JOURNAL OF AGROBIOTECHNOLOGY 2020, VOL 11(1S):32-45
e-ISSN: 2180-1983
http://dx.doi.org/10.37231/jab.2020.11.1S.232
https://journal.unisza.edu.my/agrobiotechnology/index.php/agrobiotechnology/index

Effects of Probiotic (Lactobacillus spp) Mixed with Cassava Leaves (Manihot esculenta) on Growth Performances and Meat Quality of Cherry Valley Duck (Anas platyrhynchos domesticus)

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Received: 15/08/2020, Accepted: 20/10/2020, Available Online: 31/10/2020

ABSTRACT

Probiotics are beneficial bacteria that had been used in poultry industry as alternative sources for antibiotic. The aim of this study was to determine the effect of probiotic mixed with cassava leaves (*Manihot esculenta*) on Cherry Valley Duck (*Anas platyrhynchos domesticus*) growth performance, carcass characteristics and meat quality. *Lactobacillus* spp. was used in this experiment to see its effectiveness in enhancing quality of cassava leaves as potential feed towards optimum growth performance of ducks like body weight gain, feed intake and feed conversion ratio, carcass characteristics and meat quality. 34 tails of Cherry Valley ducks aged 14 days with average weight of 500 g were randomly assigned to four treatments in triplicates. Treatments for the 35 days feeding trial were T1 at 0% probiotic + 75% commercial diet + 25% cassava leaves (control), T2 (0.15% probiotic + 75% commercial diet + 25% cassava leaves), T3 (0.30% probiotic + 75% commercial diet + 25% cassava leaves) and T4 (0.45% probiotic + 75% commercial diet + 25% cassava leaves) respectively. Proximate analysis was also conducted to determine nutritional content like protein, lipid, moisture, ash and fiber. Results show that supplementation of probiotic at 0.15% *Lactobacillus* spp. into 25% of cassava leaves and 75% commercial pellet gave highest body weight gain (BWG), low feed conversion ratio (FCR), highest carcass yield and good meat quality. It can be concluded that inclusion of probiotic at 0.15% in cassava leaves as duck's diet gives good growth performance and may become an alternative super diet for duck in future.

Keywords: Cassava leaves, probiotic, commercial feed, protein supplement

INTRODUCTION

Probiotic are living microbes (WHO/FAO, 2002) given orally to proliferate in the gastrointestinal tract (GI) of the host and create beneficial conditions for nutrient utilization (Nahashon et al., 2005; Jin et al., 2000). In South Africa, it was reported that effective microorganism (EM) was successfully being used for increasing productivity in integrated animal units and farms (Safalaoh & Smith, 2001). However, if microorganisms or/and substances, which contributes to the proper microbial balance, were added into diet, the animal will continually to receive a 'boost' in establishing the proper microbial population (Li et al., 2011) and is supported by Kabir et al. (2004) that the addition of probiotics to diets has been demonstrated to improve gut of health and feed conversion in broilers. EM products were also used as alternatives in animal husbandry and organic livestock farming to improve growth performance of animals after antibiotic was prohibited in several country and control odor and waste produced on farms (Kalavathy et al., 2003). Cassava (*Manihot esculenta*) or Cassava also called "Ubi Kayu" in Malay is a tropical root or tuber crop normally planted on mineral or peat soil. The State of Johor is the largest cassava growing area about 875 hectares in Malaysia which contributes about 83% of production in 2005 (Anem, 2009) and the immensity of cassava planting area during 2011 was estimated at around 2444 hectare with a potential yield of 41045 metric tons. Cassava foliage that consists of stems and leaves can be fed fresh, but it is often preferable to sun-dried or ensile cassava leaf meal as the leaves contain hydrogen cyanide that can be toxic to livestock (Heuzé V & Tran, 2016). Duck is a type of poultry that is reared commercially in Malaysia. It is an omnivore under the class of avian and is able to consume a wide variety of feed. Diet with good nutrition needs to be provided to duck in ensuring healthy duckling's growth with feather strength, muscle development and breeding success (Mayntz, 2016). To date, there is no specific feed catered for duck and feed for ducks is mostly dependent on available commercial poultry feed for chicken readily available in the market. However, the escalating price of commercial feed is one of the main constraints in developing the duck industry. Therefore, alternative sources need to be further exploited to find suitable ingredients that meet the nutrient requirement for duck. This, this study was done to determine the effect of probiotic *Lactobacillus* spp. mixed with cassava leaves (*Manihot esculenta*) on Cherry Valley Duck (*Anas platyrhynchos domesticus*) growth performance and meat quality.

