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THE USE OF BROWN ALGAE MEAL IN FINISHER BROILER DIETS

By

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Abstract: *A total number of 672, 18 day old, of commercial broiler chicks were distributed to 24 treatments each with 4 replicates (seven chicks each) to evaluate the nutritional value of raw brown algae (Sargassum SPP) and those of thermal treated form (boiled and autoclaved) in finisher broiler diet (18-39 days) at 0.0, 2.0, 4.0 or 6.0% levels with or without enzyme supplementation.*

Results of the chemical analysis and metabolizable energy (ME kcal/kg) of raw and those of thermal treated algae (boiled or autoclaved) indicated that all nutrients content were approximately equals and the thermal processing did not change the chemical composition of the algae. Algae meals have high percentage of sodium by about 4.02, 4.01 and 4.05 % for raw, boiled and autoclaved algae, respectively. The results show that the thermal treatments had no effect on its content of amino acids. The chemical score (CS) and the essential amino acid indexes (EAAI) of raw, boiled and autoclaved algae were 41.67, 41.67 and 31.25% for CS and 72.59, 81.50 and 72.80 % for EAAI, respectively, moreover methionine, histidine and lysine were the first, second and third limiting amino acid, respectively. Palmitic acid was the major constituent of the saturated fatty acids (25.899, 22.119 and 26.602%, respectively) and the total percentages of unsaturated fatty acids were high in all samples (64.101, 67.097 and 64.668%, respectively) for raw, boiled and autoclaved algae. The results revealed that raw, boiled and autoclaved algae are rich in their content of omega fatty acids.

Generally, the highest body weight (BW), 2164.72 g, and body weight gain (BWG), 1542.58g, were recorded for the broiler fed control diet, regardless of different studied diets. Broiler fed raw algae recoded the highest significant BW compared to which fed boiled or autoclaved algae in their diets, regardless of the levels or enzymatic treatments. The lowest total fed intake (FI),2839.02 g, and the best feed conversion (FCR), 1.88, were recorded for the broiler fed control diet (0.0% algae).

Using different levels of raw or treated algae and addition of enzymes mixture to broiler finisher diets did not significantly affect on dressing, gizzard, spleen and liver percentages. Impacted 2% algae significantly increased plasma HDL and significantly decreased plasma total cholesterol concentrations, regardless of treatments. However, enzyme supplementation had insignificant effect on all plasma constituents.

In conclusion, using brown algae in finisher broiler diet improve plasma profiles and had insignificant effect on carcass characteristic. However, further investigations are recommended to improve the nutritional value of brown algae as an untraditional poultry ingredient.

Key Word: Brown Algae, Finisher Broiler Diets

INTRODUCTION

It is well common known that marine algae could be divided into three main groups, green, brown and red algae. Algae are valuable sources of food, micronutrients (essential nutrients, especially trace elements), and raw materials for the pharmaceutical industry and considered as the food supplement for 21[st] century as source of proteins, lipids, polysaccharides, minerals, vitamins, and enzymes ***(Rimber 2007). Rizvi and Shameel (2004)*** found that brown algae *Sarga* have significant activity against bacteria as compared to the green and red algae. ***Abdel-Wahab et al. (2006)*** pointed out that the extract of some types of marine algae in the Red Sea such as *laurencia obtusa* and *Caulerpa prolifera* have an obvious effect against fungal toxins AFB1 which responsible for the beginning and encourage the emergence of cancer in the liver.

Algae carbohydrates, are in the form of starch, glucose and polysaccharides, had high digestibility and this gives no limits for use of algae in dried food and feed ***(Becker, 2004).*** Algae fats consist of glycerol and bases which esterifies to saturated and unsaturated fatty acids, which some of their are particular importance, such as omega 3 and omega-6 ***(Tzovenis et al., 2003). Mohd et al. (2000)*** showed that G. changgi (*C. changii*) algse contained a higher composition of unsaturated fatty acids (74%), mainly omega fatty acids and 26% of saturated fatty acids (mainly palmitic acid) and also relatively high levels of calcium and iron. ***David (2001)*** and ***Becker (2004)*** indicated that algae are good source for essential vitamins (A, B_1, B_2, B_3, B_{12}, C, E, nicotinic acid, biotin, folic acid, and bantothinic acid. Also, algae are rich in pigments such as chlorophyll (0.5% to 1%) of dry weight and carotenoids (0.1 to 0.2%). ***Sim et al. (2004)*** indicated that *Ecklonia acva Kjellman* (EC) brown algae dried aerobically contains 10.49% protein, 0.73% fat, 36.41% fiber, 27.23% mineral salts and 10.6% sodium chloride, and the average value of the energy represented by 1849 Kcal/kg, and the average values of 13 amino acid is about 32%. also algae contained a quantity of vitamins such as vitamin E, B_2.

Becker (2004) found that 30% of the current production of algae in the world is sold for use in animal feed. ***Yamaguchi (1997)*** demonstrated that more than 50% of current production from algae *Arthrospira* is used as feed additives.

In poultry algae can be used safely from the level of 5% to 10% while the use of algae with high concentrations for long periods gives adverse effects ***(Taher, 1986).*** The yellow color of the skin of broiler chicks and legs as well as egg yolks, are the important qualities that can be improve by feeding on algae ***(Becker, 2004). Nimruzi (2000)*** showed that the broiler chicks fed 4.0% algae powder inclusion improved their feed efficiency, and pigments of broiler chicks. ***Asar (1972)*** indicated that fed 4% of the seaweed resulted in the best increase in the chick weights. ***El-Deek et al. (1985 and1987)*** reported that feed conversion ratio did not significantly differ for layers fed on seaweed levels and found substantial improvement in body weight of chicks by using seaweed up to 10%. ***Breikaa (1993)*** noted that green algae could be used up to 10% in the ducks diets. ***Schaivone et al. (2007)*** found that marine algae (*Schizoch ytrium type*) is an alternative source for the traditional sources (fish oils) of n-3FA in the broiler diet.

