Provided for non-commercial research and education use.

Not for reproduction, distribution or commercial use.

This article was published in an Sjournals journal. The attached copy is furnished to the author for non-commercial research and education use, including for instruction at the authors institution, sharing with colleagues and providing to institution administration.

Other uses, including reproduction and distribution, or selling or licensing copied, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Text form) to their personal website or institutional repository. Authors requiring further information regarding Sjournals´s archiving and manuscript policies encouraged to visit:

http://www.sjournals.com

© 2020 Sjournals Publishing Company

Sjournals
Scientific Journals

Scientific Journal of Animal Science (2020) 9(3) 578-586
ISSN 2322-1704
doi: 10.14196/sjas.v9i3.2635

CODEN (USA): SJASAB

Contents lists available at Sjournals

Scientific Journal of **Animal Science**

Journal homepage: www.sjournals.com

Original article

Growth performances of broiler chickens fed on palm kernel meal based diet supplemented with spirulina and amino acids

Divine Doriane Yemdjie Mane[a,*], Ruben Ngouana Tadjong[a], Jean Raphaël Kana[b], Vanessa Mafouo Sonhafouo[b], Agwah Ebile Dayan[b], Aexis Teguia[b]

[a]*Laboratory of Aquatic Resources, Department of Aquaculture, Institute of Fisheries and Aquatic Sciences, University of Douala, Cameroun.*

[b]*Laboratory of Animal Nutrition, Department of Animal Science, University of Dschang, Cameroon.*

*Corresponding author: dyemdjie5@yahoo.fr

A R T I C L E I N F O

Article history,
Received 12 February 2020
Accepted 13 March 2020
Available online 20 March 2020
iThenticate screening 14 February 2020
English editing 11 March 2020
Quality control 18 March 2020

Keywords,
Broiler chicken
Growth performance
Lysine-methionine
Spirulina
Soybean meal
Palm kernel meal

A B S T R A C T

This study was assigned to assess the effect palm kernel meal as protein source in broiler chickens diet. The experimental rations consisted of replacing soybean meal by palm kernel meal at the rates of 50, 75 and 100 percent supplemented with lysine-methionine and spirulina and a control ration without palm kernel meal. The main results revealed that, all the growth parameters decreased with increasing rate of substitution of soybean meal with palm kernel meal. Compared to the control ration containing soybean meal as main protein source, feed conversion ratio increased by 25.97; 39.39 and 71.43 % with lysine-methionine mixture and by 40.34; 53.22 and 62.66% with spirulina in rations containing 50, 75 and 100 % palm kernel meal respectively. Carcass yield globally decreased, with the exception of carcass yields with 75% palm kernel meal supplemented with lysine-methionine that increased by 3.48 % compared to the control ration. The relative weight of the legs, head and digestive organs increased with increasing rate of palm kernel meal in feed regardless of the supplement. The lowest cost of production was recorded with spirulina compared to lysine-methionine regardless of the level of incorporation of palm kernel meal in feed. In conclusion, using large quantities of palm kernel meal even enriched with amino acids or proteins rich resources is not profitable to broiler chickens.

© 2020 Sjournals. All rights reserved.

1. Introduction

African countries are the major producers of peanuts, cotton and palm kernel meal, which are used as the main source of protein in animal feed. Of all these by-products, palm kernel meal is the least expensive (Olorede et al., 2000; Abd El Tawab et al., 2018). However, because of its gravelly appearance and high cellulose content, it has not yet been recommended by nutritionists in poultry feed, however its fiber contains β-mannose, an enzyme that hydrolyses mannose for the proper use of nutrients and metabolizable energy of this meal (Marini et al., 2005; Ahmed and Mostafa, 2018). Studies revealed that palm kernel meal is poorly digestible, poor in lysine and methionine which are limited in poultry (Ezieshi et al., 2007; Boateng et al., 2008; Sundu et al., 2008). This deficiency requires the use of protein-rich supplements when used in large quantity in the diet.

