

## Blood profile, reproductive performance and welfare of rabbit does fed algal biomass-based diet

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### Abstract

Algal biomass is an emerging sustainable feed resource that supplies high-quality protein, essential fatty acids and bioactive compounds which can support reproductive performance and animal welfare. However, its potential benefits in rabbit production, particularly on doe performance and kit vitality, remain underexplored. This study was therefore designed to investigate the effect of dietary inclusion of algal biomass on the blood profile, reproductive performance, and welfare of rabbit does. A total number of 20 rabbit does and 8 bucks were allotted into 4 treatment groups of 5 does and 2 bucks per group in a completely randomised design. The algal biomass (DHA GOLD<sup>®</sup>) was included in the basal diet at 0, 0.5, 1.0, and 1.5% and fed to the animals *ad libitum* for 20 weeks. Blood samples for analysis were taken via ear vein from the animals after 2 weeks of feeding trial. Data collected on haematological, serum biochemical, reproductive performance indices (doe weight, conception, gestation period, litter size, kit weight, and percentage survivability of the kit), kits' vitality and behaviour of rabbit does were subjected to one-way analysis of variance. The result revealed that all the haematological and serum biochemical parameters were similar ( $P > 0.05$ ) across the groups, indicating no negative health effect. However, reproductive performance improved as the litter size (7.33) and kit weight (50.59g) were significantly ( $P < 0.05$ ) highest in does fed 1.5% dietary inclusion level of the algal biomass. Conception rate, gestation length and kit survivability tended to increase ( $P > 0.05$ ) with the increased level of biomass. The results also showed that kit vitality was improved upon supplementation with algal biomass, as latency to teat was reduced from 26.50min (0%) to 21.00min (1.5%), and latency to suckle ranged from 25.80 to 33.50min, with significant differences ( $p < 0.05$ ). Behavioural responses of the rabbit does, such as feeding, drinking, grooming, lying position, were significantly ( $P < 0.05$ ) influenced by the supplementation of algal biomass. Based on the findings of this study, the inclusion of algal biomass at 1.5% in the diet of rabbit does did not pose any health threat but improved reproductive performance with respect to litter size and kit weight. Moreover, the vitality of kits were improved upon supplementation of algal biomass in the diet of rabbit does. It was therefore recommended that dietary inclusion of algal biomass (DHA GOLD<sup>®</sup>) at 1.5% in the diet of rabbit does can be used in rabbit production, as it enhances reproductive performance of rabbit does, and it does not pose any harmful effects on the animal.

**Keywords:** Rabbit does, Survivability, Reproductive performance, serum biochemical, haematology.

### Profil sanguin, performances reproductives et bien-être des lapines nourries avec un régime à base de biomasse algale



### Résumé

La biomasse algale est une nouvelle ressource alimentaire durable qui fournit des protéines de haute qualité, des acides gras essentiels et des composés bioactifs pouvant favoriser la reproduction et le bien-être des animaux. Cependant, ses avantages potentiels dans la production lapinicole, en particulier sur les