MATERIALS AND METHODS

Preparation of probiotic

Probiotic *Lactobacillus* spp brand YSP Biomax Premix Powder (BXP) was purchased from MyTernak Trading. Prior to feeding experiment, bacterial enumeration was carried out to determine total count of *Lactobacillus* spp according to Leuschner (2003) with some modification. Probiotic powder in 1 ml of saline water was serially diluted from 10-1 to 10-7. Dilutions had been plated on selective agar media in triplicates for the enumeration of target bacteria. In particular, Lactobacilli enumerated using de Man, Rogosa, and Sharpe (MRS) agar. Then, MRS agar was incubated at 39°C for 48 hours anaerobically before colonies were counted. Counting of bacteria is according to the following formula.

CFUs = number of colonies X the dilution factor of the plate counted **Eqn. 1**

Source and processing of cassava leaves

Cassava leaves (CL) were collected from Kampung Renek within ten to twenty km radius away from University of Sultan Zainal Abidin, Besut Campus. The leaves were collected manually by plucking leaves from twigs and kept into plastic bags before brought back to the laboratory. Leaves were washed with pipe water and dried using dryer Universal Oven Drying (Memmert 600, Germany) to reduce HCN content of leaves. The leaves were put into a container and crushed into smaller size after dried in the 3 dryers at 60°C to 70°C for 24 hours (Fasuyi, 2005). The crushed leaves were then stored at room temperature (28°C) prior to feeding experiment.

Experimental design

34 tails of day-old ducklings (DOD) were obtained from Kelantan state and were transferred alive by car to Besut Campus. They were weighted and kept in the hatchery for brooding purposes prior to feeding experiment. Commercial feed type starter (Gold Coin 201) and water were given at *ad libitum* during the brooding period.

After two weeks, ducks with average weight of 650 g were selected for 28 days feeding trial and were divided randomly into triplicates for each of 4 treatments including control with three tails per treatment into groups to man-made cages. The 4 treatments group were fed with different level of probiotic namely T1 (75% pellet + 25% cassava leaf + 0% probiotic), T2 (75% pellet + 25% cassava leaf + 0.15% probiotic), T3 (75% pellet + 25% cassava leaf + 0.30% probiotic) and T4 (75% pellet + 25% cassava leaf + 0.45% probiotic). A continuous lighting system from incandescent lamps was provided through the trial. Water container was placed in each cage to store drinking water while canvas sheets were placed underneath the cages as collectors for droppings. Swimming pools were also prepared for ducks to dip once a week for ten minutes to keep their eyes, bills, feet, and feathers in good conditions. Ducks were fed twice daily at 7-8 a.m. in the morning and 6 p.m. in evening based on 10% of their body weight. Body Weight Gain (BWG), Feed Conversion Ratio (FCR), survivability rate, Average Daily Weight Gain (ADG) and Feed Intake (FI) were taken weekly to monitor growth performance. Growth performance of duck was measured according to Safalaoh (2006) on BWG, Mwale et al. (2008) on FCR with minor modification, Safalaoh (2006) on FI, Haitook (2006) on ADG and Sandhu (2008) on survivability of ducks respectively. The calculations were calculated according to the formula below:

$$\text{BWG : Final weight of the duck} - \text{initial weight of the duck} \quad \textbf{Eqn. 2}$$

$$\text{FCR : Feed intake} \div \text{ADG} \quad \textbf{Eqn. 3}$$

$$\text{FI : amount of feed given} - \text{amount of feed leftover} \quad \textbf{Eqn. 4}$$

$$\text{ADG : (Final weight} - \text{initial weight)} \div \text{age by days} \quad \textbf{Eqn. 5}$$

$$\text{Survivality : (live duck} \div \text{total duck)} \times 100\% \quad \textbf{Eqn. 6}$$

Proximate composition

Analysis of dry matter (DM), crude protein (CP), crude fiber (CF), crude lipid, ash, and NFE in experimental diet, probiotic mixed with leaves and fresh leaves were conducted according to AOAC (2000). Proximate composition of the samples was analyzed in accordance with the official standard methods of analysis. The Kjeldahl method was adopted for the determination of crude protein while Soxhlet method was adopted for the determination of crude lipid. The samples were subjected to 550°C overnight for determination of ash while samples were placed at 105°C in an oven until a constant weight is achieved for moisture content.