Obtaining by synthesis or extraction, certain amino acids and proteins currently allows researchers to reconsider the problem of supplementation in animal nutrition. The current trend is to supplement feed with one or more amino acids and / or synthetic proteins (Mateo et al., 2007; Brown et al., 2012; Wu et al., 2014) resulting in poultry farming by the systematic introduction of methionine and lysine in diets, as the need for sulfur amino acids are highly needed in poultry production (Belloir et al., 2015). However, in most African countries these synthetic amino acids are expensive and are not always available to small farmers. Hence, there is a need to look for cheaper and available natural sources that can provide these amino acids in the diets of animals. In this perspective, *Spiriluna platensis*, an alga rich in nutrients (Evans et al., 2015; Makkar et al., 2016; Zahir et al., 2019), is a potential ingredient that can enhance the nutritional value of animal diets containing palm kernel meal. Therefore, the objective of this study is to promote the use of local feed resources like palm kernel meal in broiler chickens diet.

2. Materials and methods

2.1. Area of study

This study was conducted at the Teaching and Research Farm of the Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon. This farm is located at an altitude of 1420 m above sea level, between latitude 05°26’N, and longitude 10°26’E. The annual rain fall varies between 1500mm and 2000 mm. The wet season lasts from March to November and the dry season from late November to mid-March. The average temperature and relative humidity is 20°C and 76.8%.

2.2. Palm kernel meal

Palm kernel meal used in this study was purchased from a palm kernel oil extraction factory in the city of Douala (Cameroon). The proximate analyses showed that palm kernel meal contained 17.15% of crude proteins; 24.25% crude fiber; 9.67% fat; 3.34% ash; 0.1% Na; 4% K; 2.2% Ca; 1.4% Mg and 0.4% phosphorus.

2.3. Birds and management

Experimental animals were constituted by 294 twenty-one days old sexed chickens of Cobb 500 strain, with an average weight of 887.75g. The chicks were vaccinated against bronchitis (H120) and NewCastle's disease (Hitchner B1) on the 7th day with a booster dose on the 18th day and against Gumboro disease (IBA Gumboro) on the 10th day. Antistress (Tetracoli®) was served in drinking water for the first 3 days from the day of arrival of the chicks. An anticoccidian (Vetacox®) and vitamins (AMINTOTAL®) were served in drinking water for three consecutive days every week. The chicks were randomly distributed into 21 experimental units of 14 chicks each (07 males and 07 females).

2.4. Experimental diets

Four experimental diets were formulated from the basal diet (T0) by substituting soybean meal with palm kernel meal at the rate of 50, 75 and 100%. These rations were enriched with lysine-methionine or with spirulina (Table 1).

Table 1
Composition of experimental diets.

Ingredients (%)	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Maize	60	62.45	61.25	60.86	64	62.5	62.25
Cotton seed meal	4	3.7	3.70	2.4	3	3.5	2.35
Soybean meal	17	8.5	4.25	0	8.5	4.25	0
Palm kernel meal	0	8.5	12.75	17	8.5	12.75	17
Fish meal	5	5.25	5	5.25	5	5	4.5
Blood meal	0	1	4.25	6	3.5	4.5	6.4
Bone meal	1	1	1	1	1	1	1
Wheat bran	7	0.5	0.70	0.35	0	0	0
Sea shells	1	1	1	1	1	1	1
premix 5%*	5	5	5	5	5	5	5
Lysine	0	0.4	0.4	0.44	0	0	0
Methionine	0	0.7	0.7	0.7	0	0	0
Spirulina	0	0	0	0	0.5	0.5	0.5
Total	100	100	100	100	100	100	100
Calculated chemical characteristics							
Metabolizable Energy (Kcal/kg)	2945.74	2856	2811	2778.69	2896.16	2846.53	2816.68
Crude protein (%)	21.02	20.40	20.01	19.76	20.68	20.43	20.03
Energy/Protein	140.11	140.04	140.50	140.61	140.05	140.30	140.63
Lysine (%)	1.24	1.63	1.60	1.66	1.26	1.25	1.24
Methionine (%)	0.45	1.14	1.13	1.12	0.45	0.45	0.43
Calcium (%)	1.40	1.45	1.44	1.46	1.43	1.44	1.42
Phosphorus available (%)	0.62	0,61	0.61	0.63	0.58	0.61	0.60
Crude fiber (%)	4.71	5,84	6.24	6.57	5.83	6.28	6.57
Cost per Kg of feed (FCFA)	233.75	266.56	256.64	248.31	218.8	217.20	199.10

*Premix 5%: Mineral Nitrogen and Vitamin Complex: Crude proteins=40%, Lysine=3.3%, Methionine=2.40%, Calcium=8%, Phosphorus=2.05%, Metabolizable energy=2078kcal/kg.