performances des lapines et la vitalité des levrauts, restent peu étudiés. Cette étude a donc été conçue pour examiner l'effet de l'ajout de biomasse algale dans l'alimentation sur le profil sanguin, les performances reproductives et le bien-être des lapines. Au total, 20 lapines et 8 lapins ont été répartis en 4 groupes de traitement de 5 lapines et 2 lapins par groupe, selon un plan complètement randomisé. La biomasse algale (DHA GOLD®) a été incorporée dans l'alimentation de base à des taux de 0, 0,5, 1,0 et 1,5 % et donnée aux animaux à volonté pendant 20 semaines. Des échantillons sanguins destinés à l'analyse ont été prélevés dans la veine de l'oreille des animaux après deux semaines d'essai alimentaire. Les données recueillies sur les indices hématologiques, biochimiques sériques et de performance reproductrice (poids des lapines, conception, période de gestation, taille de la portée, poids des levrauts et pourcentage de survie des levrauts), la vitalité des levrauts et le comportement des lapines ont été soumis à une analyse de variance à un facteur. Les résultats ont révélé que tous les paramètres hématologiques et biochimiques sériques étaient similaires ( $P > 0,05$ ) entre les groupes, ce qui indique l'absence d'effet négatif sur la santé. Cependant, les performances reproductives se sont améliorées, la taille des portées (7,33) et le poids des petits (50,59 g) étant significativement ( $P < 0,05$ ) plus élevés chez les femelles nourries avec un régime alimentaire contenant 1,5 % de biomasse algale. Le taux de conception, la durée de gestation et la survie des petits ont eu tendance à augmenter ( $P > 0,05$ ) avec l'augmentation du niveau de biomasse. Les résultats ont également montré que la vitalité des levrauts s'améliorait grâce à la supplémentation en biomasse algale, le temps de latence avant la tétée étant réduit de 26,50 minutes (0 %) à 21,00 minutes (1,5 %) et le temps de latence avant la tétée variant de 25,80 à 33,50 minutes, avec des différences significatives ( $p < 0,05$ ). Les comportements des lapines, tels que l'alimentation, la consommation d'eau, le toilettage et la position couchée, ont été significativement ( $P < 0,05$ ) influencés par la supplémentation en biomasse algale. D'après les résultats de cette étude, l'ajout de 1,5 % de biomasse algale dans l'alimentation des lapines n'a pas posé de problème de santé, mais a amélioré les performances reproductives en termes de taille des portées et de poids des levrauts. De plus, la vitalité des levrauts s'est améliorée grâce à la supplémentation en biomasse algale dans l'alimentation des lapines. Il a donc été recommandé d'inclure 1,5 % de biomasse algale (DHA GOLD®) dans l'alimentation des lapines, car cela améliore leurs performances reproductives sans avoir d'effets nocifs sur les animaux.

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**Mots clés :** Lapines, Survie, Performances reproductives, Biochimie sérique, Hématologie.

## Introduction

Growing concerns about feed cost, sustainability, and livestock mortality have intensified the search for alternative and nutritionally rich feed resources, particularly for prolific animals such as pigs and rabbits. Among these, algal biomass has emerged as a promising feed ingredient due to its high protein content, fatty acids, vitamins, minerals, pigments, and bioactive compounds, which can support growth, immunity, reproductive performance and overall animal wellbeing (Khan *et al.*, 2025). Several studies have demonstrated the benefits of incorporating algal biomass into livestock and poultry diets at varying inclusion levels. For instance, inclusion

of microalgae in broiler diets at 2-5% improved growth performance, feed efficiency and antioxidant status (El-bahr *et al.*, 2020), while supplementation in laying hens enhanced egg production and yolk quality (Curabay *et al.*, 2021).

Studies in pigs and ruminants have demonstrated that dietary supplementation with docosahexaenoic acid (DHA-rich) algal biomass can enhance reproductive performance and increase neonatal survival (Edwards 2002; Webel *et al.*, 2003; Dawson and Edgar, 2005; Adeleye, 2012). Edwards (2002) reported that long-chain fatty acids (DHA) had been crucial to the survival of neonates through the development of brain,

eye and neural tissue function. Webel *et al.*, (2003) also established that the litter sizes of pigs were improved upon supplementation with DHA (in varying levels in the diet), especially during the mating period (before and after service). Similarly, Dawson and Edgar (2005) revealed that feeding ruminants algal biomass rich in DHA during gestation improved the viability of neonate and their survivability. In addition, Adeleye (2012) also reported that the dietary inclusion of omega-3 polyunsaturated fatty acid (DHA) increased farrowing duration, but reduced stillbirth and latency of live born piglets to stand, reach the udder and suckle (improved vitality) even after a long farrowing duration. These findings highlight the potential of algal biomass as a multifunctional feed resource that not only meets nutritional requirements but also contributes to reducing mortality and improving the vitality of young animals..

In rabbits, research on algae supplementation is still emerging. Al-Soufi *et al.*, (2022) reviewed the potential of microalgae in rabbit diets, reporting improvements in gut health, antioxidant status, and overall performance, while Colin *et al.* (2023) found that omega-3-rich algal extracts improved litter survival and reduced perinatal mortality in rabbits.

Due to the dearth of information available on the influence of supplementation of rabbit feed with algal biomass, this study investigated the effect of algal biomass rich in DHA (DHA GOLD<sup>®</sup>) on the performance and welfare of rabbit does, as well as the vitality and survivability of the kits. Also, since the potential impact of algal supplementation on maternal care and parturition-related behaviours in rabbits has yet to be explored, this study included observations of rabbit doe behaviour before, during, and after parturition.

