacing jute flour levels in the diet will reduce LA content, so lard in lots can replace jute flour levels 5;10;15% is not soft and has better quality.

3.4. Effect of fiber powder made from stems and leaves in the ration on the haematological characteristics of pigs.

Blood is a fluid closely related to the organs in the body. Therefore, in terms of pathology, blood is affected not only by the disease of the hematopoietic organs but also by other organs in the body and the environment.

Erythrocytes

The study's results on the parameters of red blood cells at 60 and 135 days of age in experimental pigs are presented in Table 10. The research results on the blood physiological parameters of red blood cells in Table 10 showed an increasing trend at the end of the experiment, compared to the beginning feeding by fibrous diets, regarding the amount of erythrocyte concentration and decrease concerning erythrocyte distribution. The variation in erythrocyte numbers of pigs increasing gradually from 60 to 135 days of age is reasonable to meet the increasing demand for the transport capacity of nutrients and metabolic waste products. The number of erythrocytes at 60 and 135 days of age in trials: 1; 2; 3, and 4 have no significant difference ($P > 0.05$). The results of Erythrocytesshowed at 60 days of age: 6.30; 6.00; 6.70, and 5.75 in Table 10 were higher than the results of Nguyen and Dinh (2016) with crossbreeds (LD x MC -Mong Cai) x Duroc) for swine males and females are 5.52 and 5.08; (LD x MC) x (PE – Duroc), 5.38 and 4.92; at the end of the feeding at 135 days old, the results were obtained: 1; 2; 3, and 4 were 7.14; 7.02; 6.69 and 6.82, the same results of Nguyen and Dinh (2016) on (LD x MC) x Duroc), 7.50 for swine males and 7.12 for females; while (LD x MC) x (PE x Duroc), 7.62 for males and 7.02 for females, other results of Tran et al. (2013), with a local breed were 5.01 at 60 days of age and 5.51 at 120 days of age, there were indicated byOluwole and Omitogun (2016). Our haemoglobin results at the beginning and end of the experiment were within the normal reference range of 9.9-16.5 (Table 10). The amount of haemoglobin in the experiments: trials 1, 2, 3, and 4 were increased at 135 days of age compared with 60 days of age, compared with those studied on (LD x MC) x Duroc) of Nguyen and Dinh (2016)was 10.15 for swine males and 9.49 for females, with (LD x MC) x (PE x Duroc) being 10.36 for males and 9.87 for females. At 135 days old, the results obtained in trials 1, 2, 3, and 4 were 11.97, 12.10, 11.58 and 11.70, respectively, which were lower than the results of Nguyen and Dinh (2016) in breeds (LD x MC) x Duroc, which was 13.27 and 12.37 for swine males and females, respectively. A study by Nguyen and Dinh (2016) suggested that the red blood cell count and haemoglobin decreased in the case of animals suffering from anaemia, poor nutrition and infection.

The mean volume of erythrocytes at 60 days of age had no significant differences in trials 1, 2, 3 and 4 ($P > 0.05$) (Table 10), but at 135 days of age, there was a statistically significant difference ($P < 0.05$) (table 10) (Nandagopalanet al. 2015; Kaushik et al. 2015). The results obtained at 60 days of age in plots 1, 2, 3, and 4 were 51.00, 49.85, 51.40 and 53.43, respectively (Table 10), which were lower than the results at 60 days, Nguyen and Dinh (2016). At 135 days old, the results obtained in trials 1, 2, 3, and 4 were 53.63, 57.02, 56.67, and 58.35, respectively, which were higher than the results at 120 days of age, and with crossbreeds (LD x Mong Cai) x Duroc), which were 48.17 for males and 49.76 for females, and another crossbreed (LD x MC) x (PE x Duroc) was 42.35 for swine males and 46.78 for females. The results increased from 60 - 135 days of age, different from the results from the above study, which decreased from 60-120 days of age, and the results obtained at 60 days of age in treatments 1, 2, 3, and 4 were 32.07, 29.87, 34.38 and 30.70, respectively.

