RAIN HARVESTED WATER IS THE BEST ALTERNATE OF GROUND WATER FOR BROILER PRODUCTION

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ABSTRACT: This study was conducted at the University of Agriculture Peshawar, Pakistan during spring 2024, using 120-day old commercial broiler chicks. The chicks on the arrival were randomly divided into four groups of 30 chicks each, replicated three times with ten birds per replicate. Keeping feed and other parameters similar, chicks in the experimental groups were reared on four different water sources i.e., irrigation water, harvested rain water, tape water used for drinking on campus and spring water, to observe the effect of different water sources on the performance of broilers, weekly and overall feed intake, body weight gain, FCR and carcass dressing percentage, intestinal villi length and crypt depth. Required data was collected and analyzed for the results using the relevant tools. Data were analyzed through (CRD). ANOVA was used to find the mean and SE using Statistical software (8.1). P-value equal to 0.05 or <0.05 were considered significant. The means were separated by LSD (least significant difference). There was significant (P<0.05) decrease in feed intake of the birds provided with the rain water (3075.0±3.00 g) in comparison with other groups while the body weight gain was maximum (1811.00±2.08) in broilers offered with rain water. Provision of rain harvested water also improved significantly (P<0.05) the weekly and overall FCR (1.69^{d}±0.001), dressing percentage (70.75^{a}±0.14), intestinal villi height (0.896^{a}±0.04), decreased (0.249^{d}±0.01) villus crypt depth and overall economics of broiler production. This study revealed that provision of rain harvested water for drinking to broilers improved growth performance, FCR, dressing percentage, gut health and ultimately the economics of broilers production.

Key words: Drinking water, Rain harvested water, Broilers production, Growth performance.

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INTRODUCTION

Poultry play an important role in feeding human population in term of meat and eggs. With the increasing population the demand for meat will be doubled till 2050. Feed and water are the basic need of chicken to grow (Abbas, 2020). In word of changing global climate along with feed requirements, the future drinking water requirement of the growing poultry population will also be needed to consider to save water for human consumption.

Rainwater is natural resource and is rich in trace minerals, such as iron, zinc, and manganese, play a crucial role in maintaining and improving the gut health of broilers. These minerals are essential for various physiological functions, including enzyme activation, immune response, and gut barrier integrity (Batal & Parsons, 2002). When provided as drinking water the gut environment is optimized, promoting improved nutrient absorption and overall growth performance. As a result an increased growth rates and improved feed conversion ratios are observed in flocks offered with rain water. A study conducted by Erdogan et al. (2010) found that broilers reared with rainwater had a 4.5% higher body weight gain and a 5.3% better feed conversion ratio compared to those reared with tap water. Consequently, the use of rainwater for rearing broilers can result in higher economic returns for farmers due to reduced feeding costs and increased productivity.

On average 8000-9000 liters of drinking water is consumed for the production of only one thousand broilers. In Pakistan 1163 million broilers for annual produced (PPA, 2023) will be requiring 9500 million liter of water only for drinking and a similar amount for washing annually. Harvesting rainwater for broiler production reduces the reliance on ground water and municipal water sources, preserving these resources for other essential uses. Additionally, rainwater harvesting systems can be designed and implemented at a relatively low cost, providing long-term savings for farmers. Present project was therefore designed to find out the impact of rainwater on the growth performance of broilers so that future planning could be made for saving the ground water.

MATERIALS AND METHODS

Place of Study: Experiment was conducted in university poultry farm UAP. The laboratory work was performed in Pathology lab FAHVS, University of Agriculture Peshawar.

Birds Housing and Management: A total of 120 chicks were purchased from market. Strict bio security measures were taken. Proper temperature, humidity and ventilation were maintained to the optimum level. A 24 hours access to feed and water was ensured. Proper vaccination schedule was followed. Trail period was 35 days.

