Indian Journal of Animal Sciences **90** (8): 1140–1145, August 2020/Article

Potency of probiotic on broiler growth performance and economics analysis

ANITA DWI ANDRIANI[1], WIDYA PARAMITA LOKAPIRNASARI[1✉], BALQIS KARIMAH[1], SRI HIDANAH[1] and M ANAM AL-ARIF[1]

Universitas Airlangga Jawa Timur 60115 Indonesia

Received: ; Accepted:

ABSTRACT

The study was undertaken to know the economic analysis in broilers fed probiotic containing *Lactobacillus casei* and *Lactobacillus rhamnosus* supplementation in lieu of antibiotic growth promoters (AGP) to feed conversion ratio (FCR) and body weight (BW). The treatments were T_0: control, T_1: 0.01 g AGP/kg feed, T_2: 0.05 g/ kg feed, T_3: 0.1 g/ kg feed, T_4: 0.025 g probiotic/litre drinking water; T_5: 0.05 g probiotic/liter drinking water. Data analysis was carried out using the Analysis of Variance (ANOVA) method, business analysis was held out by XLSTAT then analyzing descriptively. The results indicated that there was a significant difference among the treatments. Probiotic administration of T_2, T_3, T_4 and T_5 could increase broiler's body weight and improve feed conversion ratio. The higher production performance and most profitable economic analysis was obtained with the addition of 0.025 g probiotic/litre (T_4), which had the best results in a Break Even Point and Return Cost Ratio. It could be concluded that supplementation of 0.025 g probiotic/litre drinking water indicates the improve growth performance and profits in broiler.

Keywords: Antibiotic growth promoter, Body weight, Broiler chicken, Feed conversion ratio, Probiotics

Poultry is one of the fastest growing segments of agriculture and veterinary sector. Feed is one of the largest items of expenditure in poultry production and it alone accounts for 70% of total poultry production. The constant increase in the cost of poultry feed ingredients and compounded feed is making the profit less for poultry farmers. Therefore, balanced and effective feeding is most important requisite to superior germplasm for economic poultry production.

Several feed additives (such as growth promoter) like synthetic hormone and antibiotics have been extensively used for enhancing poultry production. However, application of AGPs in poultry can cause development of bacterial resistance to antibiotics and it can affect human health, due to the residues in chicken products. In European countries, the application of AGPs in poultry feed is prohibited. This situation has driven much research on the search for alternatives that are able to maintain high productivity and to be economically feasible, as well as not being harmful to human and animal health, thereby complying with the requirements of consumers and foreign markets. Among these alternatives, the use of probiotics in animal feeds stands out. Probiotics as feed additives prevent the gastrointestinal disorders based on competitive exclusion of potentially pathogenic bacteria, stimulate host immune response, and secrete antimicrobial substances (Corcionivoschi *et al.* 2010). These products do not leave residues in animal products and promote animal performance and health (Fuller 1989, Jin 1997, Zulkifli *et al.* 2000, Ferreira *et al.* 2002, Patterson and Burkholder 2003), because they improve diet digestibility (Apata 2008), resulting in better nutrient utilization and consequently, higher productivity (Kabir *et al.* 2004, Mountzouris *et al.* 2007, Mountzouris *et al.* 2010). Probiotic giving to poultry can be given in the form of a mixture of feed or given through drinking water (Utomo 2012).

Lactic acid bacteria probiotics showed beneficial effect by inhibiting growth of pathogen bacteria, such as *Escherichia coli* (Huda *et al.* 2019, Najwan *et al.* 2019, Wardhani *et al.* 2019, Rahman *et al.* 2019) and *Salmonella* sp (Nouri *et al.* 2010). Lactic acid bacteria can survive by forming colonies of the intestine and can also produce lactic acid and bacteriocins (Salminen *et al.* 2004). *Lactobacillus casei* has both probiotic characteristics and antibacterial activity against different pathogens and can be used as potential functional probiotics in feed (Amaravadhi *et al.* 2012).