Hydrogen cyanide (HCN) analysis

Hydrogen cyanide analysis was done according to Wangari (2013) with some modification. 10 g of dried of all feed treatment was immersed in 250 ml of distilled water and left overnight. The treatments with distilled water were filtered and filtrated for cyanide determination. 150 cm^3 filtrate from each treatment was measured and 20 cm^3 of 0.02 M of sodium hydroxide (NaOH) was added to the distillate. Distilled water was then added until volume reached 250 cm^3 in a volumetric flask. Three aliquots, two of them were 100 ml each and one of 50 ml were obtained for each treatment. 8 cm^3 of 6 M ammonium solution and 2 cm^3 of 5% potassium iodide added to the 100 ml aliquots, 4 cm^3 and 1 cm^3 added to the 50 ml aliquots. The titrates used 0.02 M silver nitrate (AgNO3), and 50 ml as a trial and readings were taken on amount of $AgNO_3$ used to get HCN in mg represented by 1ml of $AgNO_3$ for 1.08 mg HCN.

Meat and carcass quality

Meat and carcass quality were measured based on Li et al. (2011) method with some modification. At end of feeding trial, one duck with a similar body weight of each replicate was selected, then weighed and slaughtered after fasted for 12 hours. Parameters of meat quality measured were pH, color, and water holding capacity (WHC) while carcass quality was measured based on their relative organ weight. Ultimate pH of meat was measured by using portable pH-meter. Between measurements, the probe tip was cleaned and rinsed with deionized water. The color of breast muscle was determined by an imaging colorimeter (Lovibond CAM-system 500) with the CIE L* a* b* system. The parameters L*, a* and b* represent lightness, redness, and yellowness, respectively. The carcass characteristics were calculated based on following:

$$\text{Carcass yield} = \text{carcass weight/live body weight} \times 100\% \qquad \textbf{Eqn. 7}$$

WHC is the ability of the muscle to retain natural occurring moisture in the meat and was measured in detail by using Grau-Hamm method according to Carvalho et al. (2017) with minor modification. After 12 hours post-slaughter, meat samples were collected from the breast part and weighed. Meat samples were firstly placed carefully between 2 pieces of Whatman filter paper at the bottom and the top of the sample. A standard of 5 kg weight was placed on top of the sample and held for 5 minutes. The samples were then weighed again and WHC was determined using the following equation:

$$\text{WHC\%} = 100 - \frac{(W_i - W_f)}{Wi} \times 100 \qquad \textbf{Eqn. 8}$$

Where, W_i = initial weight of sample (g) W_f = final weight of sample (g)

Statistical Analysis

All data were analyzed by SPSS version 20.0 procedures for One-way Analysis of Variance (ANOVA). Significant differences among treatment means were analyzed using multiple range tests with a 5% probability.

RESULTS AND DISCUSSION

Protein and energy are the first nutritional requirements that should be considered when formulating a diet because they represent the most expensive dietary components. In addition, diet has impact on the productive and reproductive performance of flocks for meat or egg production (Fouad & El-Senousey, 2014). CF also plays an important role in growth development and performance. According to Mateos et al. (2012), it improves the development of organs, enzyme production, and nutrient digestibility in poultry. The study by Mateos et al. (2012) explains that some of these effects are a consequence of better gizzard function, with an increase in gastroduodenal refluxes that facilitate the contact between nutrients and digestive enzymes. These effects often result in improved growth and animal health.

Results on the proximate analysis in Table 1 shows that the CP values for T1, T2, T3 and T4 are 19.56±0.51, 21.39±0.08, 21.47±0.22, and 20.40 ±1.10 respectively without any significant differences among treatments. All diets are able to meet the diet requirement for ducks of 18% of proteins (Stern, 2016; Metzer Farm, 2018). According to Helmbrecht (2016), the recommended supply of CP for duck's daily intake is 20% for the first two week. Roys Farm (2016) stated that feeding regime is the feeding of starter mash diet with 10-20% CP per day until duckling become six weeks of aged duckling, then followed by 16% CP for six weeks old to two months old ducks to maintain the percentage of CP for ducks of aged four months and onwards.