Layout of the experiment: Completely Randomized Design (CRD) was used. All chicks were randomly allocated into 4 groups. Each group had 3 replicates and each replicate had 10 chicks. There were 30 chicks per group. Group A was given irrigation water for drinking, Groups B, C and D were given rain harvested water, and Tape water and spring water for drinking. Feed and water was given ad-libitum.

Layout of Experiment

Groups	Source of water	Replicates		
		R1	R2	R3
A	Irrigation water	10	10	10
B	Rain water	10	10	10
C	Tape water	10	10	10
D	Spring water	10	10	10

Data Collection

Growth performance

A) Feed Intake: The birds received certain amount of diet on a regular basis. Feed refused was deducted from provided feed. The following formula were used to determine its value,

Daily feed intake = Feed provided – Feed denied

B) Weight gain: Body weight of each group was checked on weekly basis with the help of weighing balance. To find the body weight gain, weight on day 1st was subtracted from the weight on day 7 at every week. Following formula was used to determine weekly increase in the weight:

Weight gain = Weight at 7th day of week – weight at 1st day of week

C) FCR: Each week, FCR was determined by dividing the entire food ingested by weight gain.

FCR = Food consumed ÷ Weight gain

D) Dressing Percentage: Two broilers were chosen in each replicate, then slaughtered. The skin was detached afterward. Thigh, wings and breast were weigh up. To determine dressing %, we used formula mention below.

Dressing % = Carcass weight / Whole body weight x 100

GUT Histomorphology

A) Villus Height: When the experiment was completed, the bird feed was kept off feed overnight, to determine the villus height, two broilers were selected from every replicate. After slaughtering, 2 cm segment of ileum were cut out, washed with saline secure in ten percent formalin till more processing. Each segment then cutted in 2mm portion, putted on a slide, then colored with eosin and hematoxylin. Height of villi was taken. To take the measurements, image software was used.

B) Depth of the crypt (CD): CD was determined from villi and crypt junction to the base of crypt. It was determined by using software.

Economic of study: Economic evaluation was done by finding total income and total cost.

A) **Total Revenue:** Revenue were determined using formula given below:

Revenue = weight of the bird x market price per kg

B) **Profit:** Following formula was used for profit calculation.

Profit = Revenue – cost of feed + cost of water

Data Analysis: Microsoft Excel was used. Data were analyzed through (CRD). ANOVA was used to find the mean and SE using Statistical software (8.1). P-value equal to 0.05 or <0.05 were considered significant. The means were separated by LSD (least significant difference).

RESULTS AND DISCUSSION

This chapter shows the results and discussion of this experiment

Feed Intake: Table 4.1, shows the effect of drinking water sources on feed intake of broilers. The water

sources for drinking had a significant result on weekly and overall FI. In 2nd week highest (381.67g) feed consumed by group A. Group C (379.00g) and D (379.67g) consume same amount of feed statically. Lowest feed was taken by group B (369.00g). Similarly less feed was taken by group B (613.33g), followed by group C (620g), group D (624.33g) and group A (625.33g) in 3rd week. In 4th week maximum feed was consumed by group A (905g), followed by group D (901.33g), group C (897.67g) and group B (895.67g). However week 5 showed maximum feed intake in group A (1211.7g) as compared to group D (1204.7g), group C (1199g) and group B (1197g). Total feed intake was also significant with group A consuming more feed (3123.7g), followed by group D (3110g) and group C (3095.7g). Lowest feed (3075g) was taken by group B.

Table 1. Effect of drinking water source on feed intake (g) of broilers.

Groups	Weekly feed intake of broilers in grams				Total Feed intake
	WK II	WK III	WK IV	WK V	
A	$381.67^{c}\pm1.88$	$625.22^{a}\pm1.45$	$905.00^{a}\pm1.15$	$1211.7^{a}\pm0.88$	$3123.7^{a}\pm1.20$
B	$369.00^{a}\pm1.73$	$613.33^{d}\pm1.76$	$895.67^{d}\pm1.20$	$1197.0^{d}\pm1.15$	$3075.0^{d}\pm3.00$
C	$379.00^{b}\pm0.57$	$620.00^{c}\pm0.57$	$897.67^{c}\pm0.88$	$1199.0^{c}\pm0.57$	$3095.7^{c}\pm1.85$
D	$379.67^{b}\pm0.88$	$624.33^{b}\pm0.88$	$901.33^{b}\pm0.88$	$1204.7^{b}\pm1.20$	$3110.0^{b}\pm1.00$
P-value	0.0002	0.0006	0.0010	0.000	0.0000