## **Materials and Methods**

### ***Study location, animals, design, and diets***

The experiment was carried out at the Rabbitry Unit, College of Animal Science and Livestock Production, Federal University of Agriculture,

Abeokuta, Nigeria. Algal biomass containing essential fatty acid docosahexaenoic acid (DHA GOLD<sup>®</sup>) was obtained from a reputable company in the Netherlands (DHA GOLD<sup>®</sup>, DSM company, Netherlands). The algal biomass was processed along with the feed made in a reputable feed mill in Abeokuta.

A total number of 20 does and eight bucks of mixed breed with an average weight of 1.8kg were used for this study. The animals were kept in hutches with concrete feeders and earthen drinkers, and they were fed *ad libitum*. Initially, the animals were acclimatized for two weeks, after which they were introduced to the experimental diet. The composition of the experimental diet is presented in Table 1.

**Table 1: Composition of experimental basal diets**

<b>Ingredients</b>	Dietary Inclusion level of algal biomass			
	<b>0%</b>	<b>0.5%</b>	<b>1%</b>	<b>1.5%</b>
Maize	45.00	45.00	45.00	45.00
Rice husk	20.00	20.00	20.00	20.00
Soybean meal	20.00	20.00	20.00	20.00
*Groundnut cake	5.00	5.00	5.00	5.00
Oyster shell	1.50	1.50	1.50	1.50
Common salt	0.25	0.25	0.25	0.25
Bone meal	6.00	6.00	6.00	6.00
Premix	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
<b>TOTAL</b>	<b>98.10</b>	<b>98.10</b>	<b>98.10</b>	<b>98.10</b>
<b>Algal biomass</b>	<b>0</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>
<b>Calculated analysis (%)</b>				
Crude protein	16.04	16.11	16.19	16.27
Crude fat	4.20	4.37	4.52	4.67
Crude fibre	12.41	12.44	12.48	12.51
Ash	7.57	7.62	7.67	7.73
Calcium	2.17	2.17	2.17	2.17
Phosphorus	0.80	0.80	0.80	0.80
ME (Kcal/ kg)	2530.4	2530.4	2530.4	2530.4

The 20 does were randomly divided into four treatments. Each treatment was further divided into five replicates. The rabbits were balanced for weight and allotted to treatments and replicates.

Two bucks were allotted to each treatment. The treatments were arranged in a completely randomised design with the algal biomass supplementation at 0, 0.5, 1.0, and 1.5%.

### **Data Collection**

The does were weighed and then subjected to experimental diets. A pregnancy test through palpation was carried out 14 days after mating. The does that were not pregnant were re-mated for a second mating or third time until pregnancy was established. The performance parameters that were collected were: initial body weight, final body weight, conception rate, feed intake, gestation period, litter size, kit weight and kit survivability. The experiment lasted for 20 weeks. The conception rate was expressed as 100% for those that conceived at first mating, 50% for those that were mated twice, and 33.33% for those that were mated three times before conception was established.

On the 21st day of feeding trial, 5ml blood samples were collected from two rabbit does randomly per treatment and replicate via the tip of the Rabbit ear. Needle and syringe were used to collect samples to test for haematology and serum biochemistry parameters. Sterile cotton was used to cover the punctured marginal ear vein after collection. The blood was collected in sample bottles containing ethylene diamine-tetraacetic acid (EDTA), which serves as an anticoagulant for haematology and in plain bottles without anticoagulant for serum biochemistry. All blood samples were taken to the laboratory for analysis. The following haematological parameters were determined: packed cell volume (PCV), haemoglobin (Hb), red blood cell count, white blood cell count (WBC), erythrocyte indices, including the MCV, MCH and MCHC were also determined from the values obtained from RBC count, Hb and PCV values (Duncan *et al.*, 1994). The WBC differentials, such as heterophils, lymphocytes, eosinophils, basophils and monocytes were also determined. Moreso, the following serum biochemical parameters were determined: total protein, creatinine, albumin, globulin, serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT).