2.5. Growth performances

Feed intake was determined by calculating the difference between the quantity of feed served and the left over in each experimental units at the end of the week. Chickens were weighted at the beginning of the experiment and on weekly bases thereafter using an electronic balance of sensitivity of 0.1g. The average weekly weight gain was obtained by calculating the difference between two successive weekly weights. The feed conversion ratio (FCR) was obtained by dividing the quantity of feed consumed by the weight gained during the same week.

At the end of the feeding trial (49 days), 56 chickens were randomly selected, 8 chickens per treatment (04 males and 04 females) were fasted for 24-hours, weighed and slaughtered for carcass evaluation as proceeded by Kana et al. (2015).

The cost of production was assessed based on the cost of production per kilogram of experimental diet, feed intake and weight gain of the animals. The cost of feed was evaluated based on the prevailing market prices for feed ingredients at the time of the experiment. The cost of feed intake was obtained by multiplying the average feed intake by the cost of kg of feed. The feed cost for producing a kilogram of live body weight was calculated by multiplying the cost of kilogram of feed for the various treatments by the feed conversion ratio.

2.6. Statistical analysis

The data obtained on the parameters studied were subjected to analysis of variance (ANOVA) and Duncan's multiple range test was used to compare the treatment groups means. The Statistical Package for Social Sciences (SPSS 20.0) software was used for all statistical analysis.

3. Results and discussion

Feed intake of rations enriched with lysine-methionine decreased with the increasing levels of palm kernel meal into the diets. With the exception of diets containing 100 % palm kernel meal which was significantly very low, feed intake of chickens fed on spirulina was statistically comparable (P>0.05). When compared the two feed additives, feed intake was high with spirulina than with amino acids (Figure 1).

The increased in the rate of incorporation of palm kernel meal induced a linear decrease in weight gain and body weight of chickens fed diets containing amino acids. The live weights and weight gain of chickens fed diets containing 50 and 75% palm kernel meal enriched with spirulina were comparable (P>0.05) and significantly lower than those of the control treatment and higher than the treatment containing 100% palm kernel meal. When consider only diets containing palm kernel meal, weight gain was significantly higher with spirulina compared to diets containing amino acids.

Irrespective to the feed additive, FCR increased significantly (P<0.05) with increasing level of palm kernel meal in the ration (Figure 2).

Table 2
Variation in growth performance of broiler chickens with respect to the level of substitution of soybean meal by palm kernel meal enriched with proteins rich resources.

Amino acids/Spirulina	Graded levels of palm kernel meal (%)				
	0	**50**	**75**	**100**	**P**
Feed intake (g)					
Lys+Meth	4147.96 ± 146.38^{a}	3821.12 ± 44.78^{bB}	3547.71 ± 269.21^{cB}	3075.12 ± 116.87^{dB}	0.00
Spirulina	4147.96 ± 146.38^{a}	4154.20 ± 18.50^{aA}	4122.02 ± 31.86^{aA}	3321.24 ± 149.04^{bA}	0.00
P		0.00	0.01	0.04	
Live body weight (g)					
Lys+Meth	2469.04 ± 66.01^{a}	2307.02 ± 63.95^{b}	2196.98 ± 60.30^{c}	1660.83 ± 16.21^{dB}	0.00
Spirulina	2469.04 ± 66.01^{a}	2333.77 ± 62.37^{b}	2265.23 ± 53.84^{b}	1757.26 ± 73.65^{cA}	0.00
P		0.571	0.14	0.04	
Weight gain (g)					
Lys+Meth	1865.02 ± 34.96^{a}	1676.35 ± 64.90^{b}	1544.02 ± 42.47^{c}	1023.12 ± 10.06^{dB}	0.00
Spirulina	1865.02 ± 34.96^{a}	1702.98 ± 65.54^{b}	1639.30 ± 73.08^{b}	1126.95 ± 62.51^{cA}	0.00
P		0.58	0.06	0.02	
Feed conversion ratio					
Lys+Meth	2.31 ± 0.28^{c}	2.91 ± 0.28^{b}	3.22 ± 3.22^{bB}	3.96 ± 0.08^{aA}	0.00
Spirulina	2.33 ± 0.278^{c}	3.27 ± 0.22^{b}	3.57 ± 0.18^{abA}	3.79 ± 0.03^{aB}	0.00
P		0.09	0.04	0.01	