Group A = Irrigations water B Rain water, Group C Tape water, Group D spring water. $^{A-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

Weight Gain: As shown in table 4.2 week wise and overall gain in weight of broiler was significantly impacted by the the drinking water source. In week two maximum weight was gained by group B (247.67g). Group C (240.67g) and D (240.33g) gain same amount of weight. Group A (239.00g) gain less weight as compare to others. However in 3rd week, group B (416g) gained highest weight as compared to group C (406.33g), group D (395g) and group A (392g). Similarly week four showed greater weight gain for group B (523.33g), followed by group C (518g), group D (511.67g) and group a (506.33g). Group B and group C (624g) gain more weight in week five than group D (619.67g) and group A (617g). Overall maximum weight was gained by group B (1811g), followed by group C (1789g) and D (1766.7g). Lowest total weight was gained by group A (1754g).

Feed Conversion Ratio: The impact of drinking water sources on weekly and overall FCR of broiler is presented in 4.3 Table. Overall and weekly FCR was significant by the different waters provided for drinking water. For all groups FCR were significant in 2nd week with group A has highest FCR (1.59), group C and D had same FCR (1.57), while group B (1.49) has lowest (good) FCR. During 3rd week FCR was found significant ($p<0.05$) with group B (1.47) have minimum FCR as compared to group C (1.52) while group D (1.58) and group A (1.59) had same FCR. FCR in 4rth week was also significant with group B (1.71) has better FCR, as compared to group C (1.73), D (1.76) and group A (1.78). During 5th week group B (1.91) and C (1.92) had same FCR in relation with group D (1.94) and group A (1.96). However, overall FCR was minimum (better) for group B (1.69), then group C (1.73), D (1.76). Group A (1.78) had highest overall FCR.

Dressing percentage: Table 4.4 demonstrate the mean effect of drinking water sources on dressing percentage of broilers. Water sources significantly ($p<0.05$) affect percentage of dressed body weight. Highest dressing percentage was recorded for group B (70.75%) as compared to group C (68.35%) and group D (66.40%). Minimum dressing percentage was noted for group A (64.57%).

Gut Histomorphology: Table 4.6 shows the significant effect of drinking water sources on intestinal morphology of broiler. There was a significant increase in Villi height and decrease in crypt depth. Highest villi height was calculated for Group B where rain water was used for drinking, followed by Group C and group D. Group A (control) had the shortest villus height among all groups. Crypt depth was also affected significantly, group B has short crypt depth, followed by group C, group D and group A. Villi height and crypt depth ratio was also significant with group B (3.59) had highest VH:CD followed by group C (3.30), group D (3.09) and group A (2.74). Histomorphology is shown in Figure no; 4.1, 4.2, 4.3, 4.4.

Economics: Table 4.6 demonstrated the effect of drinking water sources on economics of broilers. Water sources significantly affected gross return and net profit of broilers. Group B has more gross return and net profit in comparison with group C, group D and group A.

Table 2 . Effect of drinking water source on weight gain of broiler.

