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# Effect of macro and microalgae supplementation on productive performance, some blood constitutes and economic efficiency of growing Farafra male lambs

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## Abstract

This study was carried out to investigate the effect of supplemental macroalgae (*Padina baergensenii*) and microalgae (*spirulina*) as feed additives on body performance, some blood plasma constituents of Frafra male lambs. Twenty Frafra male lambs 5–6-month-old and with initial live body weight 22.85 ± 0.15 kg were divided into four groups for 120 days feeding trial. The lambs were randomly divided into four equal groups (5 lambs each). Control group (T1) was fed the basal diet, second group (T2) fed the basal diet supplemented with 0.2% microalgae (T2), fed the basal diet supplemented with 2% macroalgae (T3), while (T4) fed on the basal diet supplemented with 0.1% microalgae + 1% macroalgae dry / head/ day. Lambs were weighed to determine performance of growing lambs and adjusted their feeding requirements. Blood samples were collected before morning feeding. Final body weight, total gain and daily gain increased for T2 in comparison with T1, but this was slightly increased not significant. Feed conversion improved slightly for T2 compared with T1 and other treated groups (T3 and T4). Plasma total protein, globulin, ALT and glucose increased significantly ($P<0.05$) for T2 compared with other groups. Cholesterol decreased significantly for T4 compared with other groups, whereas there is no significant difference among groups for urea and AST concentration. As well as total revenue of body weight gain and net revenue as well as economic efficiency were significantly higher for lambs fed Spirulina algae rations than those of control ration.

*Keywords*: microalgae, macroalgae, Frafra lambs.

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## 1. Introduction

Algae are organisms that can range in size, from microscopic microalgae to large macroalgae (Chojnacka *et al*., 2012). Most algae are characterized by red, brown and green algae. Macroalgae have the potential to increase animal productivity, enhance resistance against diseases, provide a better digestibility of feed ingredients, and they can improve the gut flora, thus having a positive effect on the quality of animal products (Chojnacka, 2012). *Padina baergesenii* classified as a brown macroalgae. Brown macroalgae are a rich source of β-carotene, violaxanthin and fucoxanthin (Holdt and Kraan, 2011). In small ruminants the macroalgae biomass could be used as an alternative feed source due to the high organic matter content, digestibility, and rumen dry matter degradability of these macroalgae species (Hansen *et al*., 2003). *Padina boergesenii* significantly reduced the risk of calcium oxalate nephrolithiasis by increasing the urinary volume, which results in reduction in calcium oxalate super saturation in the urine (Siddhanta *et al*., 1997). *Spirulina platensis* (SP) is a blue-green microalga which has been considered as a suitable nutritional supplement because it is highly protein rich and highly abundant in vitamins and minerals (Kay and Barton, 1991). Also, Belay (2002) define that *Spirulina* is a “micro vegetable” that can provide some of the antioxidants needed. Many studies have also revealed that antioxidants like the carotenoids in fruits, vegetables, and *Spirulina* have a synergistic effect, also *Spirulina* contains phycocyanin and polysaccharides, both known to have antioxidant properties. In addition, antioxidants that have a direct effect on reactive oxygen species, *Spirulina* contains an important enzyme, superoxide dismutase (1,700 units/g), that acts indirectly by slowing down the rate of oxygen radical generating reactions. The objective of this study was to evaluate the effect of macro and microalgae supplementation on productive performance, some blood constitutes and Economic efficiency of growing Farafra male lambs.

## 2. Materials and methods

This trial was conduct out at the farm of Malawi of Animal Production Research Station, Minia governorate, Egypt belongs to Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

### *2.1 Algae collection*

Algae were collected from Red Sea beach of Hurgda and air dried then grind and calculated the quantity which adding to the concentrate feed mixture then mixed in mixture to ready for feeding to experimental animals.