Table 10. Variables of blood red cells

Variables	Days	Trial 1 M ± m	Trail 2 M ± m	Trail 3 M ± m	Trail 4 M ± m	P-value
Red blood cells (T/L)	60	6.30 ± 0.47	6.00 ± 1.34	6.70 ± 0.33	5.75 ± 0.34	0.183
	135	7.14 ± 0.39	7.02 ± 0.47	6.69 ± 0.38	6.82 ± 0.31	0.231
Hob (g/ld.)	60	10.72 ± 0.97	8.42 ± 2.56	9.52 ± 0.93	9.70 ± 0.87	0.105
	135	11.97 ± 1.13	12.10 ± 1.09	11.58 ± 0.70	11.70 ± 0.46	0.736
HCT (%)	60	32.07 ± 2.41	29.87 ± 7.74	34.38 ± 3.23	30.70 ± 2.37	0.356
	135	38.12 ± 2.32	39.93 ± 3.07	37.85 ± 2.30	39.72 ± 1.32	0.314
Hob-MCV (FL)	60	51.00 ± 1.33	49.85 ± 5.44	51.40 ± 4.56	53.43 ± 3.25	0.481
	135	**53.63^{b} ± 1.51**	**57.02^{a} ± 2.63**	**56.67^{a} ± 1.33**	**58.35^{a} ± 0.81**	**0.001**
Hob– MCH (pg.)	**60**	**16.95^{a} ± 0.78**	**13.87^{b} ± 2.17**	**14.17^{b} ± 1.30**	**16.80^{a} ± 1.08**	**0.001**
	135	16.70 ± 1.11	17.67 ± 1.00	17.67 ± 0.60	17.12 ± 0.37	0.155
Hob– MCHC (g/ld.)	**60**	**33.37^{a} ± 1.36**	**27.80^{b} ± 1.67**	**27.62^{b} ± 0.44**	**31.53^{a} ± 0.68**	**0.000**
	135	**31.30^{a} ± 1.67**	**30.68^{ab} ± 1.08**	**31.15^{ab} ± 1.05**	**29.40^{b} ± 0.44**	**0.038**
RDW- CV (%)	60	18.12 ± 1.07	20.72 ± 1.98	19.48 ± 1.94	18.73 ± 1.87	0.095
	135	18.03^{ab} ± 1.41	17.32^{ab} ± 0.82	18.67^{a} ± 0.59	16.80^{b} ± 0.55	0.011

All mean values are marked by letters in the same rows with P <0.05.

The average amount of haemoglobin at 60 days of age had statistically significant differences in trials 1, 2, 3, and 4 ($P < 0.05$); however, at 135 days of age, there was no statistically significant difference ($P > 0.05$). The results obtained at 60 days of age in plots 1, 2, 3, and 4 were 16.95, respectively; 13.87, 14.17, and 16.80 (table 10) were lower than the results at 60 days of age resulting from Nguyen and Dinh (2016) for (LD x MC) x Duroc), which was 18.47 and 18.76 for swine males and females, respectively, while (LD x MC) x (PE x Duroc) was 19.35 and 20.10 for males and females, respectively. At 135 days old, the results obtained in batches 1. 2, 3, and 4 were 16.70, 17.67, 17.67, and 17.12, respectively (table 10). The same results at 120 days of the age of Nguyen and Dinh (2016) on (LD x MC) x Duroc) were 17.714 for males and 17.40 for females, resulting in Kho et al. (2019); (Sim and Nyam 2019); Rezaie et al. (2015). Slaughter at 135 days old, the results obtained in trials 1, 2, 3, and 4 were 31.30, 30.68, 31.15, and 29.40, respectively (Table 10), which were lower than the results at 120 days, (Nguyen and Dinh 2016), with (LD x MC) x Duroc) being 36.93 for males and 35.01 for females, while crossbreed (LD x MC) x (PE x Duroc) was 43.78 for males and 37.97 for females.

Platelets parameters

The changes in platelet parameters of these experimental pigs are presented in Table 11. The number of platelets at 60 days of age in trials 1, 2, 3, and 4 was 516.17, 352.33, 421.50, and 393.20, respectively, and at 135 days of age, the number of platelets decreased to 368.67, 390.50 and 333.83, respectively. Only in trial 2 did the platelet number increase up to 359.50. Mean platelet volumes at 60 days of age were 8.45, 8.17, 8.27, and 7.92, but until 135 days of age, the results obtained in the experimental trials changed and decreased for trials 1 and 3, 8.07 and 7.92 but increased in trials 2 and 4, 8.52 and 8.65, respectively.

Table 11.*Variable of pig small white cells*

Variables	Days	Trial 1 M ± m	Trail 2 M ± m	Trail 3 M ± m	Trail 4 M ± m	P-value
PLT (G/L)	60	516.17 ± 98.74	352.33 ± 138.15	421.50 ± 100.20	393.20 ± 212.40	0.257
	135	368.67 ± 75.65	359.50 ± 140.13	390.50 ± 81.37	337.83 ± 21.44	0.788
TC (MPV) (f/L)	60	8.45 ± 0.74	8.17 ± 0.90	8.27 ± 0.59	7.92 ± 0.62	0.642
	135	8.07 ± 0.28	8.52 ± 0.72	7.92 ± 0.34	8.65 ± 0.63	0.075
PCT (%)	60	0.44 ± 0.11	0.29 ± 0.12	0.35 ± 0.08	0.28 ± 0.20	0.180
	135	0.30 ± 0.06	0.30 ± 0.11	0.31 ± 0.06	0.29 ± 0.03	0.982

PDW (%)	60	15.67 ± 0.31	15.40±0.42	15.87 ±0.52	16.05 ± 0.42	0.084
	135	15.23 ± 2.58	16.23 ± 0.38	16.20 ± 0.21	16.50 ± 0.17	0.381

White blood cells

The results in Table 12 show that our white blood cell counts at the beginning and end of the experiment were within the normal reference range (11.0 - 22.0). The white blood cell count (G/L) at 60 days of age and 135 days of age in trials 1, 2, 3, and 4 showed no statistically significant differences (P > 0.05). However the number of white blood cells in trial 1 was decreased, while white blood cells in trials 2, 3, and 4 were increased, but this fluctuation was normal. The results obtained at 60 days of age in trials 1, 2, 3, and 4 were 22.33, 14.95, 18.28, and 15.32, respectively, which were equivalent to the results of pigs at 60 days of age from (LD x MC) x Duroc), which were 17.20 and 16.92 for males and females, respectively, and from (LD x MC) x (PE x Duroc), which were 17.71 and 15.56 for swine males and females, respectively. At 135 days old, the results obtained in batches 1; 2, 3, and 4 were 17.70 ± 1.90, 19.43 ± 2.42, 20.52 ± 6.59, and 16.31 ± 3.37, respectively.