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05). A, B: Means on the same column with different superscripts are significantly different (P<0.05). 0: 100% soybean meal and 0% palm kernel meal; 50: 50% soybean meal and 50% palm kernel meal; 75: 25% soybean meal and 75% palm kernel meal; 100: 0% soybean meal and 100% palm kernel meal; P: Probability.

The relative weight of the gizzard increased significantly (P<0.05) in a linear manner with increasing rate of incorporation of palm kernel meal in the rations enriched or not with amino acids or spirulina compared to the control treatment. The lowest intestine weight was recorded with diet containing 100% palm kernel meal enriched with amino acids. The length of the intestine was not significantly affected by the different rate of incorporation of palm kernel meal in treatments enriched or not with amino acids or spirulina compared to the control group. Spirulina had no significant effect on the intestinal density irrespective of the inclusion rate of palm kernel meal. With amino acids, intestinal density was significantly lower with the total replacement of soybean meal with palm kernel in the ration compared to all other treatment groups including the control.

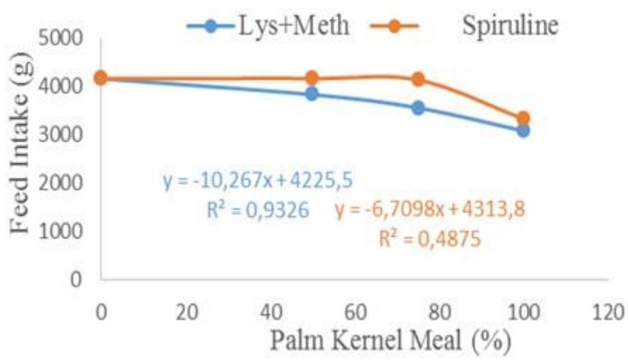

Fig. 1. Regression of Feed intake on substitution rate of soybean meal by palm kernel meal.

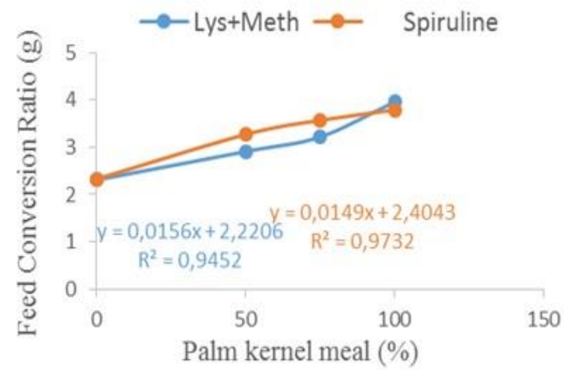

Fig. 2. Regression of Feed Conversion Ratio on substitution rate of soybean meal by palm kernel meal.

Table 3
Development of digestive organs of broiler chickens with respect to the level of incorporation of palm kernel meal enriched with amino acids and spirulina.

	Graded levels of palm kernel meal (%)				
Type of supplement	**0**	**50**	**75**	**100**	**P**
Gizzard (%)					
Lys+Meth	1.54 ± 0.12^{b}	1.78 ± 0.17^{ab}	2.13 ± 0.62^{a}	1.91 ± 0.19^{a}	0.014
Spirulina	1.54 ± 0.12^{b}	1.73 ± 0.25^{b}	1.76 ± 0.17^{ab}	1.96 ± 0.23^{a}	0.003
P		0.662	0.119	0.614	
Intestinal weight (g)					
Lys+Meth	69.00 ± 14.68^{ab}	73.13 ± 9.63^{ab}	84.25 ± 19.61^{aA}	62.25 ± 13.01^{b}	0.040
Spirulina	69.00 ± 14.68^{ab}	83.38 ± 22.19^{a}	65.13 ± 10.37^{bB}	75.13 ± 13.35^{ab}	0.131
P		0.251	0.029	0.071	
Intestinal length (cm)					
Lys+Meth	191.75 ± 24.62	199.38 ± 17.88	211.00 ± 27.16	187.75 ± 14.63	0.173
Spirulina	191.75 ± 24.62	206.13 ± 20.59	204.25 ± 41.43	201.38 ± 17.02	0.733
P		0.495	0.706	0.108	
Intestinal density (g/cm)					
Lys+Meth	0.37 ± 0.09^{ab}	0.37 ± 0.04^{ab}	0.40 ± 0.06^{aA}	0.33 ± 0.05^{b}	0.199
Spirulina	0.37 ± 0.09^{a}	0.40 ± 0.08^{a}	0.33 ± 0.05^{aB}	0.37 ± 0.06^{a}	0.220
P		0.278	0.022	0.131	

