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Research Article

Effect of different doses of probiotics on growth performance of New Hampshire chicken

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ABSTRACT

The feed additive is one of the important components in poultry production to enhance the performance of birds. An experiment was conducted atNational Animal Nutrition Research Center, Khumaltar, Lalitpur, Nepal in order to evaluate the feasibility of probiotics as feed additives in New Hampshire chicken performance. The experiment was laid out with four treatments viz. basal diet which is concentrate mixture without inclusion of probiotic (*Lactobacillus acidophilus* - $50*10^9$ cfu/kg, *Bacillus subtilis* - $1*10^9$ cfu/kg, *Bacillus licheniformis* - $1*10^9$ cfu/kg, *Saccharomyces boulardii* - $10*10^9$cfu/kg) as basal diet with 0.5 gram of probiotic per liter of water , basal diet with 1 gram of probiotics per liter of water and basal diet with 1.5 gram of probiotics per liter of water under completely randomized design replicated three times. A total of 180, 8th week New Hampshire chickens were allotted with 15 birds in each experimental unit. Experimental birds were fed *ad-libitum* amount of formulated concentrate feed and clean drinking water with proper management practices.The highest weight gain was observed in treatment group provided with 1g of probiotic in diet (1957.96 g) followed by treatment group provided with 0.5 g of probiotic in diet (1891.40 g), 1.5g probiotic in diet (1879 g) and lowest in treatment group without probiotic in diet (1793.62 g). However there was no significant difference in total feed intake between all the treatment groups. Similarly, better feed conversion ratio (FCR) was found inbirds fed with 1g probiotic (3.59) followed by 0.5g probiotic (3.67), 1.5 g probiotic (3.72) and without probiotic in diet (3.87). Dressing percentage was also found higher (85.03 %) in birds fed with 1g of probiotic included diet than other groups of birds.

Keywords: Chicken, Growth performance, New Hampshire, Probiotic

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INTRODUCTION

Probiotics are feed additives that have gained popularity in poultry production following the ban on antibiotic growth promoters (AGP). They are one of the more universal feed additives

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and can be easily combined with other additives. Probiotics have many advantages, including stimulation of the host microflora or immunomodulation. The statement "immunity comes from the intestines" has become more important in the poultry industry because probiotics have proven helpful in the fight against diseases of bacterial origin and against zoonoses (Krysiak *et al.*, 20021). In European Union, more than thirty probiotic preparations are currently registered which is allowed to use of preparations composed of several bacterial strains (Steiner *et al*., 2015). Bacteria such as *Bifidobacterium* spp., *Lactococcus* spp., *Lactobacillus* spp., *Bacillus* spp., and *Streptococcus* spp are the most common types of microorganisms used to make probiotics (Park *et al.*, 2016). The majority of the probiotic products are based mainly on Lactobacillus acidophilus, although other organisms such as *Streptococcus faecium*, *Bacillus subtilis* and yeast are also used (Cheeke, 1991). Moreover, the most widely used probiotic strains are of the genus *Lactobacillus,* which is also the dominant genus of the proximal intestine of chickens early in life (Barnes *et al.,* 1972). Edens *et al.* (1997) showed that in ovo and ex ovo administration of *Lactobacillus reuteri* resulted in an increased villus height, indicating that probiotics are potentially able to enhance nutrient absorption and thereby improve growth performance and feed efficiency. Major Probiotic mechanisms of action include enhancement of the epithelial barrier, increased adhesion to the intestinal mucosa, and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microorganism substances, and modulation of the immune system (Lebeer *et al.* 2008). Hence, the introduction of probiotic bacterial strains improves the immunity of the gastrointestinal tract, and consequently, the range of tolerance to adverse external stimuli.

Probiotics are considered to have the potential to improve production and health within the poultry industry and beyond (Krysiak *et al*., 2021), and one of the more effective methods of microbial control and are not as detrimental to the environment as antibiotics (Hejdysz *et al*., 2012). However, in poultry production particularly in dual-purpose breeds like New Hamshire, the use of probiotics and its effect on production performance seemed limited where the production level has not been as expected. Therefore the current study was designed to determine the effect of probiotics on the growth performance of New Hampshire chicken.