Groups	Weekly weight gain of broilers in grams				Total WG
	WK II	WK III	WK IV	WK V	
A	239.00^{c}±1.73	392.00^{d}±1.73	506.33^{d}±0.88	617.00^{c}±1.15	1754.3^{d}±0.33
B	247.67^{a}±1.20	416.00^{a}±1.52	523.33^{a}±1.20	624.00^{a}±2.51	1811.00^{a}±2.08
C	240.67^{b}±1.20	406.33^{b}±2.18	518.00^{b}±1.15	624.00^{a}±1.52	1789.00^{b}±0.57
D	240.33^{b}±0.66	395.00^{c}±1.15	511.67^{c}±1.20	619.67^{b}±0.88	1766.7^{c}±2.40
P-value	0.005	0.000	0.000	0.004	0.000

Group A = Irregationwater B Rain water, Group C Tape water , Group D spring water. $^{a-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

Table 3. Effect of drinking water source on FCR of broilers of broilers

Groups	Week wise FCR of broilers				Overall FCR
	WK II	WK III	WK IV	WK V	
A	1.59^{a}±0.01	1.59^{c}±0.35	1.78^{a}±0.001	1.96^{a}±0.03	1.78^{a}±0.03
B	1.49^{c}±0.05	1.47^{a}±0.04	1.71^{d}±0.10	1.91^{c}±0.04	1.69^{d}±0.001
C	1.57^{b}±0.01	1.52^{b}±0.03	1.73^{c}±0.09	1.92^{c}±0.04	1.73^{c}±0.01
D	1.57^{b}±0.01	1.58^{c}±0.04	1.76^{b}±0.3	1.94^{b}±0.02	1.76^{b}±0.004
P-value	0.000	0.000	0.000	0.000	0.000

Group A = Irregation water B Rain water, Group C Tape water, Group D spring water. $^{A-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

Table 4. Effect of drinking water source on on dressing percentage of broilers

GROUPS	DRESSING PERCENTAGE
A	64.57^{d}± 0.18
B	70.75^{a}±0.14
C	68.35^{b}±0.06
D	66.40^{c}±0.09
P-Value	0.000

Group A = irregation water B Rain water, Group C Tape water, Group D spring water. $^{A-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

Table 5. Effect of drinking water source on broiler intestinal morphology

Group	Villi Height (mm)	Villi Width (mm)	Crypt Depth (mm)	VH:CD
A	0.721^{d}±0.03	0.149^{d}±0.01	0.262^{a}±0.01	2.74^{d}±0.02
B	0.896^{a}±0.04	0.197^{a}±0.02	0.249^{d}±0.01	3.59^{a}±0.04
C	0.835^{b}±0.03	0.182^{b}±0.03	0.252^{c}±0.02	3.30^{b}±0.03
D	0.792^{c}±0.06	0.170^{c}±0.07	0.256^{b}±0.05	3.09^{c}±0.04
P- value	0.000	0.001	0.002	0.000

Group A = Irregation water B Rain water, Group C Tape water, Group D spring water. $^{a-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

Table 6. Effect of drinking water source on economics of broiler

Groups	Cost	Gross Return	Net Profit
A	662.00^{a}±0.5	675.00^{d}±0.5	13.00^{d}±0.5
B	655.00^{ab}±0.5	685.00^{a}±0.2	30.00^{a}±1.1
C	658.00^{ab}±0.4	680.00^{b}±0.3	22.00^{b}±0.8
D	660.00^{a}±0.6	678.00^{c}±0.5	18.00^{c}±1.2
P-value	0.064	0.000	0.000

Group A = Irregation water B: Rain water, Group C Tape water, Group D spring water. $^{A-d}$ values mean within the same column different superscript indicate significant difference ($p<0.05$).

