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The Effect of Altitude and Dietary Protein Level on Local Ducks Performance

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Abstract: This study was conducted to evaluate the effects of altitude and dietary protein level on performance of local ducks. Two hundred and forty of female Pitalah ducks 14 weeks old were used in this study. Ducks reared on high altitude (H) and low altitude (L). The research was carried out by using Split-plot arrangement in a Randomized Block Design with the H and L as main-plot and the dietary protein level (PL: T-1 = 14, T-2 = 16, T-3 = 18% protein) as sub-plot. Treatments were done when duck was 16 weeks old. Observations were made after the production of duck was 10 %. The environment and rectal temperature were recorded daily. Variables such as: feed intake, protein intake, egg production (Duck day and Egg mass) and Feed Conversion Ratio (FCR) were observed weekly. The altitude were highly significantly ($P<0.01$) influenced on feed intake, protein intake, egg production (Duck day and Egg mass) and Feed Conversion Ratio (FCR). PL were not significant ($P>0.05$) affect to feed intake but significantly ($P<0.05$) increased duck day production and highly significant ($P<0.01$) increased egg mass and FCR. There was no interaction ($P>0.05$) between altitude and dietary of protein level. The results of this study showed that the performance of the duck raised on the H was better than L. The increasing of protein level up to 18% have been given the best performance of Pitalah duck.

Key words: Pitalah duck, altitude, protein levels, performance

INTRODUCTION

The animal performance is influenced by environment and genetic factors. The environmental influence is more than genetic. Environmental conditions in Indonesia, especially environmental temperature generally uncomfortable temperatures for poultry. Ducks are homeothermic animals requiring a comfortable environment to reach optimum production performance. The ambient temperature for raising ducks is 18.3-25.5°C (Wilson *et al*., 1980) while the environmental temperature in Indonesia ranges from 19-26°C at high altitude and 25-35°C at low altitude.

West Sumatra is located at different altitude so that the temperature and humidity are different. Bukittinggi and Padang are representative area for high and low altitude respectively, has temperature and humidity different based on altitude which over than 750 meters above sea level (masl) and 0-250 masl. Soribasya (1989) state that low altitude areas have altitude ranges between 0-250 meters above sea level, the moderate was 250-750 meters above sea level and a high altitude of more than 750 meters above sea level. The higher altitude from above`sea level, the lower temperature, so the animals will consume more rations to reach their energy needed, feed consumption is reduce as the ambient temperature rises, growth and egg production are decreased (Bell and Weaver, 2002). A part of ration energy is converted into heat to overcome a lower environmental temperature (Leeson and Summer, 2001). When the environment temperature reaches 29.4°C, the birds will be panting andand more heat will be eliminated from its body (Bell and Weaver, 2002), the metabolic rate was increased so that the productivity of livestock can be impaired (Bouverot *et al*., 1974). Bukitinggi region lies at an altitude of 900-940 meters above sea level with a temperature range between 16.1-24.9°C, while Padang lies at an altitude of 5-250 meters above sea level with a temperature range of 27-32°C.

An important economic goal of the poultry industry is to increase the productivity. However, the productivity of this industry is threatened by climatic, physical and social stressors. High environment temperatures will reduce feed intake, body weight gain and feed efficiency (National Research Council, 1994; Seyrek *et al*., 2004). According to Hurwitz *et al*. (1980) and Yahav *et al*. (1996), growth rate of commercial broilers after 3 wk of age is usually maximal at 18 to 20°C and progressively declines in warmer conditions. Arjona *et al*. (1988), Yahav and Hurwitz (1996) and Yahav and Plavnik (1999) reported that the losses caused by heat stress can be limited by adjustment of housing conditions, by husbandry management that enhance the adaptability of birds to heat stress conditions.

The productivity of local ducks in Indonesia both egg and meat are low and likely to be improved. According to Setioko (1990) productivity of laying ducks that is raised extensively was 26.9-41.3% and if raising intensively can reach 55.6%. The low egg production is partly due to

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inadequate feed. Feeding an additional 24 grams of shrimp heads could increase the duck day production from 38.3 to 48.9% and the weight of eggs increased from 69.9 to 71.1 grams.