MATERIALS AND METHODS

This study was conducted in 15th March 2020 to 25th May 2020 under deep litter housing system as in National Nutrition Research Center farm, Khumaltar. Cleaned floor was disinfected with a 5% phenol solution and washed with fresh water. Equipment such as feeder, waterier was purchased and disinfected properly with a 5 % phenol. The experimental birds were fed with a concentrated ratios formulated with 18 % crude protein and ME 2900 KCal/kg according to need of New Hampshire chicken for growing periods from week 9 to week 18 of the experiment. The experiment was carried in complete randomized design (CRD) with 8-week-old total 180 New Hampshire chickens having 4 treatments with 3 replications. The birds were housed in experimental pens and fed *ad libitum* two times a day with formulated ration along with the commercial probiotics Biovet-YC (*Lactobacillus acidophilus* - $50*10^9$ cfu/kg, *Bacillus subtilis* - $1*10^9$ cfu/kg, *Bacillus licheniformis* - $1*10^9$ cfu/kg, *Saccharomyces boulardii* - $10*10^9$ cfu/kg) which was provided in water. The treatment details of experiments were: **T0:** Basal diet (Concentrate feed mixture); **T1**: Basal diet+ Probiotics 0.5 g/L of water; **T2**: Basal diet+ Probiotics 1 g/L of water; **T3**: Basal diet+

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Probiotics 1.5 g/L of water.Concentrate feed was formulated the ration of 18 % Crude Protein (CP) according to the need of Dual Propose breed by mixing different ingredients available. The birds were vaccinated with Marex vaccine, New Castle disease vaccine (F1), IBD vaccine for Gumbaro and vaccine for fowl pox at schedule. The weekly live weight, feed consumptions, feed conversation ration and economic of productions parameters were measured during the experimental period.

Statistical analysis

The data on the experiment was recorded in MS-Excel and analysis of variance were carried out with R Studio and SPSS 16. The mean values were compared by Duncan Multiple Range Test (DMRT) at a 5% level of significance.

RESULTS AND DISCUSSION

Feed consumption

Mean weekly feed consumption under different treatment of New Hampshire chicken is presented in Table 1. Weekly feed intake of experimental birds on different week of experimental period of different treatment group shows no significance except for the 4th week. On the 4th week of the of experimental period, highest feed intake was observed in the treatment group with the inclusion of 1g of probiotic in the diet followed by 1.5 g, 0.5 g and diet without inclusion of probiotic in the diet respectively. However, result shows that there is slightly higher feed intake in most of the week of experimental period in treatment group given with 1g probiotic in diet. Average feed intake was in increasing trend up to 5th week and starts to decline onwards up to 8th week and again increases slightly in 9th week. Among all the week, average feed intake was found highest in 5th week where diet added with 1g probiotic was consumed highest (916.39 g) followed by 1.5 g probiotics in the diet (916.06 g), 0.5 g probiotic in diet (872.58 g) and lowest was in diet without inclusion of probiotic (864.71 g) respectively.

Table 1. Weekly feed intake of experimental birds in gram

Treatment	Week1	Week 2	Week3	Week4	Week5	Week6	Week7	Week8	Week9
Basal Diet	567.91	704.11	740.88	848.66^{c}	864.71	857.32	823.11	771.82	757.96
0.5g probiotic	558.35	707.52	733.63	865.23^{bc}	872.58	866.73	818.85	765.97	749.68
1g Probiotic	548.99	713.65	763.19	918.52^{a}	916.39	878.13	818.63	750.77	728.35
1.5g Probiotic	541.12	711.33	750.72	889.76^{ab}	916.06	865.77	809.07	755.11	737.88
Grand mean	554.09	709.15	747.11	880.54	892.44	866.98	815.42	760.91	743.47
CV (%)	3.13	2.66	2.23	2.36	3.25	2.08	1.77	3.49	2.15
LSD(0.05)	32.63	35.49	31.31	39.14	54.69	34.09	27.25	50.06	30.08
F test	NS	NS	NS	*	NS	NS	NS	NS	NS
SEM (±)	5.00	5.44	4.80	6.00	8.39	5.23	4.18	7.68	4.61

Figures followed by the same letter in a column are not significantly different by DMRT at a 5% confidence level. LSD= Least Significant Difference, NS= non-significant, * significant at 5% level, ** significant at 1% and *** significant at 0.1% level.