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05). A, B: Means on the same column with different superscripts are significantly different (P<0.05). 0: 100% soybean meal and 0% palm kernel meal; 50: 50% soybean meal and 50% palm kernel meal; 75: 25% soybean meal and 75% palm kernel meal; 100: 0% soybean meal and 100% palm kernel meal; P: Probability.

Although not significant, carcass yield was low in chickens fed diet containing 100% palm kernel meal compared to chickens fed on the control diet containing only soybean meal as the main source of protein. The relative weight of the head and heart increased significantly (P<0.05) with increasing rate of palm kernel meal in the ration containing spirulina compared to the control diet. The analysis of variance did not show any significant difference (P>0.05) with regards to the relative weight of the liver and pancreas with rations containing spirulina (Table 4).

Table 4
Carcass yield and relative weight of organs of broiler chickens fed palm kernel meal enriched with lysine-methionine and spirulina.

	Graded levels of palm kernel meal (%)				
Amino acids/Spirulina	**0**	**50**	**75**	**100**	**P**
Carcass yield (%)					
Lys+Meth	74.38 ± 1.74	73.68 ± 0.78	76.97 ± 15.07	71.39 ± 1.94	0.549
Spirulina	74.38 ± 1.74	72.78 ± 1.33	72.87 ± 1.33	71.47 ± 9.25	0.688
P		0.121	0.456	0.982	
Head (%)					
Lys+Meth	2.03 ± 0.18^{c}	2.60 ± 0.23^{b}	3.10 ± 0.78^{a}	2.92 ± 0.34^{ab}	0.000
Spirulina	2.03 ± 0.18^{b}	2.69 ± 0.30^{a}	2.69 ± 0.28^{a}	3.06 ± 0.62^{a}	0.000
P		0.478	0.191	0.572	
Legs (%)					
Lys+Meth	3.45 ± 0.41	3.26 ± 0.33	3.86 ± 1.11	3.74 ± 0.48	0.274
Spirulina	3.45 ± 0.41	3.48 ± 0.45	3.46 ± 0.42	3.76 ± 0.65	0.533
P		0.284	0.354	0.932	
Liver (%)					
Lys+Meth	1.63 ± 0.12^{b}	2.07 ± 0.17^{a}	1.91 ± 0.48^{ab}	1.99 ± 0.29^{a}	0.035
Spirulina	1.63 ± 0.12	1.87 ± 0.21	1.87 ± 0.30	1.76 ± 0.27	0.259
P		0.054	0.543	0.125	
Heart (%)					
Lys+Meth	0.44 ± 0.11^{b}	0.54 ± 0.04^{ab}	0.63 ± 0.16^{a}	0.60 ± 0.11^{a}	0.012
Spirulina	0.44 ± 0.11	0.48 ± 0.08	0.51 ± 0.97	0.56 ± 0.14	0.222
P		0.066	0.081	0.572	
Pancreas (%)					
Lys+Meth	0.18 ± 0.06^{ab}	0.23 ± 0.07^{aA}	0.21 ± 0.08^{ab}	0.16 ± 0.04^{b}	0.077
Spirulina	0.18 ± 0.06	0.18 ± 0.05^{B}	0.21 ± 0.10	0.20 ± 0.06	0.802
P		0.046	0.997	0.085	
Abdominal fat (%)					
Lys+Meth	1.26 ± 0.66	1.13 ± 0.33	1.45 ± 0.44	1.42 ± 0.68	0.629
Spirulina	1.26 ± 0.66	1.53 ± 0.70	2.06 ± 0.77	2.03 ± 0.98	0.141
P		0.160	0.072	0.168	

a, b, c: Means on the same row with different superscripts are significantly different (P <0.05). A, B: Means on the same column with different superscripts are significantly different (P<0.05). 0:100% soybean meal and 0% palm kernel meal; 50: 50% soybean meal and 50% palm kernel meal; 75: 25% soybean meal and 75% palm kernel meal; 100: 0% soybean meal and 100% palm kernel meal; P: Probability.