The protein has an important role in egg formation. The protein requirement was influenced by factors of age, growth rate, reproduction, climate, energy levels, disease, family and strain, body size, egg production (National Research Council, 1994; Anggorodi, 1995), stage of production, cage, space of places to eat and ration energy (Amrullah, 2003).

Poultry require a balanced of protein and energy. A balanced feed in ingredient will be less of heat loss in the process of digestion than unbalanced ration. Rations with high protein and low energy can reduce growth and inefficient in feed usage (Leeson and Summer, 2001). This study aims to determine the interaction of altitude and protein level on the local ducks performance.

MATERIALS AND METHODS

Materials research: This study used 240, fourteen weeks old female Pitalah ducks were obtained from ducks which was raised extensively in Tanah Datar regency, Batipuh district. Ducks were divided into two groups maintained at two different altitude areas for each group which represent High (H) and Low altitude (L), they were Bukitinggi (H) and Padang (L) with altitude respectively more that 750 and 0-250 m above sea level. At each altitude were maintained 120 ducks. Ducks were divided into 12 experimental units (3 dietary of protein level treatments with 4 replications), then placed randomly in colony litter cages (100 x 200 x 75cm). The treatments were started at 16-weeks-old. From 16 to 40 weeks-old, ducks fed rations consisting of three protein level, T-1 (14% protein), T-2 (16% protein) and T-3 (18% protein). All treatment rations were formulated to be isocaloric (2700 kcal/kg).

The composition of feed and its ingredients were presented in Table 1. Rations were given three times daily in the morning (08:00), at noon (12:00) and afternoon (17:00), water was supplied *ad libitum*. Environment temperature and rectal temperature were recorded three times daily in the morning (06:00), noon (12:00) and afternoon (18:00). Rectal temperature was taken from one duck per unit. Observations for feed intake, egg production (duck day and egg mass) and Feed Conversion Ratio (FCR) were made after 10% duck production and it called the first week observation. Observations made during four-week period, such as the week of 1-4, 5-8, 9-12 and 13-16.

The research was done by experimentation, using the Randomized Block Design with Split-plot patterns 2 x 3 with 4 replications, with high altitude and low altitude as main plot and the dietary of protein level (T-1, T-2, T-3) as subplot. The data were analyzed with ANOVA and effect test from all treatments using Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1995).

Table 1: Composition and nutritive value of the diets

Ingredient	T-1	T-2	T-3
Corn	43	36	27
Rice bran	33.5	37	39.5
Soybean meal	8	6	5
Concentrate	11.5	20	28.5
Coconut oil	1	0	0
Bone meal	3	1	0
Total	100	100	100
Nutrient content			
Crude protein (%)	14.25	16.18	18.23
Metabolizable Energy (Kkal/kg)	2708	2730.7	2777.25
Crude fat (%)	3.63	2.72	6.36
Fiber content (%)	5.217	5.83	3.10
Ca (%)	2.44	2.61	3.12
P (%)	0.62	0.52	0.54

source: Analysis of laboratory, Faculty of Animal Science, Andalas University. Wahju (1997); Sabrina (2011)

RESULTS AND DISCUSSION

The first week production was calculated at 10% of duck production, where the age of ducks were 23 weeks old.

Feed intake: Average feed intake of Pitalah duck at during 16 weeks observation (four experimental periods) showed at Table 2.

Analysis of variance showed that there were no interaction effect between altitude and the dietary of protein level in average daily feed intake throughout the experimental period. However, the average daily feed intake at high altitude (H) was higher ($P<0.01$) than low altitude (L). There was no significant ($P>0.05$) of dietary treatment (PL) on average daily feed intake.

Table 2 showed that the altitude was highly significant ($P<0.01$) affected feed intake. This was caused by temperature difference between sites in both of study. The temperature on the high altitude is lower than low altitude so that ducks were kept in high altitude the consumption of ration was more than low altitude. The average temperature in the H and L during the study were 22, 74 and 26, 05°C. The temperature at H was a comfortable temperature for duck. According to Wilson *et al*. (1980) that the comfortable temperature for ducks is 18.3 to 25.50°C while above of it was an uncomfortable temperature for ducks. The increase of water consumption cause feed intake decrease. If the environment temperature rises above 25°C, the ducks should be panting and metabolic rate was increased. In this research, the environment temperature at L was 26, 5°C, so that ducks increased water consumption as one attempt to remove heat body, consequently the feed consumption of livestock was reduced. According to Baile and Mayer (1970), the increasing environmental temperature above neutral zone (thermoneutral zone) will be detected by thermoreceptor in the hypothalamus.