T**able 12.** Variables of white cells.

Variables	Days	Trial 1 M ± m	Trail 2 M ± m	Trail 3 M ± m	Trail 4 M ± m	**P-value**
(G/L)	60	22.33 ± 7.86	14.95 ±5.39	18.28 ±3.93	15.32 ± 6.38	0.161
	135	17.70 ± 1.90	19.43 ± 2.42	20.52 ± 6.59	16.31 ± 3.37	0.306

4. DISCUSSIONS

4.1. Growth performance and FCR

The weight gain was not different between the trials with (P > 0.05), as trial 3 increased by 728.89; trial 2 increased by 735.56; trial 4 increased by 752.22; while trial 1 had the highest increase with 820.00 g/head/day, comparations with the research results of Hoang et al. (2021) of 812.2 g/head/day at 120 days of age. While the increase in dietary fiber resulted in a reduction in feed intake but still good weight gain in this study. There are measures to improve the feed gives a better feed efficiency. conversion ratios in the experiment, having good results with FCR from 2.5 to 2.79. Compared with the research results of Hoang et al. (2021) and (Nguyen and Dinh 2016), There was no statistically significant difference in the feed conversion coefficient in the experimental groups as well (P > 0.05), (Atta et al.2017; Pu et al. 2022). The lowest obtained result trial 2 with FCR = 2.50; while 1 and 3 with FCR = 2.62; trial 4 with FCR = 2.79, was higher than others. The results show that if jute powder is added also

Trial	Weight Gain (g/head/day)	FCR
1	820.00	2.62
2	735.56	2.50
3	728.89	2.62
4	752.22	2.79

4.2. Meat quality and fat composition

Carcass weight in trials: 1, 65.99 was higher than 2; 3; and 4, 60.71; 60.13; and 62.27kg, respectively.However, no significant (P > 0.05), (Nguyen and Nguyen 2019), because more fiber in the diets will be less than growth and carcass weight was less than, there also studies by Hoang et al. (2021) and Du et al. (2009) there were no significant differences as well, some other studies, Li et al. (2021) and Puet al. (2022). Back fat thickness at ribs: 6-7; 10-11; and 13-14 in the experimental trials: 1 was the highest at 1.64 cm, back fat thickness at rib: 6-7 and 10-11, and 13-14 of trials 2; 3; and 4 were equivalent, there was only in rib 6-7, 1.38; 1.24 and 1.21cm of trials 2, 3 and 4 a lower than other studies by Hoang et al. (2021); (Nguyen and Dinh 2016); and Du et al. (2009). These were various fiber diets, that impacted on the reduction of fat content in the carcass. Results on lean percentage in trials 1; 2; 3; and 4 were 59.06; 62.20; 62.28; and 62.15, respectively. The softness of lard has a great in, discussed with studies by Jarrett et al. (2018); Le Sciellour et al. (2018) for showing that the trails with a higher content of fiber influenced economic efficiency by feed cost. The softer the fat, the more difficult it is to process, reducing the value of the finished product and risk reducing the storage time (Hallenstvedtet al.2012; (National Pork Producers Council 2000). Research results by Apple et al. (2007) and Hassan et al. (2018) have shown that foods high in polyunsaturated fatty acids (PUFAs), especially linoleic acid, make lard soft. The results obtained in table 9 show that there is a difference (P < 0.05) for LA, Rosarioet al. (2022).Zhang et al. (2022). Research on beneficial fatty acids of lard has binteresting studies by Nguyen et al. (2004); Zhang et al. (2020); by adding 15% DM in pig diets from water spinach, and sweet potato, as some studies mentioned in fatty acid composition had been changed by adding various fiber contents into the swine diets, as Li et al. (2019); Chen et al. (2019). Feeding a higher fiber content in pig diets for a duration of 75 days, no supported growth rate and less than feed consumer, but feed cost reduced, and has improved the meat quality and fatty acid composition in adipose tissues, the trend of the meat quality reached a higher content of PUFAs and better color, softer, risk-reducing in-store time. The more important economic aspect of feed cost during the fattening of pigs. It should be an alternative dietary fiber composition for each growing stage and suitable fiber percentages to get better growth and feed coverall.