The result shows significant difference in the cumulative feed intake in three different weeks (week 5, week 6 and week 7) of the experimental period. On the 5th week of experimental period, highest feed is consumed in in treatment group supplied with the 1 gram of probiotic in the diet (3860.75 g) followed by treatment group with 1.5g probiotic in diet (3808.99 g), 0.5g probiotic and diet (3373.33 g) and lowest in treatment group without probiotic in diet

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(3726.26 g). Similarly, 6th and 7th weeks followthe same pattern of feed intake between treatments. On the final week of the experimental period total feed intake was found the highest in the treatment group with 1g probiotic in diet followed by 1.5 g probiotic, without probiotic in diet and 0.5g probiotic in the diet. The mean total feed intake is found 6970.13g on the last week of the experimental period. The cumulative feed intake of the experimental bird is presented in Table 2.

Table 2. Cumulative feed intake of experimental birds/week in gram

Treatments	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9
Basal Diet	567.91	1272.02	2012.89	2861.55	3726.26[b]	4583.57[b]	5406.68[b]	6178.50	6936.46
0.5g probiotic	558.35	1265.87	1999.51	2864.74	3737.33[b]	4604.05[b]	5422.90[ab]	6188.87	6938.56
1g Probiotic	548.99	1262.64	2025.83	2944.35	3860.75[a]	4738.88[a]	5549.51[a]	6300.28	7028.64
1.5g Probiotic	541.12	1252.45	2003.17	2892.93	3808.99[ab]	4674.77[ab]	5422.90[ab]	6238.95	6976.84
Grand mean	554.09	1263.25	2010.35	2890.89	3783.33	4650.32	5465.74	6226.65	6970.13
CV (%)	3.13	2.07	1.49	1.23	1.20	1.06	1.18	1.13	1.02
LSD(0.05)	32.63	49.23	56.62	66.75	85.92	93.43	91.43	97.18	120.92
F test	NS	NS	NS	NS	*	*	*	NS	NS
SEM (±)	5.00	7.55	8.68	10.23	13.7	14.32	14.02	14.90	18.54

Figures followed by the same letter in a column are not significantly different by DMRT at a 5% confidence level. LSD= Least Significant Difference, NS= non-significant, * significant at 5% level, ** significant at 1% and *** significant at 0.1% level.

Similar result is also obtained by Khaksefidi (2005) when control group was fed a basal diet, whereas the experimental group was fed the same basal diet but supplemented with probiotic (six strains of variable organisms namely *Lactobacillus acidophilus, Lactobacillus casei,Bifidobacterium bifidum, Aspergillus oryzae, Streptococcus faecium* and *Torulopsis sps*.) on chicken performance showed that the no differences in feed intake between the group in all the week of the experimental period. Similarly, Sohail *et al.* (2012) observed that feed intake was not affected by the supplementation of probiotics.The performance of New Hampshire chicken can be evaluated by keeping records of several parameters like growth rate, days to market, mortality and feed efficiency. A large part of the cost is incurred in the feed purchase for poultry production so, feed efficiency is the primary tool to evaluate New Hampshire performance. Feed efficiency can be measured from feed conversion ratio (FCR), which is the ratio of weight gain to feed intake. Lower value of feed conversion ratio implies that more efficient feed is utilized (Pirgozliev *et al*., 2019).

Growth performance

Weekly body weight gains trends of experimental birds were presented in Table 3. A significant difference in weight gain was observed among different treatment groupsduring all the weeks of the experimental period. In the first-week weight gain was found significantly higher in the treatment group with 1g probiotic in the diet followed by the treatment group with 1.5 g probiotic, 0.5g probiotic, and without the inclusion of probiotics in the diet and this pattern repeats in all the nine weeks of the experimental period. The difference in weekly weight gain was found highly significant in 5th, 6th and 7th week of the experimental period. The similarity in weight gain is observed in the treatment group with 0.5g probiotic and 1.5g probiotic in the diet in all the weeks of the experimental period whereas the difference in weight gain of the treatment group without probiotics in the diet is significantly lowest of all the treatment groups. Mean weight gain was found and increases

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rapidly from the first week (183.40 g) up to 5th week (257.87g) then it declines from 6th week until the last week (week 9) of the experimental period reaching a mean weight of 164.85 g.