### *2.2 Animal management and rations*

Twenty growing Frafra male lambs aged

5-6 month with average live body weight 22.850 ± 0.150 kg. Lambs were distributed randomly into four equal groups (5 lambs each). The first group (T1) was fed the basal ration which consisted of 60% concentrate feed mixture (CFM) + 40% roughages (corn silage). The proportions of the CFM ingredients consistence of (39% wheat bran. 38% yellow corn grain, 17% sunflower meal solvent extract, 3% molasses, 2% limestone powder and 1% common salt). Second group (T2) fed the basal diet supplemented with 0.2% microalgae, third group (T3) fed the basal diet supplemented with 2% macroalgae and the fourth group (T4) fed on the basal diet supplemented with 0.1% microalgae + 1% macroalgae. Feed ingredient samples were analyzed for dry matter, ash, crude protein, crud fiber and ether extract according to methods of AOAC (1999). The chemical composition of concentrates feed mixture, corn silage, macroalgae (*Padina baergensenii*) and microalgae (*spirulina*) is presented in Table (1). The rations were formulated to satisfy lambs requirements according to the NRC (1999). The requirements were changed as body weight change. Rations were offered twice daily at 8:00 am and 3:00 pm in two equal portions. Water was available for the animals along the experimental period except the night before weighing them. The animals were weighted individually biweekly before morning feeding and drinking. The growth trial was prolonged for 120 days where the lambs achieved the marketable weight (42-45 kg) that was considered as final weight.

Table (1): The chemical analysis of concentrates feed mixture, corn silage, macroalgae (*Padina baergensenii*) and microalgae (*spirulina*).

| Item | CFM | Corn silage | *Spirulina* | *Padina baergensenii* |
|---|---|---|---|---|
| Dry Matter (%) | 86.81 | 32.88 | 87.28 | 94.24 |
| Organic matter (%) | 88.64 | 90.58 | 79.99 | 73.54 |
| Crude protein (%) | 13.95 | 9.53 | 57.63 | 2.32 |
| Crude fibre (%) | 21.26 | 24.62 | 1.82 | 57 |
| Ether extract (%) | 2.8 | 1.27 | 1.88 | 0.72 |
| NFE (%) | 50.63 | 55.16 | 18.66 | 13.5 |
| Ash (%) | 11.36 | 9.42 | 20.01 | 26.46 |

CFM (concentrate feed mixture), NFE (nitrogen free extract).

### *2.3 Blood sampling and analysis*

Blood samples were collected monthly before morning feeding. Blood samples were withdrawn from the jugular vein from each animal into clean and dried tube (10 ml) with EDTA (Ethylene Diamine Tetra Acetic Acid) which work as anticoagulant, then centrifuged at 4000 rpm for 20 minutes. Blood plasma was separated into a clean dried glass vial and stored at -20°C till chemical analysis. Plasma metabolites: Plasma total protein was determined according to Henry (1964) using assay kits supplied by Biocon, Egypt. Plasma albumin was determined according to Webster (1974) using assay kits supplied by Biocon, Egypt. Globulin calculation was obtained by subs traction between total protein and albumin concentration. Plasma GPT (ALT) and GOT (AST) were determined according to Reitman and Frankel (1957) using assay kits supplied by Diamond, Egypt. Plasma urea-N was measured according to Patton and Crouch (1977) using assay kits supplied by Diamond, Egypt. Plasma total cholesterol was determined according to Finley *et al*. (1978) using assay kits supplied by Diamond, Egypt.

### *2.4 Statistical analysis*

The data of growth performance experiments and blood constitutes of all traits were statistically analyzed according to snedecor (1980) in one way analysis of variance design by computer program of SAS (2009) as the model:

$$Yij = \mu + Ai + Eij$$

Where, Yij = experimental observation, μ = over all mean, Ai = effect of treatments (ration), i= T1, T2, T3 and T4 and Eij = experimental error (common error). Duncan's multiple range test (Duncan,1955) was as used to detect the significant differences among means. The data were analyzed according to SAS system general linear model (2009).

## 3. Results and Discussion

### *3.1 Chemical composition*

Chemical analysis (on dry matter basis) of treated rations is presented in Table (2). The data indicated that there is no difference among treatments in all nutrients, also data indicated that the nitrogen free extract (NFE) was nearly in all treatments 52.1, 52.0, 51.42 and 51.61 for T1, T2, T3 and T4 respectively.

