Growth Performance of Broiler Chickens fed with Crude Glycerin from Large and Medium Scale Biodiesel Producers in Thailand

Astiari Tia Legawa[1], Sutha Wattanasit[1], and Chaiyawan Wattanachant[1]
[1]Department of Animal Science, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songhkla 90112, Thailand.
Corresponding email: chai_tum@yahoo.com

ABSTRACT

The aim of this study was to understand the effect of crude glycerin from different sources on growth performance of broilers. Crude glycerins were derived from medium (38.36% glycerol and 23.91% crude fat) (CGM) and large (88.49% glycerol and 1.73% crude fat) (CGL) scale Thailand's biodiesel producers. A number of 180 male Ross-308 day old chicks were randomly allocated into 3 treatments group consisting 4 replication each. One way ANOVA in a completely randomized design with post-hoc tukey was used in this experiment. The treatments diet were: basal diet (T1), diet with 5% CGM inclusion (T2), and diet with 5% CGL inclusion (T3). The growth performances, such as, feed intake, body weight gain, and feed conversion ratio (FCR) were observed every week in 6 weeks rearing period. During 1 to 21 days, broilers received T2 had the highest feed intake and body weight gain, meanwhile, T3 had the lowest feed intake and similar body weight gain to the T1, consequently, T3 had the best FCR. In 22 to 42 days, crude glycerin did not give any effect to the growth performances. Overall result from day 1 to day 42, crude glycerins did not give any significant effect ($P > 0.05$) to the feed intake, body weight gain, and FCR, however, it tended to give better feed efficiency as it had lower FCR than those received control diet. In conclusion, both crude glycerins did not give any negative effect to the growth performance and it could be applied in the broiler's diet.

Keywords: Broiler chicken, Crude glycerin, Growth performance.

INTRODUCTION

Biodiesel production has been enhancing as the demand of the renewable energy in the world increasing. Southeast Asia countries such as, Indonesia and Thailand has been developing year by year and in 2024, it is expected to become the 5th and 6th biggest biodiesel producer in the world, respectively (FAO, 2015). Biodiesel has by product known as crude glycerin, crude glycerin has low commercial value due to its contaminant content. It is suggested to be applied for non ruminant 5 to 10% inclusion in the diet. Crude glycerin is recommended to be included in the broiler chicken feed about 5%, it gave a positive effect, such as, increasing the feed intake, increasing body weight, and better feed efficiency than no glycerin diet (Cerrate et al., 2006; Sehu et al., 2012; Silva et al., 2012). Study about crude glycerin in broiler chicken mainly focusing on the level of crude glycerin inclusion affecting the growth performance and it used crude glycerin from soybean oil as the biodiesel feedstock with high content of glycerol. Comparison between crude glycerin with a significant difference on its chemical and physical properties with palm oil as the biodiesel feedstock were still lacking. This study focused on the differences between those crude glycerins on the growth performance of broiler chicken. Diet with crude glycerin inclusion is expected to give better feed efficiency than diet without crude glycerin.

MATERIALS AND METHODS

A total of 180 one-day-old male broiler chickens (Ross 308) were obtained from the commercial hatchery. The chickens were allocated randomly into 3 feeding treatments each had 4 replication with 15 chickens per replicate pen (1.5 x 2.3 m^2). Experiment was conducted in an evaporative housing system. The chicken were provided with 24 hours light per day and had *ad libitum* access to the feed and water. Experimental feeds were based on corn-soybean meal, it was formulated into two feeding phases according to NRC (1994) and it was given in mash form. The crude glycerins were analyzed by Sri-muang *et al.* (2015), it had significant difference on its chemical and physical properties, the first crude glycerin was obtained from large scale biodiesel producer with palm oil as the feedstock, it had low content of fat (1.73%) and high content of glycerol (88.49%), hereafter called CGL, the appearance was light yellow and transparent. The second crude glycerin was obtained from medium scale biodiesel producer with wasted vegetable oil and animal fat as the feedstock, it had high content of fat (23.91%) and low content of glycerol (38.36%), hereafter called CGM, the appearance was black and high turbidity. Metabolizable energy contents were calculated from the previous research (Legawa *et al.*, 2017), CGL were 3068.73 kcal/kg and CGM were 4054.52 kcal/kg. Table 1 shows the feed ingredients, composition and calculated nutrient of the experimental feed. On this study, a number of 5% crude glycerin inclusions in the diet from two different sources were evaluated. Body weight and feed intake data were taken every week (from week 1 to week 6) for calculating weight gain and feed conversion ratio. Growth performance data were analyzed using Completed Randomized Design (CRD) and further analysis (post-hoc) tukey by computer program SPSS version 16 (SPSS Inc., 2007).