Table 5
Variation in cost of production of broiler chickens with respect to the rate of substitution of soybean meal with palm kernel meal enriched with lysine-methionine and spirulina.

	Graded levels of palm kernel meal (%)				
Amino acids/Spirulina	**0**	**50**	**75**	**100**	**P**
Total cost of feed intake (FCFA)					
Lys+Meth	968.01 ± 34.36^{ab}	1009.08 ± 22.40^{aA}	903.10 ± 70.65^{b}	743.59 ± 49.41^{cA}	0.000
Spirulina	968.01 ± 34.36^{a}	913.56 ± 20.26^{bB}	865.98 ± 22.97^{c}	671.22 ± 30.12^{dB}	0.000
P		0.001	0.356	0.046	
Cost of production per Kg of live weight (FCFA)					
Lys+Meth	538.51 ± 64.08^{c}	768.17 ± 73.00^{b}	820.36 ± 53.19^{b}	957.34 ± 55.45^{aA}	0.000
Spirulina	538.51 ± 64.08^{b}	718.42 ± 52.51^{a}	750.86 ± 43.90^{a}	766.73 ± 6.55^{aB}	0.009
P		0.311	0.90	0.000	

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05). A, B: Means on the same column with different superscripts are significantly different (P<0.05). 0: 100% soybean meal and 0% palm kernel meal; 50: 50% soybean meal and 50% palm kernel meal; 75: 25% soybean meal and 75% palm kernel meal; 100: 0% soybean meal and 100% palm kernel meal; P: Probability.

The cost of feed intake decreased with increasing rate of palm kernel meal enriched with amino acids or spirulina, while the production cost of kilogram of live body weight increases. With respect to amino acids and spirulina, the lowest cost of feed intake and production of kg of body weight was recorded with spirulina compared to amino acids regardless of the level of incorporation of palm kernel meal in feed.

Feed intake decreased significantly when the rate of substitution of soybean meal with palm kernel meal exceeded 50% in the diet regardless of the type of proteins sources. This decreased could be linked to the gravelly state of palm kernel meal which alters the texture, color and smell of feed. With 50 % palm kernel meal enriched with spirulina, feed intake improved by 0.15% compared to the control diet. This result corroborates the findings of Osei et al. (1986), Onwudiké (1986), Eziechi and Olomu (2004), Sundu et al. (2008) and Soltan (2008) who reported that an increased in the rate of incorporation of palm kernel meal in the ration leads to an increased in voluntary intake. This increase can be explained by the rapid passage of palm kernel meal in the digestive tract of birds (Onifade and Babatunde, 1998; Tipu et al., 2014) and the low water retention capacity (2.93 liter of water / g of feed) (Sundu et al., 2005). Above 50% incorporation of palm kernel meal, feed intake decreased significantly as previously reported by Fereira et al. (2012).

Body weight and weight gain of chickens decreased significantly with the increasing rate of substitution of soybean meal with palm kernel meal enriched with lysine-methionine or spirulina. This can be explained by the poor digestibility of palm kernel thus poor development of the digestive tract resulting to inefficient nutrient utilization by the birds. This result corroborates the findings of Eziechi and Olomu (2004), and Soltan (2008) who reported that live body weight and weight gain of chickens decreased with increased in palm kernel meal in the diet. Shakila et al. (2000) recorded a slight increase in weight gain when palm kernel meal was incorporated at a rate of 10 % supplemented with an exogenous enzyme.

Feed conversion ratio increased with increasing rate of palm kernel meal in diets containing amino acids or spirulina. This increased may be due to the chickens' inability to absorb and use more nutrients. Eziechi and Olomu (2004) recorded similar results. The poor feed conversion ratio recorded with chickens fed on high quantity of palm kernel meal could be due to the relatively high level of crude fiber in the experimental diets which could not be digested by the digestive enzymes of the chicken (Alimon, 2004). This result differs from that of Soltan (2008) who recorded a decreased in feed conversion ratio when 20% of soybean meal was replaced with palm kernel meal in the diet, this may be due to the low rate of fiber in the diet compared to that obtained in the present study.