Table (2): The chemical composition of the experimental diets.

| Item | Treatment | | | |
|---|---|---|---|---|
| | T1 | T2 | T3 | T4 |
| Dry Matter (%) | 69.35 | 69.66 | 70.13 | 69.95 |
| Organic matter (%) | 89.27 | 89.23 | 88.91 | 89.07 |
| Crude protein (%) | 12.52 | 12.63 | 12.32 | 12.48 |
| Crude fibre (%) | 22.35 | 22.29 | 23.08 | 22.69 |
| Ether extract (%) | 2.30 | 2.31 | 2.27 | 2.29 |
| NFE (%) | 52.10 | 52.00 | 51.24 | 51.61 |
| Ash (%) | 10.73 | 10.77 | 11.09 | 10.93 |

T1= basal diet without additions (control diet), T2= fed the basal diet supplemented with 0.2% microalgae (spirulina) T3 =fed the basal diet supplemented with 2% macro algae (*Padina baergensenii*), and T4= the basal diet supplemented with0.1% microalgae (*spirulina*) + 1% macro algae (*Padina baergensenii*).

### *3.2 Growth performance and feed conversion*

The effect of treatments on performance of growing male Frafra lambs is presented in Table (3). The data revealed that for initial body weight was similar in all groups without significant difference among groups. Final body weight, total gain and daily gain increased by144 gm, 146 gm and 146 gm respectively, for T2 in comparison with T1, but this was slightly increased not significant that mean there was no significant difference among groups in final body weight, total gain and daily gain. Feed conversion improved for T2 compared with T1 and other treated groups (T3 and T4) but, this improvement was slightly not significant that`s mean there was no significant among groups in feed conversion. The improvement of final body weight, total gain and daily gain, for lambs fed ration supplemented with microalgae *spirulina* (T2) may be due to that *spirulina* is an important source of nutritional compounds of high biological value used in animal nutrition (Gouveia *et al*., 2008; Kulpys, *et al*., 2009). These results obtained from this research are in agreement with those finding by Samara *et al*. (2013) and Abdoun *et al.* (2014) they illustrated that dietary macroalgae had no effect on body weight and average daily gain of growing lams fed diet supplemented with green macroalgae *Ulva lactuca* at levels of 3% and 5%. Also, the same results recorded by Abu EL-Kassim *et al.* (2021). In this connection, Bach *et al*. (2008) they reported that dietary macroalgae had no effect on body weight and average daily gain in steers.

Table (3): Effect of dietary microalgae and macroalgae on performance of growing lambs.

| Items | Treatment | | | | sig |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | |
| Initial body weight (kg) | 22.85 ± 0.71 | 23.05 ± 0.86 | 23.05 ± 0.95 | 23.012 ± 1.12 | NS |
| Final body weight (kg) | 40.038 ± 1.72 | 43.482 ± 1.61 | 40.896 ± 2.23 | 40.618 ± 1.78 | NS |
| Total body weight gain (kg) | 17.188 ± 1.16 | 20.318 ± 1.20 | 17.742 ± 1.33 | 17.606 ± 0.94 | NS |
| Daily gain (kg) | 0.144 ± 0.01 | 0.17 ± 0.01 | 0.146 ± 0.01 | 0.146 ± 0.01 | NS |
| Total dry matter consumed (kg) | 170.31 | 170.55 | 172.92 | 171.74 | - |
| Feed conversion (kg DM /kg gain) | 10.066 ± 0.60 | 8.498 ± 0.44 | 9.978 ± 0.77 | 9.864 ± 0.53 | NS |

T1 = basal diet without additions (control diet), T2 = fed the basal diet supplemented with 0.2% microalgae (*spirulina*), T3 = fed the basal diet supplemented with 2% macroalgae (*Padina baergensenii*), and T4 = the basal diet supplemented with 0.1% microalgae(*spirulina*) + 1% macroalgae (*Padina baergensenii*).

### *3.3 Blood constitutes*

The effect of treatments on blood plasma constituents is presented in Table (4). Data showed a significant ($p<0.05$) difference among experimental treatments in some blood parameters. The data revealed that plasma total protein, albumin, globulin, albumin /globulin ratio, ALT and cholesterol concentration were in the normal range, but urea-N concentration tend to be higher than the normal range which slightly varied from 46.46, 46.17 and 39.96 mg⁄dl for T1, T2 and T3 respectively. Glucose concentrations were in the normal range for T1 and T2, the values were 69.88 and 70.81 mg⁄dl, but for T3 and T4 tend to be higher than the normal range the figures were 84.27 and 93.66 mg/dl respectively. These results can be explained in view of the digestibility and nitrogen balance and the characteristic of microalgae (*Spirulina*) and macroalgae (*padina*). *Spirulina* characterized by is a "micro vegetable" that can provide some of the antioxidants needed. Many studies revealed that antioxidants like the carotenoids in fruits and vegetables have a synergistic effect (Belay, 2002), also it has rich in crude protein content which has a direct effect on reactive oxygen species, Spirulina contains an important enzyme, superoxide dismutase (1,700 units/g), that acts indirectly by slowing down the rate of oxygen radical generating reactions (Belay, 2002).