Table 1. Experimental diet composition (as fed) and nutrients contents

Feed ingredient	1 to 21 day of age			22 to 42 day of age		
	T1	T2	T3	T1	T2	T3
Corn	56.90	51.20	51.20	63.18	57.28	57.28
Palm oil	5.00	5.00	5.00	5.00	5.00	5.00
Soybean meal	27.28	28.08	28.08	21.00	22.00	22.00
Fish meal	8.50	8.50	8.50	8.50	8.50	8.50
Dicalcium phosphate	1.40	1.40	1.40	1.40	1.40	1.40
DL-methionine	0.23	0.13	0.13	0.23	0.13	0.13
L-lysine	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin-mineral mix[1]	0.49	0.49	0.49	0.49	0.49	0.49
CGL	0.00	0.00	5.00	0.00	0.00	5.00
CGM	0.00	5.00	0.00	0.00	5.00	0.00
Calculated content						
ME (kcal/kg)	3190	3218	3170	3232	3260	3214
Crude protein (%)	23	23	23	20	20	20
Ether extract (%)	7.99	9.00	7.89	8.11	9.11	8.00
Lysine (%)	1.40	1.40	1.40	1.24	1.25	1.25
Methionine (%)	0.63	0.53	0.53	0.60	0.50	0.50
Calcium (%)	1.02	1.02	1.02	1.00	1.00	1.00
Available phosphorus (%)	0.54	0.54	0.54	0.53	0.53	0.53
Sodium (%)	0.21	0.21	0.21	0.21	0.21	0.21

[1]The vitamin-mineral mix provided the following (per kg of diet) : Vitamin A 2,000,000 IU, vitamin B_1 220 mg, vitamin B_2 450 mg, vitamin B_{12} 4.5 mg, vitamin D_3 320,000 IU, vitamin E 2,000 mg, vitamin K_3 330 mg, nicotinic acid 600 mg, Fe 10,000 mg, Cu 100 mg, iodine 150 mg, Zn 8,800 mg, Mn 8,800 mg, Ca 52,800 mg, Co 130 mg.

RESULTS AND DISCUSSION

Both crude glycerin used in the experiment gave different effect on the growth performance. The growth performance in the starter phase from 0 to 21 days of 5% crude glycerin inclusion in the diet was shown in the Table 2. Crude glycerin gave a significance effect to growth performance in the starter phase. On the first two weeks, broilers with experimental feed T2 had the highest body weight gain ($P < 0.001$), this is due to broilers with T2 had the highest feed intake ($P < 0.001$). Consequently, the feed conversion ratio was no different compare to the other experimental feeds. Even though, T2 significantly increased the feed intake, T3 which the experimental feed also containing crude glycerin did not increase the feed intake like T2, instead broilers fed with T3 had the lowest feed intake in the starter phase ($P < 0.001$), however, the body weight gain is similar to the broiler fed with no crude glycerin and broiler fed with T2 ($P > 0.05$) at third week of feeding period, thus, broilers fed with T3 having the best feed conversion ratio ($P < 0.001$). The high feed intake maybe cause by the sweet taste of the feed and better feed structure, such as less dusty and better consistency than control diet, thus, increase the palatability.

Table 2. Growth performance in the starter phase (0 to 21 day)