Probiotic treatment may be given through feed and water, expect that the consumption of probiotics through drinking water can increase body weight and decrease the value of feed conversion. Economic analysis can help estimate whether giving broiler probiotics in drinking water will be more profitable. The aim of this study was to know the broiler farm economics analysis, which uses probiotics

Present address: [1]Faculty of Veterinary Medicine, Universitas Airlangga. ✉Corresponding author e-mail: widyaparamitalokapirnasari@gmail.com

containing *Lactobacillus casei* and *Lactobacillus rhamnosus* to alternative antibiotic growth promoters (AGPs) to feed conversion and body weight.

MATERIALS AND METHODS

Study area and farm management: The research was conducted in the Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, Indonesia. Broiler *day old chick* (DOC; 240) were randomized into six treatments (T_0, T_1, T_2, T_3, T_4 and T_5), each treatment consisted of forty replications and each replication consisted of 10 heads, as follows: T_0: Control, 100% standard feed; T_1: standard feed + 0.01 g AGP/kg of feed; T_2: standard feed + 0.05 g/kg of feed; T_3: standard feed + 0.1 g/kg of feed; T_4: standard feed + 0.025 g probiotic/litre in drinking water and T_5: standard feed + 0.05 g probiotic/litre in drinking water. Standard feed is a feed composed of protein feedstuff and energy sources that are formulated according to the needs of the broiler chick. In the standard feed, antibiotics were not added, but the nutrient value in feed is suitable to fulfill nutrient requirement of broiler chick. A total of 0.01 g of AGP was mixed in 1,000 g feed (T_1); 0.05 g of probiotic (T_2) (concentration 1.2×10^8 CFU/gram), dissolved in 1,000 mL of water (free of chlorine and other antiseptics), 0.1 g of probiotic (T_3) dissolved in 1,000 mL of water, and then allowed to stand for 24 h without aeration. A total of 1,000 mL of probiotic solution was sprayed evenly on 1,000 g of feed and then the feed was left to dry, so that the probiotics are absorbed well in the feed, then the feed is ready to be given. 0.025 g of probiotic (T_4) dissolved in 1,000 mL of water (free of chlorine and other antiseptics), 0.05 of probiotic (T_5) dissolved in 1,000 mL of water, then allowed to stand for 24 h without aeration. A total of probiotic solution is mixed in 1000 mL of water, then stir evenly and drinking water ready to be given. The broiler chick was fed twice daily at 7 AM and 5 PM. The feed was given *ad lib.* in mash form. Water was also provided *ad lib*.

Data collection: Data related to the sum total of the poultry feeding and weight were collected every week. The body weight was obtained by weighing the chickens every week using digital scales. The feed consumption was calculated by subtracting the leftover feeds from the sum total of the given diets per week. The results of the calculation were then employed to determine the Feed Conversion Ratio (FCR). The calculation of the feed conversion using the following formula: Feed Conversion ratio = Feed Intake (g)/average of weight gain (g). The feed price was calculated based on the total amount of consumption multiplied by the price of feed per kilogram. The revenue was calculated from the total weight produced multiplied by the selling price of the chicken weight per kilogram.

Statistical analysis: Data analysis was performed using analysis of variance (ANOVA). If the result is significantly different then continued with Duncan's multiple range test. Statistical analysis using SPSS for Windows 21.0. Economic analysis and financial data were carried out by XLSTAT then analyzing descriptively. Economic analysis included computation of production cost (Total cost = Fixed cost + Variable cost), revenue (Revenue = Price each item × Total of production), profit (Profit = Total revenue – Total cost), Break-even point (BEP) (BEP production = Total of cost/price of selling; BEP price = Total of cost/Total of production), return cost ratio (R/C ratio) (R/C=Total of revenue/Total of cost).

RESULTS AND DISCUSSION

Feed conversion ratio: Addition of probiotics through feed and water, affect the feed conversion ratio ($P<0.05$). Furthermore, T_4 showed the significantly highest difference compared to control. The treatment T_1 was significantly different to T_0, T_2, T_3, T_4, and T_5. The treatment T_2 was not significantly different from T_3 but significantly different from T_1, T_4 and T_5, while T_3 was significantly different with T_1 and T_4. The result of the feed conversion in Table 1.