Table (4): Effect of dietary microalgae and macroalgae on some blood plasma constitutes of lambs.

| Items | Treatment | | | | sig |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | |
| Total protein (g/dL) | 5.5433 ± 0.26 [b] | 6.5447 ± 0.26 [a] | 6.0167 ± 0.40 [ab] | 5.4073 ± 0.48 [b] | ** |
| Albumin (g/dL) | 2.8467± 0.14 [ab] | 3.2313 ± 0.25 [a] | 2.7407 ± 0.14 [ab] | 2.636 ± 0.14 [b] | ** |
| Globulin (g/dL) | 2.6967 ± 0.27 [a] | 3.3134 ± 0.17 [b] | 3.2773 ± 0.44 a | 2.7067 ± 0.55 [a] | ** |
| AL/Gb | 1.06±0.52 [b] | 2.46±1.47 [c] | 0.84± 0.32 [b] | 0.97± 0.25 [a] | * |
| Cholesterol (Mg/dL) | 45.2167 ± 1.84 [ab] | 52.5867±4.60 [a] | 51.8527 ± 2.81 [ab] | 42.674 ± 2.92 [b] | * |
| Glucose (Mg/dL) | 69.8787 ± 5.29 [b] | 70.8107 ± 5.60 [b] | 84.2693 ±3.92 [a] | 93.6587 ±3.39 [a] | ** |
| Urea (Mg/dL) | 46.4553 ± 2.42 | 46.174 ± 4.09 | 39.9567 ± 2.72 | 34.51 ± 2.78 | Non sig |
| AST IU | 65.1127 ± 4.51 | 65.6633 ± 5.29 | 57.4813 ± 3.25 | 58.844 ± 2.73 | Non sig |
| ALT IU | 28.2713 ± 5.94 [a] | 11.3273 ± 1.71 [b] | 24.214 ± 4.56 [a] | 18.0253 ± 3.63 [ab] | * |

[a,b,c] Means with the same letter within rows are not significantly different. T1 = basal diet without additions (control diet), T2 = fed the basal diet supplemented with 0.2% microalgae (*spirulina*), T3 = fed the basal diet supplemented with 2% macroalgae (*Padina baergensenii*), and T4 = the basal diet supplemented with 0.1% microalgae(*spirulina*) + 1% macroalgae (*Padina baergensenii*).

In this study, higher total protein albumin, globulin concentration was found in the *Spirulina* supplemented group. The increased concentrations of plasma globulin may be related to the high protein contents in *Spirulina* (Gershwin and Belay, 2008). Increased plasma globulin levels are thought to be associated with a stronger innate response in lambs and indicate higher resistance (Matanović *et al*., 2007). This result is supported by increased total leukocytic count in *Spirulina algae* fed group. These results agree with those finding by (Karatzia *et al*., 2012) who reported that total protein albumin, globulin, albumin: globulin ratio, cholesterol and urea concentration. The increase of blood total protein and albumin in treated groups may be due to the addition of macroalgae and yeast culture stimulate the development of intestinal microflora resulting in improved feed digestion and utilization of feed nutrients (Karatzia *et al*., 2012) or may be due to macroalgae supplementation can enhance immune function and overall animal health in lambs (Saker *et al*., 2004). Increase the total protein of plasma maybe it is why too high protein content in *Spirulina* algae (Gershwin and Belay, 2008). Current results are consistent with the findings that recognized by Hassanien *et al*. (2015)

who worked with goats and used *Spirulina* algae at 0.2% of their feed intake. Likewise, Hafez *et al.* (2013) found that blood total protein and albumin concentrations were significant higher with 0.2% *Spirulina platens* algae of DMI of growing lambs than those of control diet that free from algae supplement. In addition, the rest of blood parameters (globulin, cholesterol, triglycerides, creatinine, urea-N, AST and ALT) concentrations did not affect by dietary algae supplements. Moreover, similar results were observed Khalifa *et al*. (2016) with dairy goats, in which *Spirulina* algae addition at 500 mg/head/day had significant increased total protein and glucose concentrations, significantly reduced each of cholesterol, triglycerides, AST and ALT, while had no effect on urea contents, compared with the control diet that free from *Spirulina* supplement. Gaafar *et al.* (2018) reported that most blood biochemical parameters were markedly increased with increasing the *Spirulina* level in drinking water of cows.