Trial	Carcass Weight (kg)	Back Fat Thickness (cm)	Lean Percentage (%)	Linoleic Acid (LA)
1	65.99	6-7: 1.64	59.06	Significant (P < 0.05)
2	60.71	6-7: 1.38	62.20	Not significant
3	60.13	6-7: 1.24	62.28	Not significant
4	62.27	6-7: 1.21	62.15	Not significant

4.3. The haematological characteristics of pigs

Erythrocytes

The results of the study on the parameters of red blood cells at 60 and 135 days of age in experimental pigs are presented in Table 10. The research results on the blood physiological parameters of red blood cells in Table 10 showed an increasing trend at the end of the experiment, compared to the beginning feeding by fibrous diets, regarding the amount of erythrocyte concentration and decrease concerning erythrocyte distribution. The variation in erythrocyte numbers of pigs increasing gradually from 60 to 135 days of age is reasonable to meet the increasing demand for the transport capacity of nutrients and metabolic waste products. The number of erythrocytes at 60 and 135 days of age in trials: 1; 2; 3, and 4 have no significant difference (P > 0.05). The results of erythrocytes showed at 60 days of age: 6.30; 6.00; 6.70, and 5.75 in Table 10 were higher than the results of Nguyen and Dinh (2016) with crossbreeds (LD x MC - Mong Cai) x Duroc) for swine males and females are 5.52 and 5.08; (LD x MC) x (PE – Duroc), 5.38 and 4.92; at the end, the results were obtained: 1; 2; 3, and 4 were 7.14; 7.02; 6.69 and 6.82, the same results of Nguyen and Dinh (2016) on (LD x MC) x Duroc), 7.50 for swine males and 7.12 for females; while (LD x MC) x (PE x Duroc), 7.62 for males and 7.02 for females, other results of Tran et al. (2013), with a local breed were 5.01 at 60 days of age and 5.51 at 120 days of age, there were indicated by Oluwole and Omitogun (2016). The research of haemoglobin results at the beginning and end were within the normal reference range of 9.9-16.5 (Table 10). The amount of haemoglobin in the experiments: trials 1, 2, 3, and 4 were increased at 135 days of age compared with 60 days of age, compared with those studied on (LD x MC) x Duroc) of Nguyen and Dinh (2016) was 10.15 for swine males and 9.49 for females, with (LD x MC) x (PE x Duroc) being 10.36 for males and 9.87 for females. At 135 days old, the results obtained in trials 1, 2, 3, and 4 were 11.97, 12.10, 11.58 and 11.70, respectively, which were lower than the results of Nguyen and Dinh (2016) in breeds (LD x MC) x Duroc, which was 13.27 and 12.37 for swine males and females, respectively. A study by Nguyen and Dinh (2016) suggested that the red blood cell count and haemoglobin decreased in the case of animals suffering from anaemia, poor nutrition and infection. which were lower than the results at 120 days of age by Kho et al. (2019) and Chu et al. (2021). The white blood cell counts at 60 days of age in plots 2 and 4 is consistent with the study by Tran et al. (2013) on Co A Luoi pigs in Thua Thien Hue Province, which has been published father is 15.09. The results of batch 1 (DC) and batch 3 only give higher results. The results at 135 days of age in all of our experimental batches were 27.41 (table 10) lower than the results of Tran et al. (2013) published at 120 days of age and referred to by Islam et al. (2018) and (Kahar 2017).

The mean volume of erythrocytes at 60 days of age had no statistically significant differences in trials 1, 2, 3 and 4 (P > 0.05) (Table 10), but at 135 days of age, there was a statistically significant difference (P < 0.05) (Table 10) (Nandagopalan et al. 2015; Kaushik et al. 2015). The results obtained at 60 days of age in plots 1, 2, 3, and 4 were 51.00, 49.85, 51.40 and 53.43, respectively (Table 10), which were lower than the results at 60 days, Nguyen and Dinh (2016). At 135 days old, the results obtained in trials 1, 2, 3, and 4 were 53.63, 57.02, 56.67, and 58.35, respectively, which were higher than the results at 120 days of age, and with crossbreeds (LD x Mong Cai) x Duroc), which were 48.17 for males and 49.76 for females, and other crossbreeds (LD x MC) x (PE x Duroc) was 42.35 for swine males and 46.78 for females. The results increased from 60 - 135 days of age, different from the results from the above study, which decreased from 60-120 days of age, and the results obtained at 60 days of age in treatments 1, 2, 3, and 4 were 32.07, 29.87, 34.38 and 30.70, respectively. The average amount of haemoglobin at 60 days of age had statistically significant differences in trials 1, 2, 3, and 4 ($P < 0.05$); however, at 135 days of age, there was no statistically significant difference ($P > 0.05$). The results obtained at 60 days of age in plots 1, 2, 3, and 4 were 16.95, respectively; 13.87, 14.17, and 16.80 (table 10) were lower than the results at 60 days of age resulting from Nguyen and Dinh (2016) for (LD x MC) x Duroc), which was 18.47 and 18.76 for swine males and females, respectively, while (LD x MC) x (PE x Duroc) was 19.35 and 20.10 for males and females, respectively. At 135 days old, the results obtained in batches 1. 2, 3, and 4 were 16.70, 17.67, 17.67, and 17.12, respectively (table 10). The same results at 120 days of the age of Nguyen and Dinh (2016) on (LD x MC) x Duroc) were 17.714 for males and 17.40 for females, resulting in Kho et al. (2019); (Sim and Nyam 2019); Rezaie et al. (2015). Slaughter at 135 days old, the results obtained in trials 1, 2, 3, and 4 were 31.30, 30.68, 31.15, and 29.40, respectively (Table 10), which were lower than the results at 120 days, (Nguyen and Dinh 2016), with (LD x MC) x Duroc) being 36.93 for males and 35.01 for females, while crossbreed (LD x MC) x (PE x Duroc) was 43.78 for males and 37.97 for females.