Table 1. Feed conversion ratio and body weight of broiler chicken in treatment

Treatment	Feed conversion ratio±SD	Body weight (g)±SD
T_0	$2.09^{a}\pm0.01$	$1,697^{a}\pm49.7$
T_1	$1.75^{b}\pm0.01$	$1,922^{b}\pm19.0$
T_2	$1.65^{cd}\pm2.4$	$2,003^{c}\pm8.60$
T_3	$1.64^{de}\pm2.8$	$2,021^{c}\pm4.87$
T_4	$1.62^{f}\pm0.01$	$2,025^{c}\pm12.1$
T_5	$1.63^{ef}\pm0.01$	$2,010^{c}\pm12.4$

SD, Standard deviation; ^{a,b,c,d,e,f}Means having different superscripts within the same column different significantly ($P<0.05$).

T_0 was significantly different from T_1, T_2, T_3, T_4 and T_5. This shows that the addition of feed additives through broiler feed and water can reduce the feed conversion ratio. As explained by Wiryawan *et al.* (2007), feed conversion is needed to describe the extent to which the biological effectiveness of nutrient used in feed, the smaller the amount of feed needed to produce additional chicken weight, means the more efficient the feed is.

The treatment of T_2 was not significantly different from T_3, but significantly different from T_1, T_4 and T_5 treatment. Adding probiotics to feeds can maintain microflora balance in the digestive tract and inhibit pathogenic bacteria, increase digestive enzyme activity, decrease ammonia production, improve feed intake and digestion, neutralize enterotoxins and stimulate the immune system (Manin *et al.* 2010, Yulianto and Lokapirnasari 2018). These results are also consistent with the results reported by other researches (Sathya and Muragian 2015, Lokapirnasari *et al.* 2017) that probiotics can improve feed intake and decrease the feed conversion significantly.

The treatment T_3 was not significantly different from T_5, but significantly different from T_1 and T_4. The probiotics can enhance microbial activity and digestibility in the broiler digestive tract, with the increasing number of population of microbes in the digestive tract, the absorption of feed substances becomes larger and more effective, which affect feed efficiency (Suroso *et al.* 2016). The results agree with the findings of Yeo and Kim (1997) and Anjum *et al.* (2005) who reported that the use of probiotic in broiler chicks diet significantly improved the daily body weight gain and feed efficiency. This may be attributed to the increase in microbial resistance to antibiotics and residues in chicken (Perreten 2003). The *Lactobacillus* sp was able to colonize the intestinal tract and feed, and remain at a high concentration of 10^7 to 10^9 CFU/g, respectively.

The treatment T_4 had the highest significant influence on the conversion, which may be due to many factors. Water consumption of animals also depends on other factors, such as activity, environmental temperature, and dryness of the feed, which require much water and relative humidity (Aduku 2004, Lokapirnasari *et al.* 2017). Nutritional status, duration of starvation and the relationship between water consumption and animal feed could be used as one of the factors that may affect the responses of animals to be considered (Cabrera and Saadoun 2006, Lokapirnasari *et al.* 2017). It is important that farms are equipped to provide adequate water volume for optimal development. The fact that water consumption has increased significantly over the past 10 and 20 years is evidence that farm water systems may need to be evaluated to ensure drinking systems are keeping up with the changing water needs (Williams *et al.* 20013, Lokapirnasari *et al.* 2017). This result contrasts (Pambuka *et al.* 2014, Lokapirnasari *et al.* 2017) that the rise in feed and water consumption is recorded in laying hens fed with probiotics mixed liquid culture containing two types of microorganisms, *Lactobacillus* and *Bacillus* species.

The balance of microflora population in the gut is expected to lead to a greater efficiency in digestibility and utilization of feed, which consequently, results in an enhanced growth and improved FCR (Bedford 2000, Choudhari *et al.* 2008). The significant benefits of antibiotic supplementation observed on chick growth and food conversion in this study, were in agreement with many reviewers (Mehdi 2011). Probiotics could suppress the growth of pathogenic microorganisms in the intestine and the incidence of diarrhea, on the other hand has the potential to increase the bioavailability of dietary minerals resulting in an improved growth rate and feed efficiency (Lokapirnasari *et al.* 2019). Lactobacillus administration has been shown to improve growth rates and feed conversion ratio in broiler chickens (Kalavathy *et al.* 2003).