### *3.4 Economic Efficiency*

The effect of microalgae and macroalgae on economic efficiency of Farafra male sheep is presented in Table (5) the data reveled that lambs fed diet containing microalgae (*Spirulina*) showed the better economic efficiency either than lambs fed control diet (T1), macroalgae, (T3) or mixture of them (T4), which had better daily gain (0.170 gm/day), feed efficiency due to high coast of feed (Table 5).

Table (5): Economical efficiency of Farafra male sheep as affected by supplementation with the experimental diets.

| Items | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Average daily CFM Intake (Kg) | 0.752 | 0.752 | 0.752 | 0.752 |
| Cost of on kg DM/CFM consumed (LE) | 3.292 | 3.292 | 3.292 | 3.292 |
| Daily Intake corn silage (kg) | 0.669 | 0.669 | 0.669 | 0.669 |
| Coast of kg corn silage consumed (LE) | 1.116 | 1.116 | 1.116 | 1.116 |
| Average daily spirulina consumed (kg) | - | 0.00202 | - | 0.001 |
| Coast of kg corn spirulina consumed (LE) | - | 0.347 | - | 0.171 |
| Average daily *Padina baergesenii* consumed (kg) | - | - | 0.022 | 0.011 |
| Coast of kg *Padina baergesenii* consumed (LE) | - | - | 0.338 | 0.169 |
| Total coast of daily feeding (LE) (B) | 4.409 | 4.747 | 4.747 | 4.749 |
| Daily gain (gm) | 0.143 | 0.170 | 0.146 | 0.146 |
| Coast of kg gain (LE) (A) | 8.866 | 10.540 | 9.052 | 9.052 |
| Revenue = A-B (LE) | 4.457 | 5.793 | 4.305 | 4.303 |
| Economic efficiency =A – B/B | 101.09% | 122.03% | 90.69% | 90.61% |

T1 = basal diet without additions (control diet), T2 = fed the basal diet supplemented with 0.2% microalgae (*spirulina*), T3 = fed the basal diet supplemented with 2% macroalgae (*Padina baergensenii*), and T4 = the basal diet supplemented with 0.1% microalgae(*spirulina*) + 1% macroalgae (*Padina baergensenii*).

The current results showed that lambs feed ration containing supplemented microalgae (*Spirulina*) exhibited the higher daily gain, best coast Economic income, best feed conversion subsequent best revenue and Economic efficiency 122.03% than control and other treatment these results due to better growth performance, nutritive value, and best utilization of feeds. The current results showed that lambs feed ration containing supplemented microalgae (*Spirulina*) exhibited the higher daily gain, best coast economic income, best feed conversion subsequent best revenue and Economic efficiency 122.03% than control and other treatment these results due to better growth performance, nutritive value, and best utilization of feeds. These results agree with those obtained by Gaafar *et al*. (2018) who showed that *Spirulina* additive resulted in significant ($P<0.05$) improvements in economic efficiency. Similar results were recorded by Hafez *et al*. (2013) who found markedly positive effect on economic efficiency due to Spirulina algae supplementation into the rations of growing lambs. Moreover, with dairy goats Khalifa *et al*. (2016) revealed that a marked improvement in economic efficiency when added 500 mg of Spirulina powder into the control diet (100.00 *vs* 127.27%). As well as total revenue of body weight gain and net revenue as well as economic efficiency were significantly higher ($P<0.05$) for calves fed Spirulina rations than those of control ration.

## 4. Conclusion

It could be concluded that supplementation of algae (*Spirulina platensis*) powder and macroalgae in Farafra lambs' rations as a feed additive is of positive return on the health and productive status since it improved lamb productive and economic efficiency performance.

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