Parameters	T1	T2	T3	*P*-value	SEM
Initial weight (g)	44.09 ± 0.28	44.09 ± 0.28	44.09 ± 0.28	-	-
Weight gain (g)					
1 to 7 d of age	126.21 ± 3.55^{b}	132.60 ± 4.66^{a}	129.37 ± 4.39^{ab}	0.019	0.604
1 to 14 d of age	404.09 ± 25.19^{b}	432.14 ± 16.71^{a}	389.23 ± 24.16^{b}	0.000	3.208
1 to 21 d of age	813.90 ± 19.83	836.03 ± 39.33	834.45 ± 25.63	0.120	4.981
Feed intake (g)					
1 to 7 d of age	145.59 ± 5.73^{ab}	148.11 ± 8.08^{a}	141.53 ± 5.25^{b}	0.021	0.935
1 to 14 d of age	432.96 ± 31.02^{b}	463.09 ± 13.05^{a}	414.16 ± 31.06^{b}	0.000	3.773
1 to 21 d of age	1073.69 ± 20.56^{a}	1073.25 ± 55.57^{a}	934.76 ± 46.33^{b}	0.000	7.350
FCR					
1 to 7 d of age	1.154 ± 0.05^{a}	1.117 ± 0.05^{ab}	1.094 ± 0.03^{b}	0.030	0.005
1 to 14 d of age	1.074 ± 0.08	1.073 ± 0.05	1.069 ± 0.11	0.986	0.012
1 to 21 d of age	1.320 ± 0.04^{a}	1.284 ± 0.04^{a}	1.122 ± 0.08^{b}	0.000	0.011

^{a,b,c} Means within the row with different superscripts differ significantly *(P<0.05)*

Clark *et al.* (2014) explained about the sense of taste in the bird, bird is known to have fewer taste receptor genes than other vertebrates, however, the taste receptors are well developed with significant function for gustation that affect bird behavior and habit of feedings. Similar result by Simon *et al.* (1996) and Min *et al.* (2010), reported 5% inclusion of crude glycerin increase the feed intake because of the sweet taste of crude glycerin. However, the contrary result with experimental feed T3 which had low feed intake could be explained by Cerrate *et al.* (2006) and Jung and batal (2011), they reported that crude glycerin affected the feed flowability, such as, low flow rate in the feeders and digesta passages. The best FCR of T3 may be due to the low rate digesta passage, although it might cause the low feed intake, but it would increase the time for nutrient absorption, digestion and growth of gut microflora (Washburn, 1991; Sacranie *et al.* 2005). In addition, Lima *et al.* (2013) reported the young broilers have higher capacity to use the energy content from the crude glycerin than older broilers because of its physco-chemical properties, which maybe also take a part for increasing the feed efficiency.

In the next phase from 22 to 42 day of age (Table 3), there was no significant different on the growth performance between broilers fed with crude glycerin compare to the control.

Henz *et al.* (2011) reported that crude glycerin has effect on growth performance only in the first tenth days of the feeding period of broiler. Overall result from 1 to 42 day of age, there was no significant different on the body weight gain, feed intake, and feed conversion ratio between the experimental feeds due to glycerol utilization decreases as chickens age (Cerrate *et al*. 2006, McLea *et al.* 2011). Other authors which also did research with 5% inclusion of crude glycerin, concluded that crude glycerin did not affect the growth performance of broilers were Cerrate *et al.* (2006), Silva *et al.* (2012), and Urgnani *et al.* (2014).

Table 3. Growth performance in the grower phase (22 to 42 day)

Parameters	T1	T2	T3	*P*-value	SEM
Initial weight (g)	44.09 ± 0.28	44.09 ± 0.28	44.09 ± 0.28	-	-
Weight gain (g)					
1 to 42 d of age	2630.40 ± 180.77	2668.75 ± 143.88	2692.40 ± 157.57	0.686	28.444
22 to 42 d of age	1786.89 ± 60.80	1760.86 ± 36.59	1778.00 ± 43.56	0.524	9.252
Feed intake (g)					
1 to 42 d of age	4486.00 ± 166.14	4398.50 ± 97.47	4484.50 ± 130.65	0.216	23.450
22 to 42 d of age	3411.84 ± 159.16	3326.90 ± 67.34	3521.42 ± 125.73	0.137	35.619
FCR					
1 to 42 d of age	1.711 ± 0.12	1.652 ± 0.09	1.668 ± 0.08	0.358	0.017
22 to 42 d of age	1.909 ± 0.04^{ab}	1.889 ± 0.09^{b}	1.981 ± 0.06^{a}	0.017	0.012

^{a,b,c} Means within the row with different superscripts differ significantly *(P<0.05)*

In addition, Topal and Ozdogan (2013) found that 4% inclusion of crude glycerin had better feed conversion ratio than broilers with no glycerin, although the body weight gain and feed consumption were not significantly different. The same trend happened on this study, although the FCR was statistically not significant.