Table 2: The Average of feed intake (g/duck/day)

Experimental period (wk)	H T-1	H T-2	H T-3	L T-1	L T-2	L T-3	SE	Statistical analysis Alt	PL	Interaction
1-4	140.36	143.26	146.89	128.54	129.58	130.76	2.23	**	NS	NS
5-8	160.68	161.41	163.75	145.16	147.32	148.62	1.66	**	NS	NS
9-12	157.46	160.44	159.42	137.40	134.91	133.68	2.21	**	NS	NS
13-16	156.05	155.78	157.09	132.92	133.09	132.97	2.23	**	NS	NS

H: High altitude; L: Low altitude, T-1: 14% protein; T-2: 16% protein; T-3: 18% protein, **: Highly Significant (P<0.01), NS: Non significant (P>0.05), SE: Standard of error, Alt: Altitude; PL: Protein level

Table 3: The average of protein intake (%)

Experimental period (wk)	H T-1	H T-2	H T-3	L T-1	L T-2	L T-3
1-4	19.65	22.92	26.44	17.99	20.73	23.54
5-8	22.49	25.82	29.47	20.32	23.57	26.75
9-12	21.76	25.67	29.06	18.83	21.58	24.58
13-16	21.85	24.92	28.28	18.25	21.29	24.40

This signal will be taken to the "satiety" center to inhibit the appetite so the ducks reduce feed intake. Kusnadi (2006) reported that feed consumption of broiler reared at temperature of 24°C were 1899 g significantly higher than those reared at temperature 32°C with feed consumption 972 g. The results were in agreement with Lu *et al*. (2007) who reported that the feed consumption of broiler reared at temperature 21°C were 169.9 g/d significantly higher than reared at temperature 34°C with feed consumption 93.6 g/d.

According to Cole (1996) the feed intake is influenced by age, body weight, level of production, environmental temperature and nutrient content of the feedstuff. Leeson and Summer (2001) reported that poultry eat to get energy required and they will stop to eat when energy needed is achieved. The rations containing 14% protein for chicken age 0-8 old weeks can reduce feed intake to 20% and weight loss up to 25% than chickens fed 20% protein ration Leeson and Summer (2001).

Egg production

Duck day production (DDP): The average of DDP Pitalah ducks for four periods observation were presented in Table 4. Statistical analysis showed that there was no interaction between the altitude and dietary protein level (P>0.05) in DDP. The altitude were highly significant (P<0.01) affected DDP, therefor DDP at H was higher than L. It was closely related to feed consumption. The PL gave a significant effect (P<0.05) on egg production. It was shown in the observations of weeks 1-4 and 5-8. The highest egg production was obtained at 5-8 weeks of observation, 78.26% for H (Fig. 2), while the highest production at L was 54.11% (Fig. 3). At 9-12 week of observation the egg production was highly significant (P<0.05) affected by altitude while no affected by protein level (P>0.05). At 13-16 week of observation the egg production was significantly affected by altitude and significantly affected by protein level. However, overall for each period of observation there was no interaction between the altitude and level of protein but increasing levels of protein in the H and L significantly increased an egg production.