CP of T2, T3 and T4 mixed with probiotic are 21.39%±0.08, 21.47%±0.22, and 20.40% ±1.10 respectively supports Monsurat et al. (2014) that CP in CL amounts to 21.16%. However, T1 shows lower percentage as compared to other treatments. CF values for T1, T2, T3 and T4 are 5.53±0.05, 5.05±0.11, 4.89±0.10 and 5.40±0.30 respectively. Metzer Farm (2018) recommended that 5% of CF is enough as all treatments had almost met the protein requirement. According to Poultry World (2012), fibre provides energy to bacteria in the lower gastrointestinal tract where the bacteria uses nitrogen for bacterial protein synthesis and the bacterial metabolism that produces short-chain fatty acids. Lower manure pH also shifts ammonia (NH_3) to ammonium (NH_4^+), which is less volatile.

Table 1. Proximate composition of type of feeds

Composition (%)	T1	T2	T3	T4
Crude protein	19.56±0.51	21.39±0.08	21.47±0.22	20.40±1.10
Crude fiber (CF)	5.53±0.05	5.05±0.11	4.89±0.10	5.40±0.30
Crude lipid	7.72±0.32	8.01±0.87	8.28±0.09	6.66±1.50
Moisture	13.46±0.37[b]	12.12±0.49[ab]	11.18±0.11[a]	11.60±0.12[a]
Ash	4.85±0.04	4.98±0.01	4.98±0.01	4.91±0.06
NFE	48.91±0.16	48.47±0.35	49.21±0.35	51.05±0.87

Values are means ± SE of four replicate measurements. Treatments samples followed by a and b in row were significantly different (p<0.05).

Growth Performance

In Fig.1, results show there are no significant differences of BWG among all treatments at each experimental week except in W1. BWG is almost similar among treatments when compared to the control or T1 from W0 till W3. During this period, ducks tend to grow effectively. At the end of experiment, T2 (2366.67±88.19), T3 (2300.00±57.74) and T4 (2300.00±57.74) are higher than T1(2250.00±28.87) although T2 is slightly higher compared to T3 and T4. This result supports Alkhaf et al. (2010) that probiotic supplementation in diets significantly increased BWG of poultry at late ages (3-6 weeks) and enhanced BWG (Zulkifli et al., 2000; Wu et al., 2008). Feeding ducks with probiotic supplementation also gave positive result similar to CL only because Selvaraju (2017) reported that ducks with different inclusion amount of CL and BWG shows incremental trend. This study shows that CL mixed with probiotic is palatable to be consumed by duck, without any adverse effect (Lahtinen et al., 2012; Yirga, 2015) and increases BWG (Kabir et al., 2004; Khakesfidi & Ghoorchi, 2006; Mountzouris et al., 2007; Awad et al., 2009; Deniz et al., 2011; Zhang et al., 2012; Zhang & Kim, 2014).

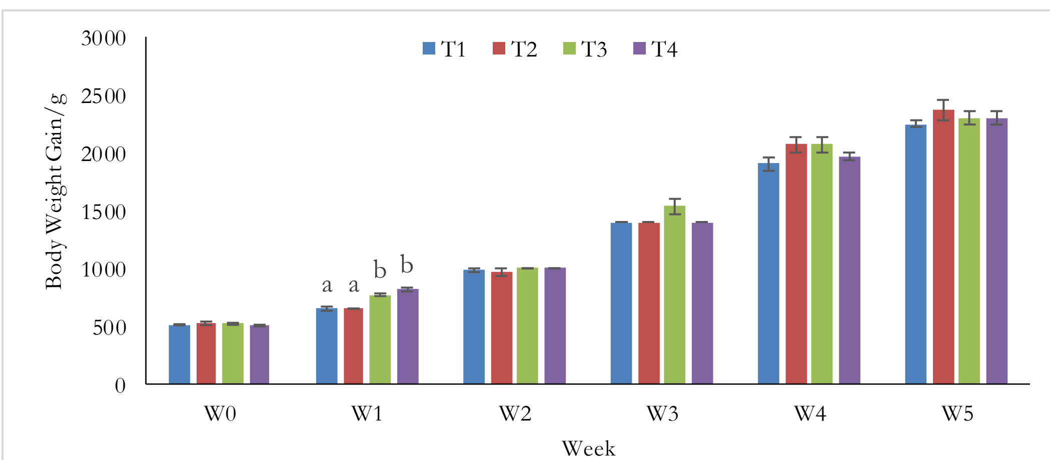

Fig.1. Body Weight Gain (BWG) of ducks throughout five weeks experimental period fed with different concentration of probiotic