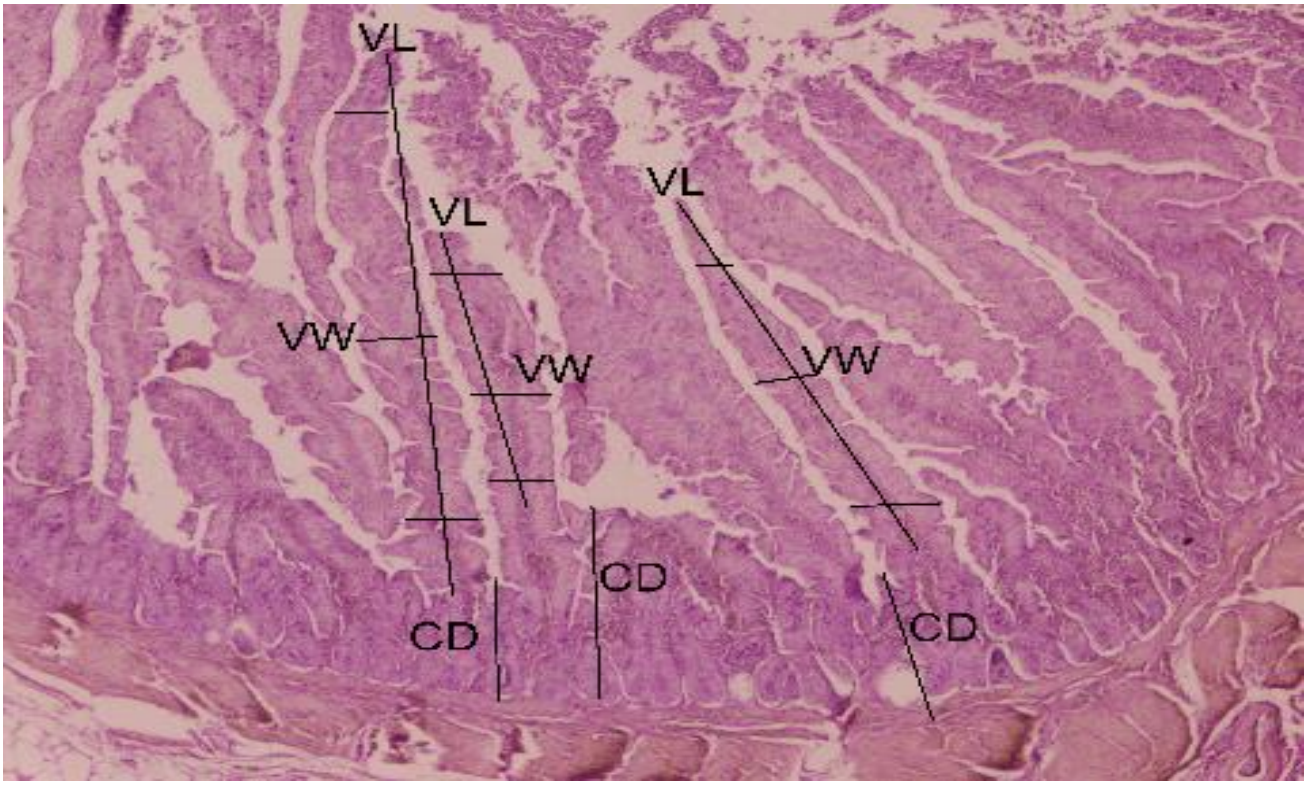

Figure 4.1. Photomicrograph (10X) of ileum of Broiler (Group A) showing villi height, villi width and crypt depth in millimeter.