The behaviour of the rabbit does were monitored and recorded three days before parturition, during parturition, and after parturition, both during the day and at night, using Closed-Circuit Television (CCTV) cameras and was backed up for watching and evaluation. Some of the behaviours of interest that were watched after the recording were drinking, feeding, lying position, belly sitting, grooming, pulling of fur, ear scratching, cuddling of kits. Also, days of pulling of furs for each of the does were recorded, as well as the timing for each birth by the does. Furthermore, the vitality of the kits were observed at birth and immediately after birth. The latency for each of the kits to stand, reach the teat and suckle was recorded. The birth interval was also recorded

### **Experimental design and statistical Analyses**

Data obtained were subjected to one-way Analysis of Variance in a completely randomised design. Significant differences ( $p < 0.05$ ) among variable means were separated using Duncan-Multiple Range Test as contained in SAS (2010). Significant means were separated using Duncan multiple range test as contained in the software.

The statistical model used was:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Where  $y_1$  = dependent variable

$\mu$  = Population mean

$T_i$  = Effect of the  $i^{\text{th}}$  term

$E$  = Random error term

## **RESULTS**

### ***Effects of algal biomass supplemented diets on reproductive performance of rabbit does***

Table 2 shows the effect of algal biomass supplemented diets on the reproductive performance of rabbit does. There was no significant ( $P > 0.05$ ) difference in all the parameters measured except Litter size and kit weight. The litter size of rabbits fed 1.5 % algal biomass (7.33) was significantly ( $P < 0.05$ ) highest, while the least litter size was from those fed 1.0% (5.00) algal biomass. Kit weight was significantly ( $P < 0.05$ ) influenced by dietary

algal biomass supplementation. Does fed 0.5% algal biomass recorded the lowest kit weight (37.33 g), while those on 0%, 1.0%, and 1.5%

inclusion levels had similar and higher kit weights of 45.63 g, 45.33 g, and 50.59 g, respectively.

**Table 2: Effects of Algal Biomass (DHA) supplemented diets on reproductive performance of rabbit does**

Parameters	Inclusion Level of algal biomass (%)				SEM	P-Value
	0	0.5	1.0	1.5		
Initial body weight (Kg)	2.01	1.97	2.03	2.01	0.92	0.99
Final body weight (Kg)	2.27	2.17	2.25	2.38	0.98	0.37
Conception (%)	46.67	60.00	70.00	80.00	9.07	0.64
Gestation Period (days)	31.33	33.00	31.33	31.33	0.43	0.47
Litter size	5.67 <sup>ab</sup>	5.33 <sup>ab</sup>	5.00 <sup>b</sup>	7.33 <sup>a</sup>	0.34	0.04
Kit weight (g)	45.63 <sup>a</sup>	37.33 <sup>b</sup>	45.33 <sup>a</sup>	50.59 <sup>a</sup>	1.60	0.04
Doe daily Feed intake (g)	89.08	94.39	115.64	102.84	5.95	0.47
Kindling period (s)	9.00	9.00	9.33	11.67	0.58	0.32
Survivability (%)	40.95	43.33	50.00	61.31	9.92	0.92

<sup>ab</sup> Means with different superscripts along the same row are significantly (P<0.05) different  
SEM – Standard Error Mean

***Effects of Algal biomass supplemented diets on Haematological parameters of rabbit does***

The effect of algal biomass on haematological parameters is shown in Table 3. The results revealed that none of the haematological parameters examined were significantly (P>0.05) influenced by the supplementation of algal biomass in the diet of rabbit does

**Table 3: Effects of Algal Biomass (DHA) supplemented diets on haematological parameters of rabbit does**

Parameters	Inclusion level of algal biomass (%)				SEM	P-Value
	0	0.5	1.0	1.5		
Packed Cell Volume (%)	26.67	33.33	35.33	29.67	1.73	1.38
White Blood Cells (x10 <sup>6</sup> /mm <sup>3</sup> )	4.30	10.83	5.55	9.50	1.45	1.22
Red Blood Cells (x10 <sup>6</sup> /mm <sup>3</sup> )	3.13	3.63	4.03	5.90	0.58	1.13
Lymphocytes (%)	54.33	41.33	44.67	41.00	3.31	0.85
Neutrophil (%)	34.67	51.33	44.67	51.33	3.68	1.21
Monocytes (%)	7.67	5.33	5.67	3.67	0.74	1.33
Basophil (%)	3.67	2.00	1.67	4.00	0.52	1.41
Haemoglobin (g/dL)	9.33	10.00	11.67	9.67	0.61340	0.64
MCV(fl)	85.00	87.00	85.67	81.67	1.46	0.52
MCH (pg)	30.33	26.67	27.33	31.33	0.86	2.34
MCHC(g/dL)	31.67	31.67	32.67	30.67	0.63	0.34

MCH: Mean Corpuscular Haemoglobin, MCHC: Mean Corpuscular Haemoglobin Concentrate,  
 MCV –Mean Corpuscular Volume, SEM – Standard Error of Mean

**Effects of Algal biomass supplemented diets on Serum Biochemical parameters of rabbit does**

The effects of algal biomass on serum biochemical parameters is presented in Table 4.