Fig. 2 shows significant differences (P<0.05) among treatments in W1 and W2. At W1, ADG of T4 (44.48±1.34) is the highest while T3(35.91±1.66) is higher than T1 (19.76±2.32) and T2 (18.14±2.36) but lower than T4. At W2, ADG is similar between T1 (47.48±4.08) and T2 (45.00±4.72). T1 and T2 demonstrated highest ADG, followed by T3 (32.62±1.67) and T4 (26.19±2.38). According to Lilburn and Loeffler (2015), there are growth response and nutrient utilization from 0 to 8 weeks in poultry for diets containing 8 to 12% of fat, that is related to BWG and ADG of ducks. ADG for W3, W4 and W5 have no significant difference and this could be due to critical growth factor that requires high digestibility of key nutrients according to age as suggested by Lilburn and Loeffler (2015). In comparison, W5 does not have high amount of ADG as duck may have reach a matured stage during that specific age.

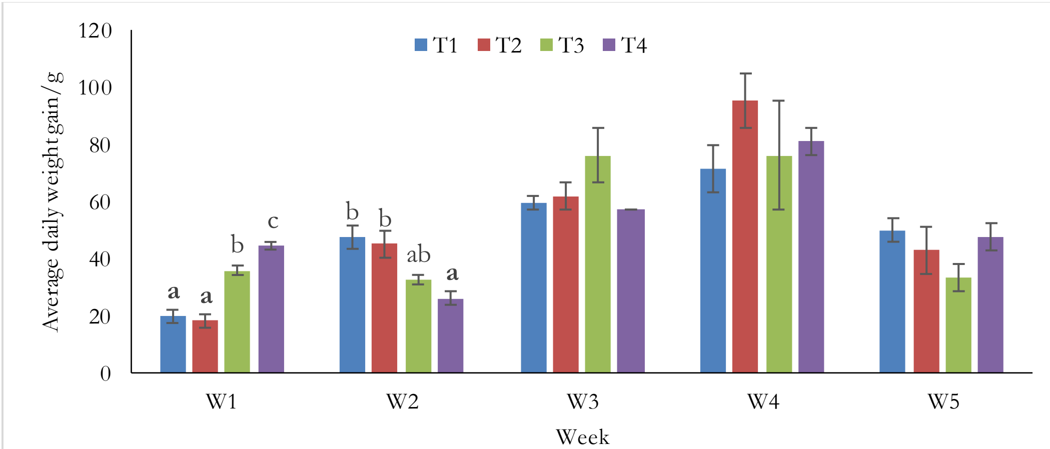

Fig.2. Average Daily Weight Gain (ADG) of ducks throughout five weeks experimental period fed with different concentration of probiotic

FI is the amount of feed eaten by an animal when the feed is given without restriction. The amount taken by animal varies depending on quality and quantity of feed. High feed intake is important for good growth performances. As shown in Fig. 3, significant differences (p T3 > T2 > T1) in W1 shows that higher dosage of probiotic promotes good FI for duck. All treatments with inclusion of probiotic shows higher FI compared to control although no significant differences were observed among treatments from W2 to W4. According to Zhang and Kim (2014), the addition of a mixture L. Acidophilus, B. subtilis and C. butyricum significantly improved the body weight gain (BWG) and feed conversion ratio (FCR) with no effect on feed intake (FI) throughout the finisher period, independent of the probiotic concentration in the diet. Similar observation was reported by Zhang et al. (2012) on increase of BWG by the administration of 105 and 108 CFU/kg of Bacillus strain probiotic. Increase of BWG may not be attainable by overfeeding animals. According to Wen et al. (2015), excessive feed consumption gradually decreases apparent digestibility of dry matter and crude protein of Pekin ducks. Therefore, it is crucial to feed duck at optimum level so that duck is able to reach a weight of 3.2 – 4.0 kg in approximately eight weeks (Sahoo et al., 2005).