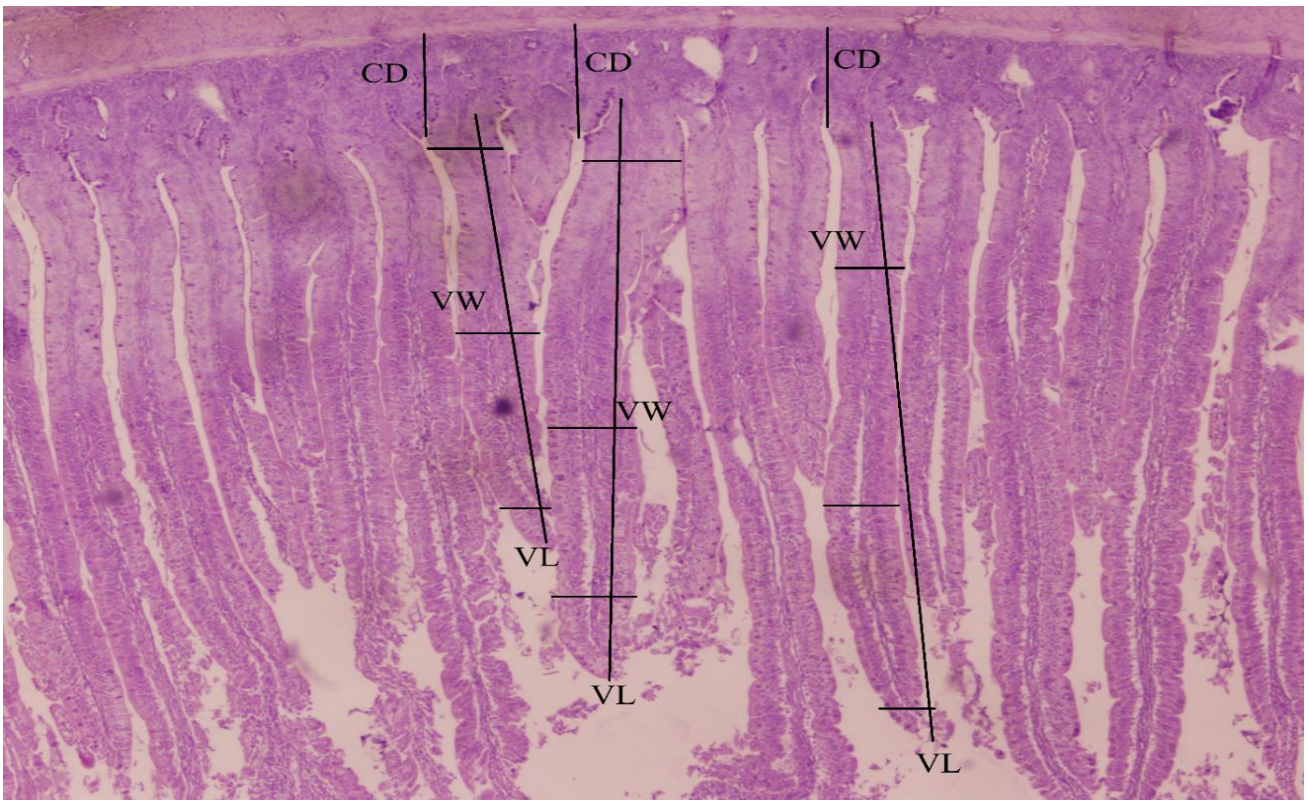

Figure 4.2 Photomicrograph (10X) of ileum of Broiler (Group B) showing villi height, villi width and crypt depth in millimeter.