The results showed that supplementation of algal biomass in the diet of rabbit does did not have a significant (P>0.05) influence on the serum biochemical parameters.

**Table 4: Effects of Algal Biomass (DHA) supplemented diets on Serum Biochemical parameters of rabbit does**

Parameters	Inclusion level of algal biomass (%)				SEM	P-Value
	0	0.5	1.0	1.5		
Total Protein (g/L)	6.37	5.40	7.53	5.90	0.41	1.32
Albumin (g/L)	3.70	3.97	5.17	4.17	0.35	0.81
Globulin (g/L)	2.67	1.43	2.37	1.73	0.22	2.06
Alanine aminotransferase (U/L)	45.00	34.00	37.00	45.33	6.48	0.15
Aspartate aminotransferase (U/L)	54.33	35.33	62.33	57.00	8.43	0.41
Glucose (mg/dL)	70.00	52.33	64.00	42.33	4.76	2.24
Urea (mg/dL)	26.00	26.67	27.00	29.33	2.15	0.09
Creatinine (mg/dL)	0.87	1.00	1.33	1.00	0.19	0.20
Blood platelets (x10 <sup>5</sup> mL)	1.89	1.44	1.38	1.94	0.34	0.14

SEM – Standard Error of Mean

**Effects of Algal biomass supplemented diets on birth interval, and vitality of kits**

Table 5 shows the effect of algal biomass supplemented diets on birth interval and vitality of kits. There was no significant ( $P>0.05$ ) difference in all the parameters measured except latency to teat and latency to suckle. Latency to teat and latency to suckle were significant in kits across the treatment.

<sup>ab</sup> Means with different superscripts along the same row are significantly ( $P<0.05$ ) different

Parameters	Inclusion level of algal biomass (%)				SEM	P-Value
	0	0.5	1.0	1.5		
Birth Interval (min)	1.571	1.846	1.400	1.800	0.256	0.622
Kindling Duration (Min)	14.000	10.500	7.000	8.500	2.170	0.599
Latency to Stand(min)	3.429	3.462	2.600	2.700	0.424	0.313
Latency to Teat (min)	26.500 <sup>b</sup>	29.154 <sup>a</sup>	23.400 <sup>ab</sup>	21.000 <sup>c</sup>	1.048	0.000
Latency to Suckle (min)	28.570 <sup>b</sup>	32.076 <sup>ab</sup>	25.800 <sup>c</sup>	33.500 <sup>a</sup>	1.048	0.000

SEM – Standard Error Mean

**Effects of Algal biomass supplemented diets on Behaviour of Rabbit does**

Table 6 show the effect of algal biomass supplemented diets on behaviour of rabbit does is shown in Table 6. It was revealed that there was a significant ( $P>0.05$ ) difference in feeding,

drinking, lying position LL, lying position LR, grooming and ear scratching behaviour. However, it was observed that there was no significant influence of algal biomass on pulling of fur, cuddling of kits and belly sitting behaviour.

**Table 6: Effects of Algal Biomass (DHA) supplemented diets on behaviour of rabbit does**

Parameters	Inclusion Level of algal biomass (%)				SEM	P-Value
	0	0.5	1.0	1.5		
Feeding	66.71 <sup>bc</sup>	67.64 <sup>b</sup>	61.29 <sup>c</sup>	77.00 <sup>a</sup>	1.65	0.000
Drinking	62.71 <sup>ab</sup>	60.07 <sup>b</sup>	60.79 <sup>b</sup>	67.64 <sup>a</sup>	1.55	0.005
Lying position LR	52.43 <sup>a</sup>	45.36 <sup>b</sup>	34.45 <sup>d</sup>	39.86 <sup>c</sup>	1.17	0.000
Lying position LL	63.29 <sup>a</sup>	42.79 <sup>b</sup>	45.57 <sup>b</sup>	39.00 <sup>c</sup>	2.13	0.000
Belly Sitting	72.21	68.50	71.21	67.50	2.34	0.446
Grooming	59.71 <sup>c</sup>	64.93 <sup>b</sup>	76.36 <sup>a</sup>	75.07 <sup>a</sup>	1.13	0.000
Pulling of Fur	46.14	52.57	45.93	61.57	7.03	0.360
Ear Scratching	21.14	17.93	23.00	31.64	0.70	0.345