Body weight: Addition of probiotics through feed and water, affect the body weight (P<0.05). Furthermore, treatments T_2, T_3, T_4 and T_5 were not significantly different, but significantly different to AGP (P1), and T_4 showed had the highest body weight. The result of the body weight are given in Table 1.

T_0 was significantly different from T_1, T_2, T_3, T_4 and T_5. Based on probiotic studies used using probiotics *Lactobacillus* sp., probiotic *Lactobacillus* sp can metabolize carbohydrates into lactic acid, which causes the atmosphere of the intestines to become acidic, so that pathogenic bacteria cannot survive in the intestine (Reddy *et al.* 2008) which will have an impact on feed efficiency and increase in final weight.

The treatment of T_2, T_3, T_4 and T_5 did not show significant difference, but significantly different from AGP (T_1), and T_4 had the highest influence on the final body weight. Probiotics can help cultivate beneficial microflora population in the intestines and eliminate pathogenic bacteria. These beneficial bacteria also release several enzymes which aid in digestion of food (Fioramonti *et al.* 2003, Yulianto and Lokapirnasari 2018, Yulianto *et al.* 2019). The benefits seen in the study include maintenance of normal intestinal microbiota and improved nutrition by detoxifying hazardous compounds in feeds and denaturing potentially indigestible components in the diet with hydrolytic enzymes amylases and proteases (Fuller 1989, Balcazar *et al.* 2006, Suzer *et al.* 2008, Lokapirnasari *et al.* 2018). Moreover, during the entire rearing period (0–42 days of age), those authors found that birds fed the probiotic product presented higher weight gain as compared with the other broilers. Boratto *et al.* (2004), similarly to Zulkifli *et al.* (2000), observed higher weight gain in the group treated with a probiotic (*Lactobacilus acidophillus*, *Enterococcus faecium* and *Saccharomyces cerevisiae*) relative to the control group, but no difference from the group fed antibiotics (virginiamycin and nitrovin) in the starter phase; however, weight differences were not observed during the subsequent periods. These results are in agreement with that given by Alloui *et al.* (2011) and Mehdi *et al.* (2011). This result in line with Panda *et al.* (2005) who reported that application of probiotics in broiler diet increased final body weight gain and improved FCR at week 6 of age. Zulkifli *et al.* (2000) used a probiotic product containing *Lactobaccillus* spp and obtained a similar weight gain for probiotic- and antibiotic-fed broilers, whose values were higher as compared with the control group during the period of 0–21 days of age. The difference in final body weight results can be influenced by the number of doses given to chickens, feed consumption in each individual chicken and different absorption rates of chickens. This is confirmed by the statement of Mahdavi *et al.* (2005) who reported that probiotic microbes can produce an optimum response in the digestive tract in certain doses. In this study using half a dose of packaging can reach the optimal final weight. Probiotic administration through drinking water can facilitate better absorption of nutrients by broilers (Purwanto 2014).

Economics analysis: The result of economic analysis is given in Tables 3–6. The investment is also called capital in an enterprise, which is a start-up fund. The investment costs are those costs incurred in the 1st year of the project consisting of pen, equipment, and land lease. Pens are used for the production of broiler. Land lease fees consist of space lease, electricity, and water for a month. Cost of equipment consists of the feeding, drinking, wire, sprayer, etc. The investment cost of each treatment is equal because the cost

Table 2. Fix cost of treatment

Description	Economic period	T_0	T_1	T_2	T_3	T_4	T_5
Pen depreciation (IDR)	2 Years	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Tools depreciation (IDR)	2 Years	159,500	159,500	159,500	159,500	159,500	159,500
Total (IDR)		1,159,500	1,159,500	1,159,500	1,159,500	1,159,500	1,159,500

IDR, Indonesian rupiah.

Table 3. Variable cost of treatment

Description	T_0	T_1	T_2	T_3	T_4	T_5
Transport (IDR)	200,000	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00
Bran (IDR)	150,000	150,000.00	150,000.00	150,000.00	150,000.00	150,000.00
Feed additive (IDR)	0	226,96.00	3,502.50	6,957.50	4,912.50	9,857.50
DOC broiler (IDR)	80,000	800,000.00	800,000.00	800,000.00	800,000.00	800,000.00
Feed (IDR)	1,310,168	1,288,817.00	1,272,917.00	1,264,285.00	1,219,765.00	1,276,097.00
Total (IDR)	2,110,168	2,089,044.00	2,076,419.00	2,071,243.00	2,024,667.00	2,085,954.00

IDR, Indonesian rupiah.