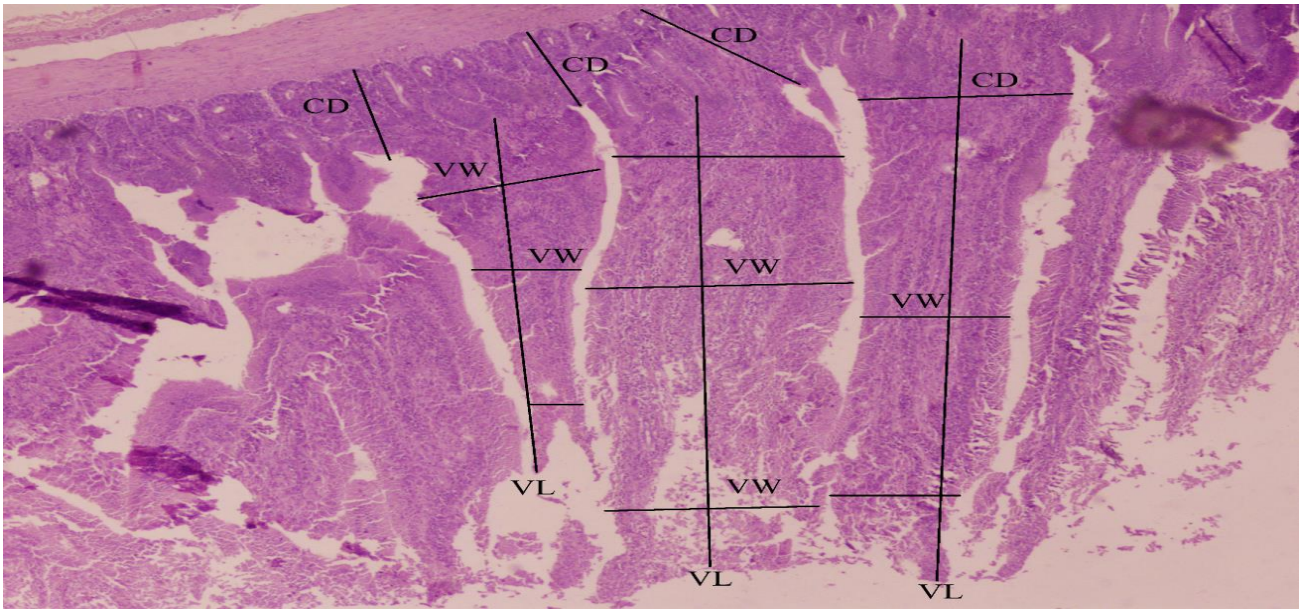

Figure 4.3. Photomicrograph (10X) of ileum of Broiler (Group C) showing villi height, villi width and crypt depth in millimeter.

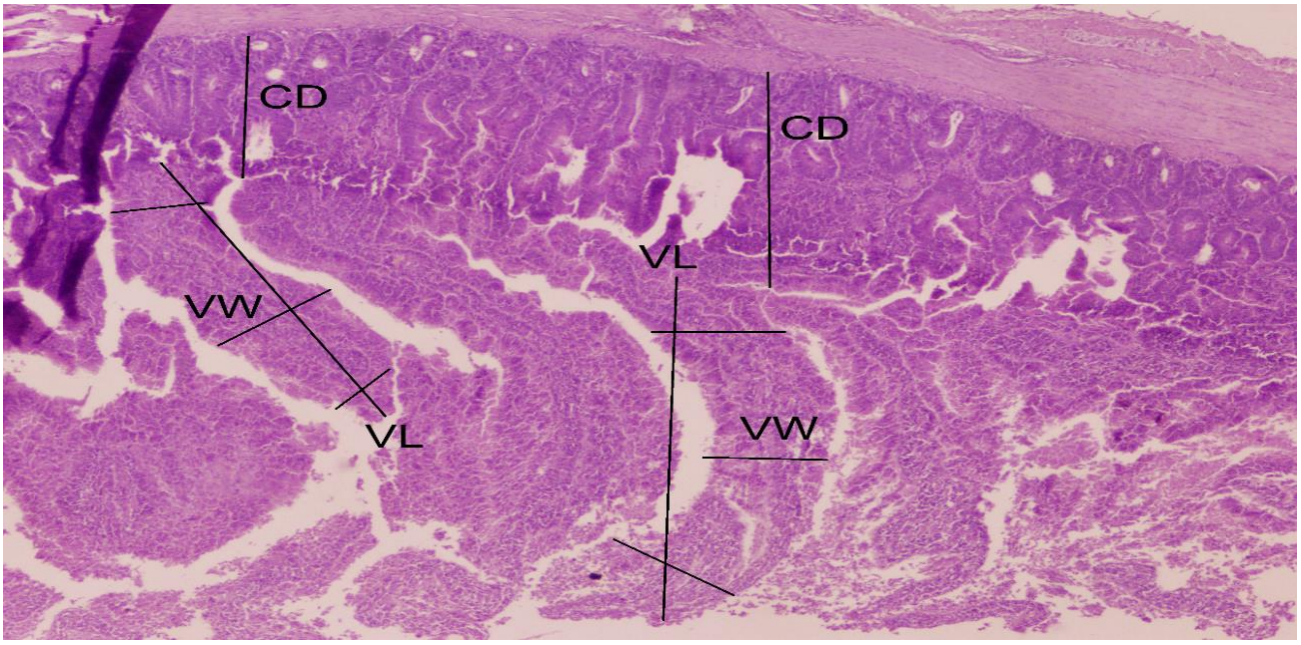

Figure 4.4 Photomicrograph (10X) of ileum of Broiler (Group D) showing villi height, villus width and crypt depth in millimeter