Platelet parameters

Platelets are one of three types of blood cells in the animal body, and platelets are produced in the bone marrow and are very small in size. The primary function of platelets is to stop bleeding and help animals make the vessel walls supple and soft due to the function of rejuvenating endothelial cells. The changes in platelet parameters of these experimental pigs are presented in Table 11. The number of platelets at 60 days of age in trials 1, 2, 3, and 4 was 516.17, 352.33, 421.50, and 393.20, respectively, and at 135 days of age, the number of platelets decreased to 368.67, 390.50 and 333.83, respectively. Only in trial 2 did the platelet number increase up to 359.50. Mean platelet volumes at 60 days of age were 8.45, 8.17, 8.27, and 7.92, but until 135 days of age, the results obtained in the experimental trials changed and decreased for trials 1 and 3, 8.07 and 7.92 but increased in trials 2 and 4, 8.52 and 8.65, respectively. According to Nguyen and Nguyen (2019), the blood composition is changed by feeding, and Nguyen and Dinh (2016); Kho et al. (2019); Chu et al. (2021). The obtained results are higher than the results of studies published on native pigs in Dien Bien Province by Nguyen and Nguyen (2019), where the number of TCs was 330.8 ± 46.4, the mean volume TC was 4.53 ± 0.12, the TC volume was 0.16, and the TC distribution was 13.84 ± 0.23, and Adnan et al. (2020) and Ammar et al. (2020), also indicated an increase in platelets.

Blood while cells

The number of white blood cells in the blood increases abnormally, animal is affected by pathogenic factors, making the body respond by increasing the production of white blood cells to fight pathogens (Choe and Kim 2014). The results in Table 12 show that our white blood cell counts at the beginning and end of the experiment were within the normal reference range (11.0 - 22.0). The white blood cell count (G/L) at 60 days of age and 135 days of age in trials 1, 2, 3, and 4 showed no statistically significant differences ($P > 0.05$). However the number of white blood cells in trial 1 was decreased, while white blood cells in trials 2, 3, and 4 were increased, but this fluctuation was normal. The results obtained at 60 days of age in trials 1, 2, 3, and 4 were 22.33, 14.95, 18.28, and 15.32, respectively, which were equivalent to the results of pigs at 60 days of age from (LD x MC) x Duroc), which were 17.20 and 16.92 for males and females, respectively, and from (LD x MC) x (PE x Duroc), which were 17.71 and 15.56 for swine males and females, respectively. At 135 days old, the results obtained in batches 1; 2, 3, and 4 were 17.70 ± 1.90, 19.43 ± 2.42, 20.52 ± 6.59, and 16.31 ± 3.37, respectively, which were lower than the results at 120 days of age by Kho et al. (2019) and Chu et al. (2021). The white blood cell count at 60 days of age in plots 2 and 4 are consistent with the results of the study by Tran et al. (2013) on Co A Luoi pigs in Thua Thien Hue Province, which has been published father is 15.09. The results of batch 1 (DC) and batch 3 only give higher results.

The results at 135 days of age in all of our experimental batches were 27.41 (table 10) lower than the results of Tran et al. (2013) published at 120 days of age and referred to by Islam et al. (2018) and (Kahar 2017).

Ecomomic aspects

Economic efficiency is recorded in table 13 including total production cost, total revenue and profit. The reason for the different feed prices for experimental pigs is that the diets of pigs in the experimental batches are different. The meat quality of the experimental batches was better, so it was sold at a higher price of 60,000 VND/kg than the trial 1, sold for 52.000 VND/kg (based on the market price of live pigs in Thua Thien Hue at the end of the experiment). experiment). Our economic accounting results show that the profit of trial 1, 100%, then trial 2 with the substitution of 5% jute powder in the diet gives a profit of 171.10%, which is higher than 71.10%. compared with trial 1 and trial 3 with the replacement of 10% jute meal in the diet gave a profit of 163.47%, which was 63.47% higher than that of the control group and trial 4 with the replacement of 15% of jute powder in the diet, the profit obtained is 161.36% higher than that of trial 1, 61.36%.

CONCLUSION

Feeding growing pigs with more fiber *(Hibiscus cannabinus L.)* content, the growth performance was no difference, meat quality (carcass meat, fat content, PUFAs) trends better meat for consumers as fatty acid composition (Omega 3), and blood composition was changed, RDW - CV (%) increased by a higher fiber and the Hb – MCH (pg), Hb – MCHC (g/dL), MPV(f/L) decreased so MCH levels refer to the average amount of haemoglobin. MCH levels should increase the MCHC level, and MCH levels are the average amount of haemoglobin in each red blood cell. MCHC levels are the average weight of that haemoglobin based on the volume of red blood cells and healthy subjects. Both are a reflection of the health of the haemoglobin in the blood. They were also related to meat quality and color during processing. When replacement of fiber content in the diets, growing pigs has a better economic aspect. For up to 15% of pigs, the cost for each product and meat quality responsible for color, tenderness, and elasticity were much better. Market pork was much more attracted by consumers and a higher 161% beneficiary than control pigs.