Table 4. Total of revenue and profit for 100 broiler chickens treatment

Description	T_0	T_1	T_2	T_3	T_4	T_5
Final of body weight production (kg)	179,255	193,574	201,805	204,202	205,000	200,553
Final of body weight sell/kg (IDR)	24,000	24,000	24,000	24,000	24,000	24,000
Total of Revenue (IDR)	4,302,120	4,645,776	4,843,320	4,900,848	4,920,000	4,813,272
Total of cost (IDR)	3,269,668	3,248,544	3,235,919	3,230,743	3,184,177	3,245,454
Profit (IDR)	1,032,452	1,397,232	1,607,401	1,670,105	1,735,823	1,567,818

IDR, Indonesian rupiah.

Table 5. Economics analysis each treatment

Description	T_0	T_1	T_2	T_3	T_4	T_5
Break-even point (price)	18,240	16,781	16,034	15,821	15,532	16,182
Break-even point (product)	0,76	0,70	0,67	0,66	0,65	0,67
R/C ratio	1,32	1,43	1,50	1,52	1,55	1,48

of the pen and land lease fee of each treatment for all inputs which used in this analysis is real. Input price is the price which prevailing at the time of the study.

Fixed cost: Fixed costs are costs that are not influenced by the size of total product, and it is equal in every year. The fixed costs consist of pen and equipment depreciation. Pen and equipment depreciation costs are calculated with depreciation formula that divided the economic life of the investment costs, which the equipment has an economic life of 2 years. There are no electricity costs because it is already included in the land lease fee and there are no labour costs because everything is done by the researcher. Fixed costs have the same amount of treatments because the equipment used is the same. Fixed costs are given in Table 2.

Variable cost: Cost of production consists of fixed costs and variable costs (Alfikri *et al.* 2013). Project time is based on a long research, which is 4 weeks, so that the variable costs are calculated on the cost of production for 5 weeks. Variable costs are costs which amount is influenced by the amount of product. Variable costs consist of the cost of transport, bran, feed, feed additives, DOC broiler and feed. The difference showed in variable cost, on the feed and feed additive costs.

In poultry production, total expenses greatly influenced by the price of feed that can reach up to 70% of the total cost (Abdurofi *et al.* 2016). The cost of feed is calculated from the total of feed intake of each treatment for five weeks multiplied by the price of feed is the Indonesian rupiah (IDR) 4,543 per kilogram feed. The precise information on feed conversion is important to calculate each bird feed consumption (Sahzadi *et al.* 2006). The results showed that the lowest feed costs was IDR 1,219,765 (T_2).

Cost of feed additives is the amount of feed additive given for 5 weeks multiplied by the price of feed additive, which is IDR 40,000 per 500 g of AGPs (T_1) and IDR 25,000 per 100 g of probiotic (T_2, T_3, T_4, and T_5). The T_0 is not given a feed additive, so that the cost of feed additive is IDR 0. The highest cost of feed additive was with T_5 which uses 0.05 probiotic/liter in drinking water (IDR 9,857,5) and the lowest feed additive cost was in the P1 which used AGPs, IDR (226,96).

The results showed that the lowest variable cost or the most efficient was with T_4 (IDR 2,024,667) while the highest variable costs in P0 (IDR 2,110,168) due to the high cost of feed additives. The variable cost is given in Table 3.

Revenues and profits: The flow of revenues is from the sale of total final weight. Revenues are obtained based on broiler final weight (kg) multiplied by the selling price of broiler IDR 24,000/kg final body weight.

The results showed that the highest total income in the T_4 (Standard feed + 0.025 probiotic/liter in drinking water) IDR 4,920,000 and affects the profits, where T_4 get the highest benefit IDR 1,735,823, which is due to higher production of final body weight in T_4. Profit condition happens if the income is greater than the cost of production (Soepranianondo *et al.* 2013). Total revenues and profits can be seen in Table 4.