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Cuddling of Kits	45.4	70.9	66.9	50.0	10.5	0.247
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<sup>ab</sup> Means with different superscripts along the same row are significantly (P<0.05) different

SEM – Standard Error Mean

LR: Lying position to the right

LL: Lying position to the Left

## Discussion

This study revealed the significant effect of both litter size and kit weight, which could be attributed to the positive effects of algal biomass on the fertility rates of rabbits. This corroborates the results of Colin *et al.*, (2005), who stated that the incorporation of plant-derived omega-3 fatty acids in the diet of rabbits significantly improves the number of live rabbits per litter and their respective weights.

Rooke *et al.*, (2001) also established that the dietary inclusion of algae rich in docosahexaenoic acid in pig diets improves the reproductive performance of sows, while supplementing the algae to the sow during pregnancy at a level of 1.75% improved piglet survival and improved brain development of piglets. The higher kit weight was recorded in doe fed 1.5% algal biomass which also recorded higher litter size, this observation may be due to the nutritional importance of algal biomass to neonate development which is in accordance with the findings of Kowalskad *et al.*, (2008) who reported that the addition of fatty acids to the dietary ration of female rabbit had a positive effects on increasing the neonatal weight of rabbits, The authors further established that the supplementation of fat in diets of rabbits enrich milk contents which in turn positively affect the weight of kit. Rooke *et al.*, (2001) also established that DHA supplementation played a key role in the brain developments of young pigs. Furthermore, Mateo *et al.*, (2009) observed that piglet born and reared on sows fed 10g/kg of fatty acid have a higher weight at weaning.

There was a numerical increase in the feed intake of does fed algal biomass, which is similar to the

results of Rebbolar *et al.*, (2014), who reported that the use of fish oils as a dietary supplement had a positive effect on the body weight and feed intake of rabbits. Some possible explanations for this result are that omega-3 fatty acids may positively affect the appetite of rabbits, resulting in an increased feed intake and improved intestinal absorption as reported by Rebbolar *et al.*, (2014). Furthermore, conception percentage, kit survivability and gestation period were similar; it was observed that as the level of algal biomass is increased, the value of the indices of the above parameters increased. This is attributed to the nutritional importance of algal biomass in enhancing fertility rate, milk yield and milk composition. Milk nourishment improves immunity, growth, joint mobility, heart health, eye health, and neurodevelopment of young animals (Innis *et al.*, 2007).

Moreso, According to the result of this experiment it was revealed that survivability of the kits were improved upon the supplementation of DHA, this could be attributed to the significant effect of DHA which has been considered to be the most important structural component of the fetal central nervous system, and they are transferred through the placenta and accumulate in the brain and other organs which is significant for fetal development as reported by Innis *et al.*, (2005). Furthermore, Sinedimo *et al.*, (2017) reported that adding DHA functional fatty acids in the diet of livestock during late gestation can positively increase and alter their reproduction performance through hormone synthesis, anti-oxidative stress and energy supply. In addition, the improved kit survivability reported in this study could also be linked to the significant effect

of DHA algal biomass in enhancing milk yield and composition, which is key to the survivability of young rabbits. This is in line with the results of Bai *et al.*, (2017), who established that fatty acids provide enough energy to maintain a high milk yield, reduce maternal weight loss in livestock, and improve the hormone levels of estrus and the ovarian and uterine microenvironment during mating. Also, Innis *et al.*, (2007) observed that adding functional fatty acids in the diet of animals boosts neurodevelopment, immunology and also helps increase the fat and protein contents in colostrum. Colostrum is a type of milk that is produced during the later stage of pregnancy and the first three days after kindling. The colostrum enhances the overall performance of young rabbits.