Acknowledgments

All the authors contributed to each role of the research, and I am responsible for all steps of the experiments and writing the article. Thanks to the University's station, Dr. Le Duc Thao, head of the station, and all of the staff and students, faculty of Animal Husbandry's laboratory systems, and Hue University's research project to support, No. DHH 2021.105 to experiments and funding.

Conflict of interest: No

Disclaimer: Scientific manuscripts published in the European Chemical Bulletin are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

Authors's contribution*:* *Bui Van Loi* has plan, experimental monitoring, data analysis, first manuscript; *Phan Ba Thuy* responded to experimental monitoring and data collection, and feed mixture and blood analysis, and manuscript preparation; *Doan Truong Phuong Thu*, responded to plant of *Hibiscus cannabinus L* and cutting, making the feed and fiber supplied; *Hoang Dinh Trung* have data collection on field and farm, analysis and writing some parts; *Nguyen Quang Linh* responded in all of steps, research strategy, experimental design, editing, submission

REFERENCES

1. Adnan M, Obyedul Kalam Azad M, Madhusudhan A, Saravanakumar K, Hu X, Wang MH, Ha CD. Simple and cleaner system of silver nanoparticle synthesis using kenaf seed and revealing its anticancer and antimicrobial potential. *Nanotechnology.* 2020 April; 31(26):265101. DOI: 10.1088/ 1361-6528/ ab7d72
2. Adnan M, Oh KK, Azad MOK, Shin MH, Wang MH, Cho DH. Kenaf *(Hibiscus cannabinus L.)* leaves and seed as a potential source of the bioactive compounds: effects of various extraction solvents on biological properties. *Life (Basel). 2020 September;* 10 (223), 1–16. *doi.org/10.3390/life10100223*
3. Agyekum AK, Nyachoti CM. Nutritional and Metabolic Consequences of Feeding High-Fiber Diets to Swine: A Review.

Engineering. 2017 October;3(5): 716-725. doi.org/10.1016/J.ENG.2017.03.010.