Table 3. Weekly body weight gains trend of experimental birds in gram

Treatments	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9
Basal Diet	175.76^c	186.39c	215.30^c	236.63^c	248.19^c	207.77^c	189.12^c	174.33^b	160.13^b
0.5g probiotic	187.14^{ab}	197.96^b	226.23^b	249.16^b	260.96^{ab}	217.16^b	203.55^{ab}	183.27^a	165.97^a
1g probiotic	188.97^a	206.88^a	241.03^a	267.94^a	264.07^a	266.74^a	208.49^a	186.04^a	167.80^a
1.5g probiotic	181.77^b	198.51^b	225.19^{bc}	249.49^b	258.25^b	220.52^b	198.31^b	182.03^a	165.48^a
Grand mean	183.40	197.44	226.94	250.81	257.87	218.05	199.87	181.42	164.85
CV (%)	1.58	1.87	2.34	1.96	0.95	1.27	2.18	1.43	1.35
LSD (0.05)	5.46	6.97	9.98	9.24	4.62	5.23	8.22	4.87	4.19
F test	**	**	**	***	***	***	**	**	*
SEM (±)	0.84	1.07	1.53	1.42	0.71	0.80	1.26	0.75	0.64

Figures followed by the same letter in a column are not significantly different by DMRT at a 5% confidence level. LSD= Least Significant Difference, NS=non-significant, * significant at 5% level and *** significant at 0.1% level.

Weekly cumulative weight gain revealed that there is highly significant difference in the weight gain in all the weeks of experimental period presented in Table 4. Highest weight gain is observed in treatment group with 1g of probiotic in diet followed by 0.5 g and 1.5 g probiotic in diet in all the weeks of experimental period. Whereas lowest cumulative weight gain was observed in treatment group without inclusion of probiotic in diet which is much smaller than all other treatment groups. At the final week of experimental period total body weight gain was found highest (1957.96 g) in treatment group containing 1g of probiotic, second highest (1891.40 g) in the group containing 0.5g probiotic in diet, third highest (1879.56 g) in group containing 1.5 g probiotic in diet and the lowest weight gain (1822.62 g) was observed in treatment without the inclusion of probiotic in diet.

Table 4. Cumulative body weight gains trend of experimental birds in gram

Treatments	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9
Basal Diet	175.76^c	362.15^c	577.46^c	814.08^c	1062.27^c	1270.05^c	1459.17^c	1633.49^c	1793.62^c
0.5g probiotic	187.14^{ab}	385.09^{ab}	611.33^b	860.48^b	1121.44^b	1338.60^b	1542.15^b	1725.43^b	1891.40^b
1g Probiotic	188.96^a	395.85^a	636.88^a	904.83^a	1168.89^a	1395.63^a	1604.12^a	1790.16^a	1957.96^a
1.5g Probiotic	181.77^b	380.28^b	605.47^b	854.96^b	1113.22^b	1333.73^b	1532.04^b	1714.07^b	1879.56^b
Grand mean	183.40	380.84	607.78	858.59	1116.46	1334.50	1534.37	1715.78	1880.64
CV (%)	1.58	1.61	1.75	1.53	1.26	1.03	1.12	1..03	1.07
LSD (0.05)	5.46	11.52	19.98	24.69	26.49	25.88	32.34	29.95	30.88
F test	**	***	***	***	***	***	***	***	***
SEM (±)	0.84	1.77	3.06	3.79	4.06	3.97	4.96	4.59	4.73

Figures followed by the same letter in a column are not significantly different by DMRT at a 5% confidence level. LSD= Least Significant Difference, NS= non-significant, * significant at 5% level and *** significant at 0.1% level.

Similar result is also reported by Neupane *et al*. (2019) in which significant difference (P<0.05) for weight gain with different level of treatment of probiotic in Giriraja and Sakini chicken. The growth promoting effect of probiotic is also in accordance with the result of Shah *et al.* (2013). According to him probiotic supplementation in diet significantly (p<0.05) increases the body weight in all weeks

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compared to that of without probiotic. Similarly, Carvalho (2005) also reported that probiotic in broiler chicken diets effectively improved body weight at market age. Khaksefidi, (2005) also reported that the live weight of the group receiving probiotic (similar proportion of six strains namely *Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium bifidum*, *Aspergillus oryzae*, *Streptococcus faecium* and *Torulopsis sps*) supplemented with 100 mg per kg diet on the 4th, 5th and 6th weeks (was higher (p<0.05) than control. Above findings were also similar to those of Rahman *et al.* (2013) and Shah *et al.* (2013) as they found significant increase in body weight gain of broilers fed diet supplemented with enzymes and probiotics. Significant positive effect of probiotics is also in line with the Fritts *et al*. (2000) and Kabir *et al*. (2004). Moreover, Edens *et al.* (1997) reported that inovo and ex ovo administration of *Lactobacillus reuteri*couldincreasevillus height, indicating that probiotics are potentially able to enhance nutrient absorption and thereby improve growth performance and feed efficiency.