Furthermore, it was revealed in this current research that not all the serum biochemical was influenced by the supplementation of algal biomass in the diet of rabbit does. These observations are in agreement with the findings of Khanna *et al.*, (2016), who also stated that there were no significant effects in serum biochemical indices as a result of supplementing rabbit diets with *spirulina plantensis*. Furthermore, Ayoub *et al.*, (2019) showed that some of the serum biochemical indices of rabbits fed supplemented microalgae *A. coffareformis* were within normal values, which is in agreement with observations from the current study. Generally, the obtained findings in the present study regarding the serum biochemical parameters demonstrated that the dietary inclusion of algal biomass in the diet of rabbits had no harmful effect on the overall reproductive physiological performance of the rabbit does.

The effects of dietary supplementation of algal biomass on the haematological indices of rabbit does in this study revealed that algal biomass did not have any significant effect on all the haematological parameters. Blood assessment is a precise tool for evaluating the welfare and health status of animals. Therefore, the result from this present experiment shows that the

dietary supplementation of DHA-rich algal biomass showed no signs of deleterious influence on the rabbit does. These results are in contrast with the research of Abdul khaliq *et al.*, (2002), who established that the supplementation of fatty acids in rabbit diet led to a significant increase in all blood parameters except MCV and MCH. The difference in the study outcome could be attributed to the differences in the overall nutritional composition (such as the type of the fatty acids) of the test ingredients.

The effects of algal biomass supplemented diets on birth interval, and vitality of kits in this current study showed that latency to suckle and latency to teat were significantly affected by the inclusion of algal biomass in the maternal diet, this could be attributed to an increased concentration of DHA in the brain lipids, which may have an impact on brain function and result to an increased vitality of young animal (Crawford 2000). Moreso, in this present study, kits from does fed 0.5% DHA GOLD<sup>®</sup> were quicker to stand, get to the udder and suckle. This is similar to a report by an earlier study, which reported a reduced latency to suckle when tuna oil was fed to pregnant sows (Rooke *et al.*, 2001).

Jensen (1986) revealed that the main elements of maternal behaviour relevant to neonate survival appear to be: the selection of the birth site and behaviours involved in nest building/pulling of fur, grooming and cuddling of the litter. It was observed in this study that grooming behaviour was significantly higher in rabbit does fed 1.5 % algal biomass. This could be attributed to the improved functionality of the brain, which is part of the important function of omega-3 fatty acids. McNamara and Carlson (2006) stated that omega-3 fatty acids are instrumental to the function of cell membranes of the brain, which are important for the transmission of brain signals which induce proper parturition behaviour in livestock animals.

The behaviour of rabbit does is a significant factor when looking at the survivability of kits. The changes in posture and movement of the

does, including their feeding behaviour during parturition, might affect the existence of the kits (Jansen, 1986). According to this current experiment, it was revealed that the feeding behaviour of the rabbit does was significant across the treatments, with those fed 1.5 % algal biomass recording the highest feeding behaviour frequency (77.00). This could be attributed to the fishy flavour of the algal biomass, which ignites the appetite of the animals on the diets with algal biomass (Lafarga, 2019).

Pre-lying behaviours are behaviours carried out by the rabbit does just before they lie or sit down. Damm *et al.*, (2005) revealed that lying down behaviour, especially at an increased frequency, is dangerous to the survivability of kits. He further stated that the lying down behaviour could lead to the crushing of the kits. However, this current experiment revealed that rabbit does without algal biomass recorded the highest frequency for both lying behaviours (to the left and to the right), which led to a high mortality rate of the kits. Moreso, rabbit does fed 1.5 % algal biomass showed less frequency of the lying down behaviour. This result could be connected to the status of the kits, which is an important factor influencing crushing. Malnourished kits appear to be more vulnerable to crushing, perhaps because persistent suckling attempts cause them to spend more time near the does to obtain warmth and food, which correlates with the observation of Weary *et al.*, (1998), who revealed that piglets that are malnourished tend to be more exposed to being crushed by their mothers.

### **Conclusion**

From this study, it could be concluded that the supplementation of DHA GOLD<sup>®</sup> algal biomass at 1.5% level of inclusion in the diet of rabbit does improve the reproductive performance of rabbits with respect to litter size and kit weight, which is highly beneficial to rabbit farmers as it serves as a way to increase the profitability of rabbit production. In the same vein, dietary inclusion of DHA GOLD<sup>®</sup> algal biomass in the diet of rabbit does had no harmful effect on the health and

overall well-being of the animal, as the blood parameters were not significantly affected across all treatments, while the vitality of kits was improved upon supplementation of algal biomass (DHA GOLD<sup>®</sup>) in the diet of rabbit does.

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