4. Ammar H, Yosra I, Mohamed AL, María LT, Rau ́l B, Francisco JG, Abdelfattah ZMS, Secundino L. Biomass production and nutritive value of Kenaf (*Hibiscus cannabinus*) at various stages of growth. *Agroforest Syst* 94, 1171–1178 (2020).DOI: *10.1007/s10457-019-00420-5*
5. Association of Official Analysis Chemists (AOAC). *Official method of analysis of the association of official analytical of chemist*. Arlington (U.S.): The Association of Official Analytical Chemists, Inc; 2005. https://www.aoac.org/official-methods-of-analysis
6. Chen Y, Wang Z, Ding J, Ming D, Wang W, Jiang Z, Liu L, Wang F. Effects of dietary fiber content and different fiber-rich ingredients other endogenous loss of fat and fatty acids in growing pigs. *J Animal Sci Biotechnol. 2019 June;* 10: 42. https://doi.org/10.1186/s40104-019-0348-3
7. Chia, S. Y., Tanga, C. M., Osuga, I. M., Alaru, A. O., Mwangi, D. M., Githinji, M., ... & Dicke, M. (2019). Effect of dietary replacement of fishmeal by insect meal on growth performance, blood profiles and economics of growing pigs in Kenya. Animals, 9(10), 705. https://doi.org/ 10.3390/ani9100705
8. Choe JH, Kim BC. Association of blood glucose, blood lactate, serum cortisol levels, muscle metabolites, muscle fiber type composition, and pork quality traits. *Meat Sci.* 2014 June; 97 (2): 137–142. DOI: 10.1016/j.meatsci.2014.01.024
9. Chu CC, Chew SC, Nyam KL. Recent advances in encapsulation technologies of kenaf (*Hibiscus cannabinus*) leaves and seeds for cosmeceutical application. *Food Bioprod. Process.* 2021 May; 127; 99–113. DOI: 10.1016/j.fbp.2021.02.009
10. Coelho, D., Alfaia, C. M., Lopes, P. A., Pestana, J. M., Costa, M. M., Pinto, R. M., ... & Prates, J. A. (2022). Impact of Chlorella vulgaris as feed ingredient and carbohydrases on the health status and hepatic lipid metabolism of finishing pigs. Research in Veterinary Science, 144, 44-53. https://doi.org/10.1016/j.rvsc.2022.01.008
11. Du TH, Nguyen QL, Everts H, Beynen AC. Ileal and total tract digestibility in growing pigs fed cassava root meal and rice bran with the inclusion of cassava leaves, sweet potato vine, duckweed, and stylosanthes foliage. *Livestock Research for Rural Development.* 2009 January; 21 (1). *http://www.lrrd. org/lrrd21/1/hang21012.htm*
12. Du, J., Zhao, Y., Wang, Y., Xie, M., Wang, R., Liu, N., ... & Qi, J. (2022). Growth, carcase characteristics, meat quality, nutrient digestibility and immune function of broilers fed with enzymatically treated or raw dandelion (taraxacum mongolicum hand.-mazz.). Italian Journal of Animal Science, 21(1), 1117-1125. https://doi.org/ 10.1080/1828051X.2022.2096488
13. Hassan KM, Bhuyan MI, Islam MK, Hoque MF, Monirul M. Performance of some jute & allied fiber varieties in the southern part of Bangladesh. *International Journal of Advanced Geosciences*. 2018 March; 6(1), 117–121. DOI:10.14419/ijag.v6i1.10184
14. Hoang TM, Le DP, Nguyen XB, Van NP, Phan VH, Nguyen DTK, Tran TH, Pham HSH, Nguyen MH, Ho LQC. Reproductive performance of GF24 sows x GF337, GF280, GF399 board in Central Vietnam. *Hue Univ. J. Sci. Agric. Rural Dev.* 2019 June;128 (3C):37-49. DOI: 10.26459/hueuni-jard.v128i3C.5279
15. Jarrett S, Ashworth C. The role of dietary fibre in pig production, with a particular emphasis on reproduction. *J Animal Sci Biotechnol. 2018 August;* **9**:59. DOI: 10.1186/ zs40104-018-0270-0
16. Kahar SP. Rheometry of Roselle (*Hibiscus sabdariffa* L.) seed oil. *Int. J. Pure Appl. Biosci.* 2017 April; 5(2): 987–993, DOI: 10.18782/2320-7051.2846
17. Karma BR, Chavan UD, Nimbalkar CA, Kahar SP. Rheometry of Roselle (Hibiscus sabdariffa L.) Seed Oil. *International Journal of Pure and Applied Bioscience*. 2017 April; 5(2), 987–993. DOI: org/10.18782/2320-7051.2846
18. Kaushik P, Dowling K, Barrow CJ, Adhikari B. Microencapsulation of omega-3 fatty acids: A review of microencapsulation and characterization methods. *Journal of Functional Foods*. 2015 December; 19, 868–881. DOI.org/10.1016/j.jff.2014.06.029
19. Kho K, Sim YY, Nyam KL. Antioxidant activities of tea prepared from kenaf (*Hibiscus cannabinus* L. KR9) leaves at different maturity stages. *J. Food Meas. Charact.* 2019 April; 13(3):2009–2016, DOI: 10.1007/s11694-019-00121-8
20. Kim, D., Min, Y., Suminda, G. G. D., Hur, C. G., Lee, S. C., Lee, H. K., ... & Lee, D. S. (2022). Bacillus-supplemented diet improves growth performance in Jeju native pigs by

modulating myogenesis and adipogenesis. Animal Biotechnology, 1-13. https://doi.org/10.1080/10495398.2022.2047996