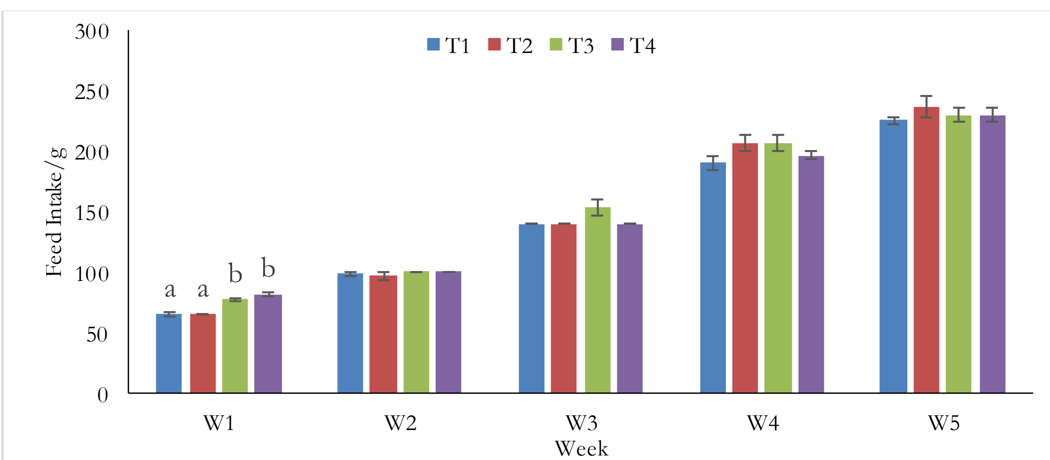

Fig. 3. The feed intake (FI) of ducks throughout five weeks experimental period fed with different concentration of probiotic

Economic implication of probiotic supplementation is important to be considered in feed industry. Increasing BWG and FCR are measures that indicate increased profitability for the producer. FCR varied significantly among treatments in W1 and W2 as shown in Fig. 4. In W1, T3 (1.82±0.09) and T4(1.46±0.04) are lower compared to T1 (3.37±0.35) and T2 (3.73±0.55) while in W2, T1(2.03±0.17) and T2 (2.16±0.25) are the lowest followed by T3 (2.93±0.15) and T4(3.70±0.37) as the highest. Apparently, FCR are higher to nearly 3.5 in those with higher inclusion of probiotic in W1 and adversely changed to lower inclusion in W2. The differences of these patterns are unexplainable and may be due to palatability adjustment towards TL as the previous feed given to the ducks was commercial diet. Feeding trend changed in W3 and W4 with FCR less than 3.0 for all treatments with ducks attaining average weight below 1500 g. According to Lahtinen et al. (2012), probiotic inclusion gives positive effect in diet. Results in W3 and W4 conform to Sahoo et al. (2007) that duck had FCR of 2.10 at 6 weeks of 1897.4±18.87g weight gain. found that diets containing *Lactobacillus* cultures had not only provided enhanced BWG but also improved FCR to poultry reared under stressful environments (Zulkifli et al., 2000) that contradicted with a study by O'Dea et al. (2006) on negative effect of probiotics on poultry productivity when applied in poultry-rearing operation. However, all treatments show encouraging BWG and FCR in accordance to Bulletin (2011) that suggest all treatments were of high-quality feed that resulted low FCR until W4. The study also observed that increment of protein content in diet causes high FCR.