Economic analysis: Results indicate that best BEP production and BEP price is T_4 only with the production of 0.65 kg final body weight at a price of IDR 15,532/kg which does not give a profit or a loss. BEP value can indicate the level of production and the price of what a business does not provide a profit nor a loss (Soepranianondo *et al*. 2013). The economics analysis is shown in Table 5.

Based on the results, the best R/C ratio was shown in T_4 treatment (1.55). The criteria for the calculation of business efficiency, namely, when the R/C ratio <1, then the business is said to be inefficient, when the R/C ratio is equal to one, the business is said to be unprofitable or no damage and if the R/C ratio is more than one then said to be efficient or beneficial (Soepranianondo *et al.* 2013). Hence, the business is worth it because it has a value of more than 1. Net R/C 1.34 means that every IDR 1, the costs over the life of the project resulted in IDR 1.34 revenue.

Probiotics administration of T_2, T_3, T_4 and T_5 through feed and drinking water can increase body weight and reduce feed conversion. The higher production performance results and most profitable economic analysis are the addition of 0.25 g probiotic/liter through drinking water. So the farmers can give 0.025 g probiotic/liter through the water to get the best production performance and profit.

REFERENCES

Abdurofi I, Ismail M M, Kamal H A W and Gabdo B H. 2016. Economic analysis of broiler production in Peninsular Malaysia. *International Food Research Journal* **24**: 761–66.

Aduku A O. 2004. Animal nutrition in the tropics typeset. Davon Computer and Business Bureau Zaria, Nigeria. 10–31.

Alfikri S N, Susiningsih W, Nimas M S and Irfan H D. 2013. Study of technical and financial aspects of ducks hybrids farm development in saonada farm in Jombang (Thesis), Faculty of Agricultural Technology, Brawijaya University, Malang.

Anjum M I, Khan A G, Azim A and Afzal M. 2005. Effect of dietary supplementation of multi-strain probiotic on broiler growth performance. *Pakistan Veterinary Journal* **25**: 25–29.

Alloui N, Chafai S and Alloui M N. 2011. Effect of probiotic feed additives on broiler chickens health and performance. *Journal of Animal and Feed Research* **2**: 104–07.

Amaravadhi S C, Mallam M, Manthani G P and Komireddy K R. 2012. Effect of dietary supplementation of probiotics and enzymes on the haematology of rabbits reared under two housing systems *Veterinary World* **5**: 748–53.

Apata D F. 2008. Growth performance, nutrient digestibility and immune response of broiler chicks fed diets supplemented with a culture of *Lactobacillus bulgaricus*. *Journal of Science Food Agriculture* **88**: 1253–58.

Balcazar J L, De Blas I, Ruiz-Zarzuela I, Cunningham D, Vendrell D and Muzquiz J L. 2006. The role of probiotics in aquaculture. *Veterinary Microbiology* **114**: 173–86.

Bedford M. 2000. Removal of antibiotic growth promoters from poultry diets: Implications and strategies to minimize subsequent problems. *World's Poultry Science Journal* **56**: 347–65.

Bidarkar V K, Swain P S, Ray S and Dominic G. 2014. Probiotics: Potential alternative to antibiotics in ruminant feeding. *Trends in Veterinary and Animal Sciences* **1**: 01–04.

Boratto A J. 2004. Uso de antibiótico, de probiótico e de homeopatia, inoculados ou não com Escherichia coli, para frangos de corte criados em conforto. *Revista Brasileira de Zootecnia* **33**: 1477–85.

Cabrera M C and Saadoun A. 2006. Fasting duration influences the inhibition of food intake by histamine in chickens. *Physiology Behaviour* **88**: 506–15.

Choudhari A, Shilpshri S and Ramteke B N. 2008. Prebiotics and probiotics as health promoter. *Veterinary World* **1**: 59–61.

Corcionivoschi N, Drinceanu D, Pop I M, Stack D, Stef L, Julean C and Bourke B. 2010. The effect of probiotics on animal health. *Animal Science and Biotechnology* **43**: 35–41.

Ferreira A J P, Pizarro L D C R and Leme I L. 2002. Probióticos e prebióticos. Spinosa, H.S.; Gorniak, S.L.; Bernardi, M.M. (Eds.) Farmacologia aplicada à medicina veterinária. 3. ed. Rio de Janeiro: Guanabara Koogan. 574–578.