Feed conversion ratio and dressing percentage

The conversion ratio and dressing percentage of experimental birds was presented in Table 5. The feed conversion ratio and dressing % was found better in 1g Probiotic supplementation followed by 0.5g and 1.5g Probiotic supplementation.

Table 5. Feed conversion ratio and dressing percentage of experimental birds

Treatments	Feed Intake (g)	Weight Gain (g)	FCR	Dressing %
Basal Diet	6936.46	1793.62^{c}	3.87^{a}	78.55^{b}
0.5g probiotic	6938.56	1891.40^{b}	3.67^{bc}	84.02^{a}
1g Probiotic	7028.64	1957.96^{a}	3.59^{c}	85.03^{a}
1.5g Probiotic	6976.84	1879.56^{b}	3.72^{b}	81.73^{ab}
Grand mean	6970.13	1880.64	3.71	82.33
CV (%)	0.92	0.87	1.36	2.86
LSD (0.05)	120.92	30.88	0.09	5.33
F test	NS	***	***	**
SEM (±)	18.54	4.73	0.01	0.44

Figures followed by the same letter in a column are not significantly different by DMRT at 5% confidence level. LSD= Least Significant Difference, SEM= Standard error of the mean, * significant at 5% level, and *** significant at 0.1% level.

There is no significant difference in the total feed intake among the treatment group but there is a highly significant difference in the total body weight gain among different treatment groups where the highest is in the treatment group with 1g probiotic in diet followed by 0.5 g, 1.5 g, and the group without the inclusion of probiotics in diet respectively. The feed conversion ratio was significantly better in the treatment group with the inclusion of 1g probiotic in a diet than that of the treatment group with 1.5 g probiotic in diet and diet without the inclusion of probiotic but the feed conversion ratio of the treatment group with 1g probiotic in the diet has statically similar feed conversion ratio with that of 0.5g of probiotic in the diet. This result is supported by the Pelicano *et al.* (2004) who used two commercial probiotics, the first composedof Bacillus subtilis (150 g/ton feed) and the second with *Lactobacillus acidophilus* and *casei, Streptococcus lactis and faecium, Bifidobacterium bifidum and Aspergillus oryzae* (1 kg/t feed) for broilers and observed an improvement in feed conversion ratio in birds receiving probiotics, regardless of the composition, in relation to the group without any addition. Anjum *et al.* (2005) observed that there was a significant (P≤ 0.05) improvement in feed conversion ratio after supplementation of multi-strain probiotics (protexin) in broilers.

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The Dressing percentage of experimental birds has a significant difference between treatments. The mean dressing percentage of experimental birds was noted as 82.33%, the highest dressing % (85.03%) was noted in treatment with the inclusion of 1 g probiotic in diet and followed by treatment with 0.5 g probiotic in diet (84.01%) and the lowest dressing percentage was observed in treatment without the inclusion of probiotics in the diet which was 78.55%. The higher value of the dressing percentage of birds inthe treatment group with a 1-gram probiotic in the diet is an indication that total edible meat from birds on this treatment is higher than meat yield from other treatments

CONCLUSION

This study concluded that there was no significant effect of probiotics in the feed intake of birds this may be due to fulfillment of the energy and nutrient requirement by improved digestion and utilization of consumed in probiotic-fed birds. Lower mortality also adds economic benefits throughthe inclusion of probiotics in the feed.Higher weight gain with the same level of feed intake in New Hampshire chicken may be because of the beneficial role of probiotics. Therefore, probiotics could be the choice due totheir better impact on New Hampshire’s performance.

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Authors’ Contributions

L. N. Pandey arranged the research concept, design, data analysis and writing the manuscript. M.K.Shah and J. Chaudharycontributed recording, entry of data, and statistical analysis.

Conflict of Interest

The authors of the paper declare that there is no conflict of interest for the publication of this manuscript.

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