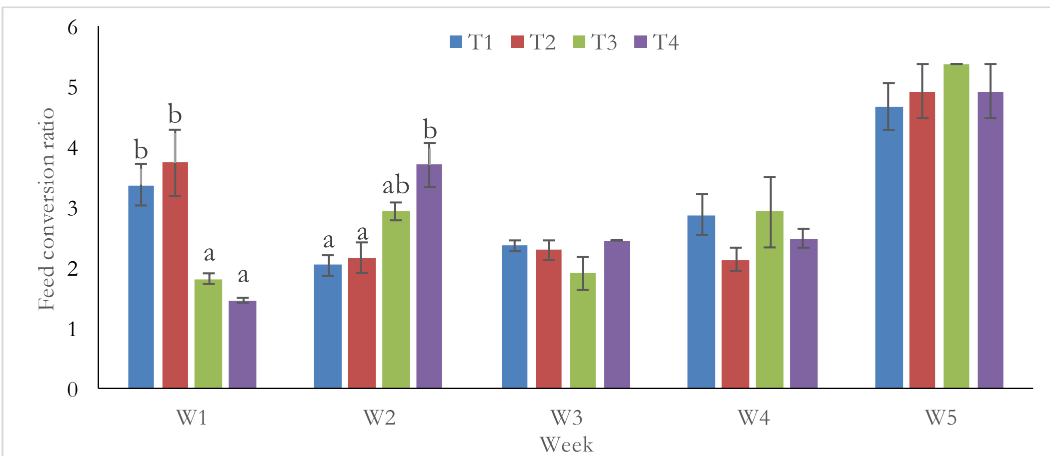

Fig. 4. The feed conversion ratio (FCR) of ducks throughout five weeks experimental period fed with different concentration of probiotic

CL has significant level of the anti-nutrient hydrocyanic acid (HCN) and low digestible energy, which limits cassava leaves usage in poultry feed. FI in cassava products is limited in poultry due to its dustiness and bulkiness. It also creates gut-filling effects and reduces appetite in animals (Morgan & Choct, 2016). The physical condition of CL may also cause low palatability of feed due to dry physical appearance of CL after dried in oven. According to Borin (2005), 100 mg HCN kg-1 suggested to be used in feed on dry matter basis could be the permissible maximum level. It was reported that poultry broilers could tolerate diets containing 141 mg total cyanide kg-1 without any negative effects on growth performance. Therefore, the result shows that T1, T2, T3 and T4 at 9.79±0.15 mg, 6.26±0.50 mg, 15.70±0.69 mg and 14.79±0.32 mg which are much lower than the suggested amount shows that 25% inclusion of TL is suitable for duck's growth performance without giving negative impact to its health.

Okoli et al. (2012) stated that lower cyanide levels are needed for optimal inclusion of cassava products in animal diets, especially those meant for monogastric animals. Suggested range for desirable value intended for poultry diet was from 10 to 25 mg in which similar to T3 and T4. Although T1 and T2 are both lower than 10 mg, it is observed that there were no signs of cyanide toxicosis like panting, eye blinking, salivation and lethargy observed during the experiment. No mortality occurred too as death usually occur about 15 to 30 min after consumption of HCN and if birds stay alive at 60 min, it indicates that they are frequently recovered (Eisler & Wiemeyer, 2004). This condition may be probably due to hydrocyanic acid, which is solution of hydrogen cyanide in water form. This condition is caused by beta-glucosidase produced by the intestinal microflora, glucosidase produced by the liver and other tissues and acid hydrolysis in the intestine. In addition, HCN is changed into thiocyanate by the enzyme rhodanase in liver, which is then excreted in the urine (Morgan & Choct, 2016).

Carcass yield and meat quality

The carcass yields of the ducks for each treatment are summarized in Table 2 below. There are significant differences ($P<0.05$) among treatments. T1 and T4 are the lowest (76.13±0.58% and 75.98±0.49%) followed by T3 (79.2±1.05%) and T2 is the highest (82.35±0.00%). According to Kandir and Yardimci (2015), probiotic improved meat and carcass quality. In comparison, carcass yield in T2 is good and high compared to control and others treatment. This observation is evidence that probiotics give a positive result towards carcass quality (Pelicano et al.,2008; Kalavathy et al., 2003). Kalavathy et al. (2003) also demonstrated that *Lactobacilli* strains reduced the fat content and this is also observed by Kandir and Yardimci (2015) study on poultry. They found that leafy ingredient like Kefir has shown better performance in broiler than others (geese and duck).