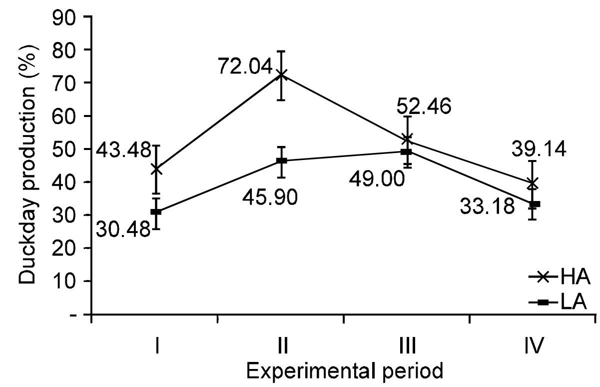

Fig. 1: Duck/day production at H and L

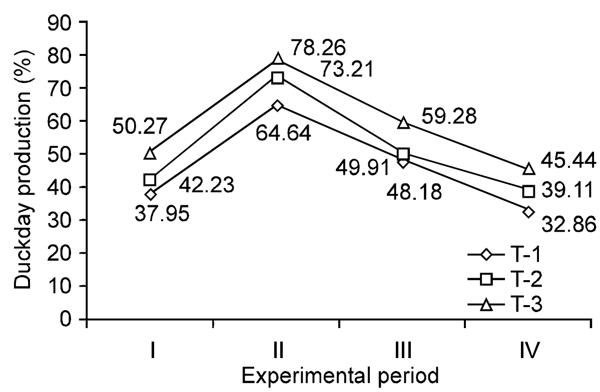

Fig. 2: Duck/day production at high altitude

Figure 1 showed the highest egg production obtained at 5-8 week of observation at H area (78.26%). It was caused the feed intake was significantly higher in H area so that the intake nutrients for egg formation was higher too. According to Yasin (1988) that the external factors which affecting production and egg weight are feed, cages, temperature, light, weight, age, level of production, disease and moulting. The result in this research is lower than the research of Chavez and Lasmini (1978) such as: 83% in Tegal ducks and 92.7% in Alabio duck at 2-3 months of production. This is caused by difference of production phase age of duck

Table 4: The Average of egg production (duck day production, %)

Experimental period (wk)	H T-1	H T-2	H T-3	L T-1	L T-2	L T-3	SE	Statistical analysis Alt	PL	Interaction
1-4	37.95	42.23	50.27	25.98	30.45	35.00	3.52	**	*	NS
5-8	64.64	73.21	78.26	41.70	41.88	54.11	4.67	**	*	NS
9-12	48.18	49.91	59.28	42.98	53.57	50.45	3.41	*	NS	NS
13-16	32.86	39.11	45.44	26.43	32.05	41.07	4.26	**	*	NS

H: High altitude; L: Low altitude, T-1: 14% protein; T-2: 16% protein; T-3: 18% protein, **: Highly Significant (P<0.01), *: Significant (P<0.05), NS: Non significant (P>0.05), SE: Standard of error; Alt: Altitude; PL: Protein level

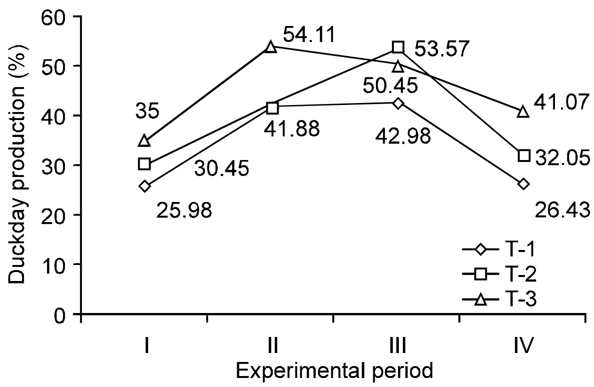

Fig. 3: Duck/day production at low altitude

that used. At low ambient temperatures the metabolism rate of homoeotherms livestock was follow the demand for heat. Temperatures were recorded during the study on the H and L respectively, are 18-27 and 25-31°C. Increasing temperature causes decreased metabolic rate (Abbas, 2004). Wilson *et al*. (1980) stated that ideal temperature for ducks and laying hens between 18.3 and 25.5°C. Temperature in Bukit Tinggi is ideal temperature for breeding duck. This result is consistent with Abbas (2004) who reported that on the high temperature on the life of poultry, 13-21°C is the ideal temperature for the life of poultry, while at 21-30°C feeding is reduced and drinking is increased. Consequently, production was decreased which usually followed by poor quality egg shells. At 30-32°C feed consumption, production and quality of eggs greatly reduced. At temperature 32-35°C, the feed consumption was decreased whereas the water consumption was increase. It was danger because of the heat. The higher environmental heat influenced egg production because of lower feed intake. At experimental period week 9-12 the altitude factor have significant effect (P<0.05) on egg production whereas the PL no different. At experimental period week 13-16, there was highly significant difference (P<0.01) between H and L but significant differences (P<0.05) in the PL.