Fioramonti J, Theodorou V and Bueno L. 2003. Probiotics: what are they? What are their effects on gut physiology? *Best Practice and Research in Clinical Gastroenterology* **17**: 711–24.

Fuller R. 1989. Probiotic in man and animals. *Journal of Applied Bacteriology* **66**: 365–78.

Gaggia F, Mattarelli P and Biavati B. 2010. Review: Probiotics and prebiotics in animal feeding for safe food production. *International Journal of Food Microbiology* **141**: S15–28.

Huda K, Lokapirnasari W P and Soeharsono S. 2019. Addition of probiotic *Lactobacillus acidophilus* and *Bifidobacterium sp* to the analysis of laying hens infected by *Escherichia coli*. *Mimbar Agribusiness* **5**: 176–82.

Jin L Z. 1997. Probiotic in poultry: modes of action. *World's Poultry Science Journal* **53**: 351–68.

Kabir S M L, Rahman M M and Rahman M B. 2004. The dynamics of probiotics on growth performance and immune response in broilers. *International Journal of Poultry Science* **3**: 361–64.

Kalavathy R, Abdullah N, Jalaludin S and Ho Y W. 2003. Effect of *Lactobacillus* cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of brother chickens. *British Poultry Sciences* **44**: 139–44.

Lokapirnasari W P, Dewi A R, Fathinah A, Hidanah S, Harijani N, Soeharsono, Karimah B and Andriani A D. 2017. Effect of probiotic supplementation on organic feed to alternative antibiotic growth promoter on production performance and economics analysis of quail. *Veterinary World* **10**: 1508–14.

Lokapirnasari W P, Pribadi T B, Al Arif A, Soeharsono S, Hidanah S, Harijani N, Najwan R, Huda K, Wardhani H C P, Rahman N F N and Yulianto A B. 2019. Potency of probiotics *Bifidobacterium* spp. and *Lactobacillus casei* to improve growth performance and business analysis in organic laying hens, *Veterinary World* **12**: 860–67.

Mahdavi A H, Rahmani H R and Pourreza J. 2005. Effect of probiotic supplements on egg quality and laying hen's performance. *International Journal of Poultry Science* **4**: 488–92.

Manin F, Hendalia E and Aziz A. 2010. Isolation and production of lactic acid bacteria and *Bacillus sp*. from gastro intestinal non ras chicken origin Gambut land as source of probiotic. *Scientific Journal of Animal Science* **8**: 221–28.

Mehdi T, Majid T and Sayed A T. 2011. Effect of probiotic and prebiotic as antibiotic growth promoter substitutions on productive and carcass traits of broiler chicks. International Conference on Food Engineering and Biotechnology IPCBEE, IACSIT Press, Singapore.

Mountzouris K C, Tsirtisikos P and Kalamara E. 2007. Evaluation of the efficacy of a probiotic containing *Lactobacillus, Bifidobacterium*, *Enterococcus* and *Pediococcus* strains in promotion broiler performance and modulation cecal microflora composition and metabolic activies. *Poultry Science* **86**: 309–17.

Mountzouris K C, Tsirtisikos P and Palamidi I. 2010. Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobunis, and cecal microflora composition. *Poultry Science* **89**: 58–67.

Najwan R, Lokapirnasari W P and Huda K. 2019. Effect of the addition of probiotic *Lactobacillus acidophilus* and *Bifidobacterium* to the production of laying hens infected with *Escherichia coli*. *Briliant* **4**: 125–31.

Pambuka S R, Sjofjan O and Radiati L E. 2014. Effect of liquid probiotics mixed culture supplements through drinking water on laying hens performance and yolk cholesterol. *Journal of World's Poultry Research* **4**: 5–9.

Panda A K, Raju M V L N, Rama Rao S V and Sharm S R. 2005. The influence of supplementation of *Lactobacillus sporogenes* on the performance of broilers. *Indian Journal of Animal Nutrition* **22**: 37–40.

Patterson J A and Burkholder K M. 2003. Application of prebiotics and probiotics in poultry production. *Poultry Science* **82**: 627–31.

Perreten V. 2003. Use of antimicrobials in food-producing animal in Switzerland and the European Union (EU). *Mitteilungen aus Lebensmitteluntersuchung und Hygiene* **94**: 155–163.