As shown in Table 2, the color of breast muscle was determined by an imaging colorimeter (Lovibond CAM-system 500) with the CIE L* a* b* system. The parameters L*, a* and b* represent lightness, redness, and yellowness, respectively. L* is higher than a* and follow by b*. L* of T1 (57.38±2.57) is lowest while T2 (59.06±1.36), T3(61.22±2.84) and T4(61.28±5.05) are much higher. According to Carvalho et al. (2017), the normal value of inner meat of L*, a* and b* are 56.86±1.93, 3.89±0.58 and 1.07±1.18 respectively. All results on a* and b* in this study are extremely high as compared to Carvalho et al. (2017). Eye observation also found that meat quality of all treatments was all pale, that conforms to Barbut et al. (2008) and Woelfel et al. (2002) that high L* values indicate paler meat. According to Erisir et al. (2009), the normal pH for meat is between 5.4 to 6.3. All treatments in this study have exceeded the suggested values. Results from Table 2 indicate that meat quality for all treatments is in good quality and is not catagorised as pale, soft and exudative (PSE) meat. Good quality of meat samples could be affected by prolonged storage of meat in freezer prior to this analysis. Freezing samples under minus 80°C after the feeding trial has reduced denaturation of sarcoplasmic protein and myosin. The pH of normal beef and pork muscle starts to fall after their death to its ultimate value of about pH 5.5. This pH fall reduces the ability of the muscle to hold water tightly. Decrease in pH values reduces WHC and causes meat being PSE. PSE is usually caused by low WHC, low pH and low intensity of the colour (Carvalho et al., 2017). According to Barbut et al. (2008), the main cause of quality defect is denaturation of sarcoplasmic protein and myosin that led to a decrease in a water-binding capacity of the protein and resulted a decrease in WHC of meat. Listrat et al. (2016) explained that during storage, the internal structure of muscles changes. The muscle fibers shrink laterally while expelling intracellular water to extracellular spaces, whose size increases. Subsequently, this water is expelled at the cut ends of muscles. The water holding capacity is strongly influenced by the rate and extent of decrease in the post-mortem pH. A large extent of pH reduces the net electric charge of proteins, which also reduces the WHC. According to Zhang et al. (2005), the frozen meat with high pH indicated as a good meat quality with a range are WHC between 67.8-74.4%, L* is between 35.9-38.9, a* is 16.0-18.2 and b* is 5.6-6.9 and varies with a time storage. In this study, meat from T2 is the best because according to Bowker et al. (2014) due to its lower WHC that causes higher L* value and lower pH values, signifying good qualities of meat.

Table 2. Carcass yield, colour, pH and WHC of ducks for each treatment

Treatment	T1	T2	T3	T4
Carcass Yield (%)	76.13±0.58[a]	82.35±0.00[c]	79.2±1.05[b]	75.98±0.49[a]
L*	57.38±2.57	59.06±1.36	61.22±2.84	61.28±5.05
A*	22.11±0.23	22.12±0.50	21.69±1.23	22.39±1.74
B*	15.77±0.64	16.77±1.40	14.40±1.53	16.20±1.88
Ph	6.71±0.11	6.61±0.06	6.56±0.02	6.40±0.07
WHC (%)	83.12±1.73	65.17±7.31	80.44±3.03	82.03±1.75

CONCLUSION

Probiotic supplementation mixed with cassava leaves may give positive growth performance and positive effects towards carcass characteristics and meat quality of duck. Cassava leaves can grow well in any climate area such as drought and warm and also have potential to become one of the main sources of protein in Malaysia especially when mixed with probiotic such as *Lactobacillus* spp. Cassava leaves and probiotic can be mixed or added in poultry diet to reduce the cost of commercial pellets and reduced competition between animals feed source and human food source. Detoxified cassava leaves are an improvised good protein source for poultry growth performance. The ration in this study determined the amount of probiotic that is suitable for effective growth performance, carcass characteristics and meat quality of duck. The study found that the supplementations of 0.15% of probiotic mixed with 25% of dried cassava leaves with commercial pellet showed a positive growth and feed conversion ratio without any adverse effects. The supplementations of more than 0.15% in the diets may increase the loss due to lower growth performance, lower carcass quality and lower meat quality. It can be concluded that inclusion of 0.15% in ducks diet show good growth performance, carcass yield and meat quality.

ACKNOWLEDGMENTS

The authors would like to acknowledge staffs of Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin Besut Campus for their kind assistance in rearing period of the ducks and laboratory analyses.

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How to cite this paper:
Hassan, N.A.S & Komilus, C.F. (2020). Effects of probiotic (*Lactobacillus* spp) mixed with cassava leaves (*Manihot escilenta*) on growth performances and meat quality of cherry valley duck (*Anas platyrhynchos domesticus*), Journal of Agrobiotechnology, 11(1s), 32-45.