Statistical analysis showed that egg production (duck day) was significant difference (P<0.05) affected by PL (14, 16 and 18%) with isocaloric of energy metabolism (2700 kcal/kg). Although feed intake was not significantly different but there was different in protein intake. Rations with high protein content has cause increase protein intake. Protein intake is needed to produce eggs. Pan *et al*. (1981) suggested that there was a significant increase in egg production and egg weight of ducks where the protein content increased from 15 to 19% with metabolic energy is 2650 and 2850 kcal/kg. Lack of protein in ration will result lower egg production, small egg produced, weight loss, weak of body and moulting (Forbes, 1985).

Egg Mass Production (EMP): The average of Egg Mass Production (EMP) of Pitalah ducks for four experimental period showed in Table 5.

Statistical analysis showed that there was no interaction between altitude and PL (P>0.05) on Egg mass of Pitalah Duck for all the experimental period. Observations 1-4 weeks and 5-8 weeks showed that EMP at H was highly significant difference (P<0.01) than L but at 9-12 weeks altitude was no significant affect (P>0.05) on egg mass. At the experimental period 13-16 week showed that altitude is highly significant difference (P = 0.01) on egg mass. The PL was significantly affect egg mass from 1-16 week of experimental period. The highest of EMP was obtained in ducks maintained at H with fed 18% of protein ration was 42.76g/duck, whereas at L the highest egg mass was obtained in the experimental period 9-12 weeks with a PL of 18% it was about 34.20 g/duck.

The eggs mass production (Egg Mass) is closely related to egg weight and egg production, because egg mass is obtained from multiplied of egg weight with egg production (Bell and Weaver, 2001). Leeson and Summer (2001) stated that the weight of poultry in special breed is closely related with egg weight. The main factors affecting egg weight is genetic and environmental factors. According to Stadelman and Cotterill (1973) poultry maintained at a temperature of 30°C produces eggs smaller than lower temperature (8 and 19°C). Similar results were obtained by Rasyaf (1991) who reported that egg weight was influenced by feed consumption, especially consumption of protein. Ivy and Glaves (1996) stated that weight of eggs were influenced by the balance of nutrients, especially amino acids, ingredients and the composition of ration consumed.

Observations 1-4 weeks showed that egg mass was low. It was caused by lack of egg production so that the average of production per duck was highly significant

Table 5: The Average of egg mass production (g/duck/day)

Experimental period (wk)	H			L				Statistical analysis		
	T-1	T-2	T3	T-1	T-2	T-3	SE	Alt	PL	Interaction
1-4	18.73	21.99	28.74	13.38	15.82	18.85	2.09	**	**	NS
5-8	34.54	42.44	42.76	22.08	24.35	31.95	2.61	**	**	NS
9-12	23.49	27.34	34.90	24.93	30.56	34.20	1.97	NS	**	NS
13-16	17.14	21.03	26.70	14.19	18.15	24.04	2.30	**	**	NS

H: High altitude; LA: Low altitude, T-1: 14% protein; T-2: 16% protein; T-3: 18% protein, **: Highly Significant (P<0.01), NS: Non significant (P>0.05), SE: Standard of error; Alt: Altitude; PL: Protein level

Table 6: The average of feed conversion ratio

Experimental period (wk)	H			L				Statistical analysis		
	T-1	T-2	T-3	T-1	T-2	T-3	SE	Alt	PL	Interaction
1-4	7.56	6.60	5.22	9.99	8.52	7.23	0.85	**	*	NS
5-8	4.66	3.84	3.49	6.83	6.11	4.84	0.49	**	*	NS
9-12	6.71	5.87	4.63	5.78	4.50	4.11	0.41	**	**	NS
13-16	9.12	7.68	5.94	9.44	7.60	6.00	0.74	**	**	NS