Purwanto I. 2014. Effect of herbal remedy on cholesterol performance and content of quail eggs (thesis). Faculty of Animal Husbandry. Bogor Agricultural Institute. Bogor.

Rahman N F N, Lokapirnasari W P, Soepranianondo K, Hidanah S and Sarmanu S. 2019. The effect of using *Lactobacillus casei* and *Bifidobacterium sp*. probiotics on feed conversion ratio and feed consumption in laying hens infected with *Escherichia coli*. *Briliant* **4**: 167–73.

Reddy G, Altaf M, Naveena B, Venkateshwar M and Kumar E. 2008. Amylolytic bacterial lactic acid fermentation. *Biotechnology Advances* **26**: 22–34.

Sahzadi T M S, Kalsoom U E and Shahzad K. 2006. Growth performance and feed conversion ratio (FCR) of hybrid fingerlings fed on cottonseed meal, sunflower meal and bone meal. *Pakistan Veterinary Journal* **26**: 163–66.

Salminen S, Wright A V and Ouwehand A. 2004. Lactic acid Bacteria: microbiologycal and functional aspects, revised and expanded. 3rd ed. Marcel Dekker, Inc. New York. pp. 177.

Sathya C and Muragian P. 2015. Effect of dietary supplementation of probiotic and Curculigo orchioides rhizome powder on egg quality parameters and biochemical composition of Japanese quail (*Coturnix coturnix japonica*). *International Journal of Advances in Pharmacy*, *Biology* and *Chemistry* **4**: 162–70.

Soepranianondo K, Sidik R, Nazar D S, Hidanah S, Pratisto and Warsito S H. 2013. Entrepreneurship. Airlangga University Press, Surabaya. pp. 192–197.

Suroso, Kalsum U and Wadidi M F. 2016. Effects of probiotics encapsulation addition to feed consumption, egg production and feed efficiency in quail. *Animal Husbandry Journal* **1**: 1–5.

Suzer C, Çoban D, Kamaci H O, Saka Þ, Firat K, Otgucuoðlu Ö and Küçüksari H. 2008. Lactobacillus spp. bacteria as probiotics in gilthead sea bream (*Sparus aurata L.*) larvae: effects on growth performance and digestive enzyme activities. *Aquaculture* **280**: 140–45.

Utomo A M. 2012. Effect of probiotic giving with *Lactobacillus sp*. and *Saccharomyces cerevisiae* against broiler weight gain. (Thesis), Airlangga University. Surabaya.

Wardhani H C P, Lokapirnasari W P and Soepranianondo K. 2019. Use of combination probiotic *Lactococcus lactis* and *Lactobacillus acidophilus* as a substitute of antibiotics in chicken layer infected by *Escherichia coli* on business analysis. *Mimbar Agribusiness* **5**: 183–92.

Williams C L, Tabler G T and Watkins S E. 2013. Comparison of broiler flock daily water consumption and water-to-feed ratios for flocks grown in 1991, 2000–2001, and 2010–2011. *Journal of Applied Poultry Research* **22**: 934–41.

Wiryawan K G, Sriasih M and Winata I D P. 2007. Appearance of Broiler given Probiotics (EM-4) as Substitute for Antibiotics. (Thesis), Mataram Lombok University.

Yeo J and Kim K I. 1997. Effect of feeding diets containing an antibiotic, a probiotic, or yucca extract on growth and intestinal urease activity in broiler chicks. *Poultry Science* **76**: 381–385.

Yulianto B and Lokapirnasari W P. 2018. Isolation and identification of lactic acid bacteria from the digestive tract of kampung chicken (*Gallus gallus domesticus*). *Philippine Journal of Veterinary Medicine* **55** (SI): 67–72.

Yulianto A B, Lokapirnasari W P, Najwan R, Huda K, Wardhani H C P and Rahman N F N. 2019. Characterization of cellulolytic bacteria as candidate probiotic for animal. *Indian Veterinary Journal* **96**: 29–31.

Zulkifli I. 2000. Growth performance and immune response of two commercial broiler strains fed diets containing Lactobacillus cultures and oxytetracycline under heat stress conditions. *British Poultry Science* **41**: 593–97.