21. Le Sciellour M, Labussière E, Zemb O, Renaudeau D. Effect of dietary fiber content on nutrient digestibility and fecal microbiota composition in growing-finishing pigs. *PLoS ONE*. 2018 May; 13(10): e0206159. https://doi.org/10.1371/journal.pone.0206159
22. Li H, Yin J, Tan B, Chen J, Zhang H, Li Z, Ma X. Physiological function and application of dietary fiber in pig nutrition: A review. *Anim Nutr*. 2021 June; 7(2): 259–267. DOI: 10.1016/ j.aninu. 2020. 11.011
23. Li Z, Xu B, Lu Z, Wang Y. Effects of long-chain fatty acid supplementation on the growth performance of grower and finisher pigs: a meta-analysis. *J Animal Sci Biotechnol. 2019 August;* 10:65. https://doi.org/10.1186/s40104-019-0374-1
24. Lin, Y., Yu, C., Ma, Z., Che, L., Feng, B., Fang, Z., ... & Wu, D. (2022). Effects of Yeast Culture Supplementation in Wheat–Rice-Based Diet on Growth Performance, Meat Quality, and Gut Microbiota of Growing–Finishing Pigs. Animals, 12(17), 2177. https://doi.org/10.3390/ani12172177
25. Liu Y. Fatty acids, inflammation, and intestinal health in pigs. Journal of Animal Science and Biotechnology. 2015 September; volume 6, 41 (2015). DOI 10. 1186/s40104-015-0040-1
26. Lonergan SM, Huff-Lonergan E, Rowe LJ, Kuhlers DL, Jungst SB. Selection for lean growth efficiency in Duroc pigs influences pork quality. *J Anim Sci*. 2001 Aug;79 (8):2075-85. DOI: 10.2527/2001.7982075x
27. Ministry of Agriculture and Rural Development. TCVN 3899-84. Slaughter Technology for pigmeat survey. Proceedings. Vol. V. ISO Vietnam: 1: Livestock and Veterinary. 2003. Retrieved from *https://thuvienphapluat.vn/TCVN/Nong-nghiep/Tieu-chuan-Viet-Nam-TCVN-3899-1984-lon-giong-quy-trinh-mo-khao-sat-pham-chat 900708.aspx*
28. Nandagopalan D, Johnson V, Gritto MA. GC-MS analysis of bioactive components of the methanol extract of *Hibiscus tiliaceus* Linn. *Asian J. Plant Sci.* 2015; *Res.*, 5: 6–10. https://www. imedpub. com/ articles/gcms-analysis-of-bioactive-components-of-the-methanol-extract-of-hibiscus-tiliaceus-linn.pdf
29. National Pork Producers Council. *Pork composition and quality assessment procedures*. Edited by Eric Berg; published by National Pork Producers Council, Des Moines, Iowa, 515:223-260. 2000. https://porkgateway.org/wp-content/uploads/2015/07/pork-composition-and-quality-assessment-procedures.pdf
30. Nguyen LQ, Everts H, Hue HT, Beynen CA. Feeding of Spinach or Sweet-potato leaves and growth performance of growing pigs kept on smallholder farms in Central Vietnam. *Tropical Animal Health and Production.* 2004 November; 36, 815–822. https://doi.org/10.1023/B:TROP.0000045958.84521.ab
31. Nguyen TN, Pham THP, Ngo QT. *Textbook of diagnosis of livestock and poultry diseases.* Agricultural publisher. 2016.
32. Nguyen TTV, Dinh VD. Study in blood variables of two crossbreeds (Landrace × Mong Cai Local) × Duroc and (Landrace × Mong Cai Local) × (Piétrain × Duroc) in Phong Dien, Thua Thien Hue. *Scientific Journal of Ho Chi Minh City University of Education*. 2016 May; 12(90).*https:// vjol.info. vn/index.php/sphcm/article/view/26563*
33. Nguyen VT, Nguyen TKL. The changes of blood variables of local pigs infected by lungworms in Dien Bien, Vietnam. *TNU Journal of Science and Technology. 2019 October;* 207(14): 143–148. *https://vjol. info.vn/index.php/tnu/article/view/45983*
34. Nobllet J, Perez JM. Prediction of digestibility of nutrients and energy values of pig diets from chemical analysis. *Journal of Animal Science*. 1993 December*;* 71(12): 3389-98. DOI: 10.2527/1993.71123389x
35. Oluwole OO, Omitogun GO. Haematological traits of Nigerian indigenous Pig and its hybrid (50% Large White x 50 NIP) at post weaning ages. *Am. J. Mol. Biol.* 2016 January; 06(01): 45–52, DOI: 10.4236/ ajmb.2016.61005
36. Park, S. O., & Seo, K. H. (2023). Digital livestock systems and probiotic mixtures can improve the growth performance of swine by enhancing immune function, cecal bacteria, short-chain fatty acid, and nutrient digestibility. Frontiers in Veterinary Science, 10. https://doi.org/10.3389/fvets.2023.1126064
37. Pu G, Hou L, Du T, Wang B, Liu H, Li K, Niu P, Zhou W, Huang R, Li P. Effects of short-term feeding with high fiber diets on growth, utilization of dietary fiber, and microbiota in pigs. *Front. Microbiol*. 2022 July; 13:963917. DOI: 10.3389/fmicb. 2022.

963917

38. Rezaie M, Farhoosh R, Iranshahi M, Sharif A, Golmohamadzadeh S. Ultrasonic-assisted extraction of antioxidative compounds from Bene (*Pistacia Atlantica* subsp. *mutica*) hull using various solvents of different physicochemical properties. *Food Chem*. 2015 April; 173:577–583. doi.org/10.1016/ j. foodchem.2014.10.081
39. Rosario M, Cristina M, Ana GMG., María López-J., J. P, Consolación, M, Francisco, B., Jesus M. P. (2022). Bioavailability and biotransformation of linolenic acid from basil seed oil as a novel source of omega-3 fatty acids tested on a rat experimental model. ***Food Funct.*** 2022 June; **13**:7614-7628, DOI: 10.1039/d2fo00672c
40. Sim YY, Nyam KL. Effect of different drying methods on the physical properties and antioxidant activities of *Hibiscus cannabinus* leaves. *J. Food Meas. Charact.* 2019 February; 13(2):1279–1286, DOI: 10.1007/s11694-019-00043-5
41. Tran ST, Nguyen TTV, Nguyen DH. Growth performance and some blood physiological parameters of wild pigs raised in A Luoi district, Thua Thien Hue province. *Hue University Journal of Science: Agriculture and Rural Development*. 2013 March; 70(1). https://doi.org/10.26459/jard.v79i1.3121
42. Vonapartis E, Aubin MP, Seguin P, Mustafa AF, Charron JB. Seed composition of ten induslothemp cultivars approved for production in Canada. *Journal of Food Composition and Analysis*. 2015 May; 39, 8–12. *doi.org/10.1016/j.jfca.2014.11.004*
43. Zhang H, Li X, Kang H, Peng X. Effect of tannic acid-grafted chitosan coating on the quality of fresh pork slices during cold storage. *Meat Sci*. 2022 June; 188, 108779. https://doi.org/10.1016/ j.meatsci. 2022. 108779.