DISCUSSION

Water is an essential nutrient and is vital for all living beings. Birds can survive without food for few weeks, but will die in few days if water is not available. Water is suspected to be one of the major causes of high mortality rate in broiler farming in the state as the farmers use natural stream water, springs or harvested rain water (Jamlianthang *et al*., 2018). People use rainwater for toilet flushing or watering the garden or crops, animals and birds because it is available for free and its use reduces their expenses for purified drinking water that they obtain from drinking water companies (Schets *et al*. 2007). One of the probable reasons for higher water consumption in treated water might be due to absence of hardness after treatment with acidifier and sanitizer (Manwar *et al*., 2012a). In a similar study, Das (2013) found numerically higher feed intake by about 29.21 g in

broiler chicken offered treated water. Similarly (Ibitoye *et al.* 2013) found numerically higher body weight and body weight gain in broiler chicken offered bore well water.

This was in agreement with the report of Manwar *et al*. (2012a) and Das (2013) who reported that the final body weight of broiler chicken increased significantly ($P<0.05$) due to the addition with combination of acidifier and sanitizer at the rate of 0.01% in bore well, open well and ring well water. The improved body weight due to the addition of acidifier and sanitizer might be due to the reasons like Acidifier improved the quality of drinking water, Acidifier in drinking water reduce pH of drinking water as well as gastrointestinal tract of poultry, thus it controls the growth of pathogenic microbes, Acidifier decreases water viscosity and prevent formation of slime and growth of pathogen, Acidifier help the bird to populate with commensal in the gut, which in turn improved the total gut health and improves the absorption of nutrients, Addition of sanitizer to water decreases oxidation of iron and thus decreases formation of rust in pipes and waters, Sanitizer protects the pipeline from blocking due to growth of algae(Das, 2013).

The improved FCR in pond water offered group during the initial four weeks of age might be due to positive correlation between FCR and sulphate level at water sources (Zimmermann and Douglan, 1998 and Abbas *et al.*, 2010). In a study conducted by Saidy *et al.* (2015) on differences of water, they found improved FCR in farm stored water which was due to high concentration of potassium and chloride ion comparing to the other sources of water. The overall carcass growth showed that the different water sources had no significant effect on the carcass characteristics. This agrees with the findings of Asaniyan *et al.* 2012 and Folorunsho *et al*. 2012), who reported similar findings, it may be due to insignificant effect on feed intake and feed conversion ratio. Contrary to the present findings, several workers (Abbas *et al*., 2008; Abbas *et al*., 2010; Ibitoye *et al*., 2013; Zimmermann and Douglan, 1998; Folorunsho *et al*., 2012; Asaniyan and Adene, (2013) reported that water from different sources had no significant effect on growth performance of broilers birds. According to Huff *et al.* (1994) and Parker *et al.* (2019), continuous high acidic environment could lead to proventriculitis, inflammation of the intestine and consequent fragile intestinal wall. Hence, acidic drinking water like rainwater will negatively affect the growth performance of broilers and at the same time damages the gastrointestinal tract of the birds.

Sodium bicarbonate can help maintain the acid-base and electrolyte balance, and alleviate respiratory alkalosis following the exposure to high ambient temperatures (Mujahid, 2011). Furthermore, sodium bicarbonate can also neutralize the strong acidity of vitamin C without destroying its electron donor and antioxidant activities (Padayatty and Levine, 2016). Consequently, sodium bicarbonate supplementation in hens was used to improve shell quality and in broilers to enhance body weight which was consistent with the current work (Ahmad *et al*., 2009).

It has been demonstrated that the addition of sodium bicarbonate in water gives positive effects to broilers raised above thermos neutral conditions. Sodium is the major cation in the extracellular fluid and is closely associated with bicarbonate in the management of acid-base balance for the synthesis of tissue proteins, enzymatic reactions and osmotic pressure that influence the host immunity status.

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