CONCLUSIONS

Physical and chemical variation in crude glycerin would give different effect on feed intake, body weight gain, and FCR in the starter phase. Broilers fed with crude glycerin were likely to have better FCR than broilers without crude glycerin during 42 days rearing period**.** Crude glycerin from large and medium scale biodiesel producer was applicable to be used in broiler diet.

REFERENCES

Cerrate, S., F. Yan, Z. Wang, C. Coto, P. Sacakli, and P. W. Waldroup. 2006. Evaluation of glycerine from biodiesel production as a feed ingredient for broilers. Int. J. Poult. Sci. 11: 1001-1007.

Clark, L., J. Hagelin, and S. Werner. 2014. The Chemical Senses in Birds. USDA National Wildlife Research Center, Lincoln.

FAO. 2015. Biofuels, in OECD-FAO Agricultural Outlook 2015. OECD Publishing, Paris:

Henz, J. R., R.V. Nunes, C. Eyng, P.C. Pozza, R. Frank, R.A. Schone, and T. M. M. Oliveira. 2011. Effect of dietary glycerin supplementation in the starter diet on broiler performance. Czech J. Anim. Sci. 12: 557-563.

Jung, B. and A. B. Batal. 2011. Nutrional and feeding value of crude glycerine for poultry. 2. evaluation of feeding crude glycerine to broilers. J.Appl. Poult. Res. 20: 514-527.

Legawa, A. T., S. Wattanasit, and C. Wattanachant. 2017. Dry matter digestibility and metabolizable energy of crude glycerin originated from palm oil using fed rooster assay. Acta Sci. Animal Sci. (in press).

Lima, E. M. C., P. B. Rodriques, R. R. Alvarenga, V. M. P. Bernardino, L. Makiyama, R. R. Lima, V. S. Cantarelli, and M. G. Zangeronimo. 2013. The energy value of biodiesel glycerine products fed to broilers at different ages. J. Anim. Physiol. Anim. Nutr. 97: 896-903

McLea, L., M. E. E. Ball, D. Kilpatrick, and C. Elliott. 2011. The effect of glycerol inclusion on broiler performance and nutrient digestibility. Brit. Poult. Sci. 52: 368-375.

Min, Y. N., F. Yan, F. Z. Liu, C. Coto, and P. W. Waldroup. 2010. Glycerin-a new energy source for poultry. Int. J. Poult. Sci. 9: 1-4.

Sacranie, A., P. A. Iji, and M. Choct. 2005. Reflux of digesta and its implications for nutrient digestion and bird health. Australian Poultry Science Symposium. Vol 17: 171-175.

Sehu, A., S. Kucukersan, B. Coskun, B. H. Koksal, and O. B. Citil. 2012. Effects of dietary glycerol addition on growth performance, carcass traits and fatty acid distribution in cloacal fat in broiler chickens. Revue Med. Vet. 163: 194-200.

Silva, C. L. S., J. F. M. Menten, A. B. Traldi, R. Pereira. K. C. Zavarize, and J. Santarosa. 2012. Glycerine derived from biodiesel production as a feedstuff for broiler diets. Rev. Bras. Cienc. Avic. 14: 159-232.

Simon, A., H. Bergner, and M. Schwabe. 1996. Glycerol-feed ingredient for broiler chickens. Arch. Anim. Nutr. 49: 103-112.

SPSS Inc. 2007. SPSS for Windows version 16.0. SPSS Inc, Chicago.

Sri-muang, S., C. Wattanachant, W. Ngampongsai, and A. Settapong. 2015. Quality of crude glycerin from small medium and large biodiesel production. Thai J. Anim. Sci. 2: 245-250.

Topal, E. and M. Ozdogan. 2013. Effects of glycerol on the growth performance, internal organ weights, and drumstick muscle of broilers. J. Appl. Poult. Res. 22: 146-151.

Urgnani, F. J., C. R. A. Duarte, A. E. Murakami, K. P. Picoli, C. Eyng, and J. C. Fanhani. 2014. Performance, meat quality and lipid profile of broiler chickens fed with crude and semi-purified vegetable glycerin from biodiesel production. Anim. Nutr. Feed Techn. 14: 431-445.

Washburn, K. W. 1991. Efficiency of feed utilization and rate of feed passage through the digestive system. Poult. Sci. 70: 447-452.