HA: High altitude; LA: Low altitude, T-1, : 14% protein; T-2: 16% protein; T-3: 18% protein, **: Highly Significant (P<0.01), *: Significant (P<0.05), NS: Non significant (P>0.05), SE: Standard of error; Alt: Altitude; PL: Protein level

(P<0.01) decreased at L. Rasyaf (1991) stated that egg weight is influenced by feed consumption, especially consumption of protein ration. Ivy and Glaves (1996) stated that weight of egg is influenced by balance of nutrients, especially amino acids from material and composition of ration consumed. Although feed consumption at various levels of the protein did not show significant differences but protein intake with PL in the ration up to 18% was higher than 16%, as well as protein level 16% higher than 14% as shown in Table 3. The increase of PL was also highly significant (P<0.01) increased of egg mass. At 5-8 weeks showed that ducks reared H had highest (P<0.01) egg mass than L. The increase PL also highly significant increased egg mass in 5-8 weeks. Egg mass was highest that obtained in ducks raised on H which observation at 5-8 weeks with PL in the ration as much as 18% is equal 42.76 g/duck, whereas in L the highest egg mass obtained in observation periods 9-12 weeks with PL of 18% was 34.20 g/day/duck. At 9-12 weeks the egg mass was not influenced by altitude (P>0.05). This indicated that ducks have acclimatized to environmental temperature. According to Daghir (2008) adult birds will undergo acclimatization after 3-5 days when it was brought to temperature hot or cold environments. As stated by Cole and Haresign (1989) egg production can be increased in hot temperature (30°C) with increasing nutrients concentration. Improved PL is also highly significant affect egg mass. At week 13-16 the altitude significant influenced (P<0.01) egg mass. The ducks reared at H had highest egg mass than L. Rates of protein fed high significantly affect egg mass at week 13-16 in observation period. In this period egg mass production was very low. It caused by duck day production was also very low, that indicating ducks will be moulting.

Feed Conversion Ratio (FCR): The average of Feed Conversion Ratio (FCR) of Pitalah duck for four periods of observation showed at Table 6. Statistical analysis showed that there was no interaction between the altitude and PL (P>0.05) on feed conversion ratio of Pitalah duck. So FCR was highly significant influenced (P<0.01) by altitude and significant influenced (P<0.05) by protein level.

Observations (FCR) at weeks 1-4 showed that increasing PL in the H and L produce a better FCR well. The best FCR obtained at 5-8 weeks of observation in H while in L the best FCR obtained at 9-12 weeks of observation. Increasing protein levels are generally able to improve FCR.

Table 6 showed that the FCR at week 1-4 in H area was highly significant (P<0.01) better than L. The average FCR in the H is 6.46 and in Lis 8.58. Improving PL at each altitude significantly (P<0.05) improve FCR. It was closely related to higher egg production in H production with increasing PL. At 5-8 weeks FCR was highly significant (P<0.01) better than L an average of 4.00 and 5.93. This was indicated that Duck maintained at H have FCR better than the L because the temperature on the H is more convenient. Consequently, the feed utilization was improved. According to Ketaren (2002) laying ducks FCR ranged from 3.2-5, this is worse than laying chicken i.e., 2.4-2.6. This indicates that feed efficiency in laying ducks is very bad compared laying chicken. It was caused by (1) genetic factors (2) amount of spilled feed (3) nutritional feed is achieved the needed. FCR is affected by ration protein level, metabolic energy, age, breed, size, the availability of nutrients in the ration, temperature and animal health (Whittow, 2000).

Average FCR in this study ranged 6.46 to 8.58 (at weeks 1-4) and 4.00 to 5.93 (at weeks 5-8), were higher than the statement of Ketaren and Prasetyo (2000) is 4.10. The smaller FCR the better ration fed level.

Conclusion: Feed intake, protein intake, egg production (Duck day and Egg mass) and Feed Conversion Ratio (FCR) were highly significant influenced by altitude. PL was not significantly affected feed intake but increase day duck production, egg mass and FCR. There was no interaction between altitude and protein level. The performance of the ducks reared on the High altitude area were better than Low altitude area. The increasing of protein level up to 18% was the best for ducks performance.

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