The highest carcass yield was recorded with 75% palm kernel meal enriched with lysine-methionine. This result contradicted the findings of Soltan (2008) who recorded no significant difference on carcass yield with 20% incorporation of palm kernel meal to replace soybean meal in the diet. This can be attributed to the low level of inclusion of palm kernel meal, compared to the levels used in this study.

Palm kernel meal, enriched or not, had no significant effects on abdominal fat and relative weight of the legs irrespective of the level of incorporation. The relative weights of the head, heart, liver and gizzard increases with the rate of incorporation of palm kernel meal containing lysine-methionine or spirulina. The increased in the relative weight of the gizzard in the present study could be due to the high fiber content in the diets, which may have induced a more intense digestive activity in this organ (Fasina et al., 2006).

The cost of feed intake of chickens fed on the control diet was significantly higher compared to the other treatments throughout the study. This can be due to the lower price of palm kernel meal compared to that of soybean meal. This result is similar to Osei and Awo (1986) findings who incorporated palm kernel meal at the rates of 15 and 40% respectively in chicken’s diet. The average cost of production of kg of live weight increased with increasing rate of incorporation of palm kernel meal. This results contradicts the results of Osei and Awo (1986), who revealed that the average cost of production of kg of body weight decreases as the level of inclusion of palm kernel meal increases in the diet. This discrepancy could be attributed to the low conversion of diets containing higher rate of palm kernel meal in the present study compared to the rates used by the latter.

4. Conclusion

Enriched palm kernel meal based diet with lysine-methionine, or spirulina as source of protein resulted in a decrease in growth performances of chickens suggesting that using large quantities of palm kernel meal in the ration is not profitable in broiler chickens production.

References

Abd El Tawab, A.M., Khattab, M.S.A., 2018. Utilization of polyethylene glycol and tannase enzyme to reduce the negative effect of tannins on digestibility, milk production and animal performance. A. J. Anim. Vet. Adv., 13, 201-209.

Ahmed, M.A.T., Mostafa, S.A.K., 2018. Utilization of palm kernel cake as a ruminant feed for animal: A revew. A. J. Biol. Sci., 11, 157-164.

Alimon, A.R., 2004. The nutritive value of palm kernel cake for animal feed. Palm Oil Developments, 40, 12-14.

Belloir, P., Lessire, M., Berri, C., Lambert, W., Corrent, E., Tesseraud, S., 2015. Revisiting amino acid nutrition in broiler. 20th European Symposium on Poultry Nutrition, 24-27 August 2015, Prague, Czech Republic.

Boateng, M., Okai, D.B., Baah, J., Donkoh, A., 2008. Palm kernel cake extraction and utilization in pig and poultry diets in Ghana. Liv. Res. Rural Dev., 20.

Brown, L.D., Rozance, P.J., Thorn, S.R., Friedman, J.E., Hay, W.W. Jr., 2012. Acute supplementation of amino acids increases net protein accretion in IUGR fetal sheep. Am. J. Phys. End. Met., 303, E352-E364.

Evans, A.M., Smith, D.L., Moritz, J.S., 2015. Effects of algae incorporation into broiler starter diet formulations on nutrient digestibility and 3 to 21 days bird performance. Appl. Poult. Res., 24(7), 206-214.

Ezieshi, E.V., Olomu, J.M., 2004. Comparative performance of broilers chicken feed varying levels of palm kernel meal and maize offal. Pak. J. Nut., 3(4), 254-257.

Ezieshi, E.V., Olumu, J.M., 2007. Nutritional evaluation of palm kernel meal types: 1. proximate composition and metabolizable energy values. Afr. J. Biotech., 6, 2484-2486.

Fasina, Y.O., Classen, H.L., Garlich, J.D., Black, B.L., Ferket, P.R., Uni, Z., Olkowski, A.A., 2006. Response of Turkey poults to soybean lectin levels typically encountered in commercial diets. 2. effect on intestinal development and lymphoid organs. Poult. Sci., 85, 870-877.

Fereira, A.C., Ronaldo, L.O., Adriana, R.B., Gleidson, G.P.D.C., Raimundo, N.V.S., Paulo, A.O., 2012. Intake, digestibility and intake behaviour in cattle fed different levels of palm kernel cake. J. MVZ Cordoba, 17, 3105-3112.

Makkar, H.P.S., Tran, G., Heuze, V., Giger-Reverdin, S., Lessire, M., Lebas, F., 2016. Seaweeds for livestock diets: A review. Anim. Feed. Sci. Tech., 212, 1-17.

Marini, A.M., Daud, M.J., Noraini, S., Jame'ah, H., Azahan, E.A.E., 2005. Performance of locally isolated microorganism in degrading palm kernel cake (PKC) fiber and improving the nutritional value of fermented PKC. J. Trop. Agr. F. Sci., 33, 311-319.

Mateo, R.D., Wu, G., Bazer, F.W., Park, J.C., Shinzato, I., Kim, S.W., 2007. Dietary L-arginine supplementation enhances the reproductive performance of gilts. J. Nut., 137, 652-656.

Olorede, B.R., Longe, O.G., 2000. Effect of replacing palm kernel cake with sheabutter cake on egg quality characteristics, haematology and serum chemistry of laying hens. Niger. J. Anim. Prod., 27, 19-23.

Onifade, A.A., Babalunde, G.M., 1998. Comparison of the utilization of palm kernel meat, brewers dried grains and maize offal by broiler chicks. Br. Poult. Sci., 39, 245-250.

Onwudike, O.C., 1986. Palm kernel as a feed for poultry 3. replacement of groundnut cake by palm kernel meal in broiler diets. Anim. Feed. Sci. Tech., 34, 37-47.

Osei, S.A., Awo, J., 1986. Palm kernel cake as a broiler feed ingredient. Poult. Sci., 66, 1870-1873.

Shakila, S., Sudhakara Reddy, P., Ramana, J.V., Ravi, 2000. Development of poultry science. Col. Vet. Sci. Tirupat., 8, 502-517.

Soltan, M.A., 2008. Effect of dietary organic acid supplementation on egg production, egg quality and some blood serum parameters in laying hens. Int. J. Poult. Sci., 7(6), 613-621.

Sundu, B., Kumar, A., Dingle, J., 2005. Response of birds feed increasing levels of palm kernel meal supplemented with enzymes. Proceedings of the 17th Australian Poultry Science Symposium, Sydney, New South Wales, Australia, 7-9 February 2005. 227-228.

Sundu, B., Kumar, A., Dingle, J., 2008. Amino acid digestibilities of palm kernel meal in poultry. Int. J. Poult. Sci., 8(1), 16-20.

Tipu, M.A., Ahmad, F., Khalique, A., Haque, M.N., Mirza, R.H., Tayyab, U., 2014. Replacement of cotton seed cake with palm kernel cake in growing nili-ravi buffalo male calves. J. Anim. Plant Sci., 24, 24-27.

Virah-Sawmy, M., 2014. From by-product to buy product: Building markets for sustainable palm kernel expeller (PKE). WWF and NSW, Australia.

Wu, G., Fuller, W.B., Zhaolai, D., Defa, L., Junjun, W., Zhenlong, W., 2014. Amino acid nutrition in animals: Protein synthesis and beyond. Ann. Rev. Anim. Biosci., 2(1), 387-417.

Zahir, U.R., AnwarulHaque, B., Maksuda, B., Mahfui, U.P., 2019. Effect of dietary supplement of algae (*Spirulina platensis*) as an alternative to antibiotics on growth performance and health status of broiler chickens. Int. J. Poult. Sci., 18, 576-584.

How to cite this article: Yemdjie Mane, D.D., Ngouana Tadjong, R., Kana, J.R., Mafouo Sonhafouo, V., Ebile Dayan, A., Teguia, A., 2020. Growth performances of broiler chickens fed on palm kernel meal based diet supplemented with spirulina and amino acids. Scientific Journal of Animal Science, 9(3), 578-586.

Submit your next manuscript to Sjournals Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in DOAJ, and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at www.sjournals.com

Sjournals
where the scientific revolution begins