According to the latest developments of the forage strategy in the Kingdom of Saudi Arabia, it was found that the size of the subsidy for imported rations. up nearly 6 billion riyals/year, also the basic materials in the composition of poultry diets (corn and soybeans) are rising still, resulting in higher product prices by up to 40%, which compels us to search for other alternatives ingredients that could be used in poultry diets. The aim of this study was to evaluate the nutritional value of different levels of brown algae meal as alternative ingredient for broiler diets in the raw or treated forms with or without enzyme supplementation on the growth of broiler performance and their plasma lipid profile.

MATERIALS AND METHODS

This study was carried out at the poultry farm of the Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdul Aziz University. The aim of this investigation is to evaluate the nutritional value and the suitable level of raw or treated brown algae as alternative ingredient for broiler finisher diet supplemented with or without enzyme.

1- Algae sources:

Many types of marine algae and their gender have been identified by the specialists, deployed in the catchments area of those algae on the coast of the Red Sea city of Jeddah by the specialists, the most important available species are Cysto Seira Myrica, Sargassum dentifebium, Turbinaria Triqvetra and Colpomenia sp.

Type *Sargassum* was selected to be used in this study because it is the most prevalent of brown algae at Red Sea shore in Saudi Arabia near Jeddah.

Brown algae (*Sargassum dentifebium*) which will be included in this study had the following characteristics: had alvicozantin dye in its structure in addition to the chlorophyll pigment, food saver in the form of carbohydrates and polysaccharides and its cells wall composed of cellulose and lignin.

2- Gathering and preparing marine algae:

Algae were harvested, transported to the college farm, sun derided (the environmental temperatures about 40 C^{o} during the most day), then were crushed to dry powder, sieved to the appropriate size for feeding and then stored in dark bags until use in diet formulation.

3- Thermal processing treatments (boiling and autoclaving):

Dried brown algae have been taken and boiled in cooking unit using for 20 minuets with stirring, transferred directly to the trays, with continuous stirring for 36 hours in drying unit then dried algae were grinded again and sieved. Another part of the raw algae were exposed to the sterilization process (autoclaved) under pressure for 20 minutes and temperature of 121 C^{o}.

4- Chemical evaluation:

Samples of raw and thermal treated algae meals were taken for a complete chemical analysis according to methods of the ***AOAC (1985)***, Table (1). Metabolizable energy (ME) of raw and treated algae samples were calculated according to ***Carpenter and Clegg (1956)*** equation as following:

ME (kcal/kg) = (35.3 * CP %) + (79.5 * EE %) + (40.6 * NFE%) + 199.0.

The amount of the essential amino acids in greatest deficient in raw or treated algae meals were considered, the first and second limiting amino acids compared with the chicks requirement present in the **NRC (1994)**. Essential amino acid index (EAAI) was calculated according to ***Woodham and Deans (1977)***, Table (2).

$$EAAI = \sqrt[n]{\frac{100aa_1}{AA_1} \times \frac{100\,aa_2}{AA_2} \times \ldots\ldots \times \frac{100\,aa_n}{AA_n}}$$

where:

aa_1, aa_2, ... aa_n : percentge of the essintial amino acids in the ingredient

AA_1, AA_2,...... AA_n : percentage of the same amino acids in NRC

N : The number of amino acids entering into the calculation

If in that protein an essintial amino acid is present in a greater quantity than in the NRC, then it percentage content is lowered to 100.

Chemical score (CS): The content of each of the essential amino acids of a protein is expressed as a percentage of that in the standard (NRC, chicks requirement), the lowest percentage being taken as the chemical score ***(Mc Donald et al., 1973)***, Table (2).

5- Enzymatic mixture:

The enzyme mixture formulation which used in the experimental diet was consisted of Xylem 500 and Amcozyme 2x enzyme in equal ratio and used with a rate of 1 g / kg broiler diet. Xylem 500 (extracted from the Bacillius Sabtilis bacteria and their components are X-amylase 8000 U/gm and 1-4 B xylanase 1260 U/gm) and Amcozyme 2x enzyme (its components: Amylase 2500000 U/gm, Protease 2000000 U/gm, Lipase 150000 U/gm, Beta-glucanase 30000 U/gm, Xylanaze 500000 U/gm, Cellulase 15000 U/gm, Phytase and X glactocidase).

6- Experimental design:

Finisher broiler diets (Table 4) were formulated according to the catalog of the supplier company using a computer program to configure the feed at the lowest cost, then calculated according to the ***NRC (1994)***. A total number of 672, 18 day old, distributed to 24 treatments each treatment with 4 replicates (seven chicks per each). Feed and water were provided *ad-libitum* throughout the experimental period (18-39 days). Vaccination and medical program were done according to the different stages of age under supervision of a veterinarian.

Twenty four experimental diets were formulated to contain 0.0, 2.0, 4.0 and 6.0 % of raw or treated algae meal with or without enzyme preparation.

7- Measurements:

Body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were weekly calculated. At the end of the experimental (39 days of age) 5 birds from each treatment were randomly selected and slaughtered for carcass evaluation. Carcass was eviscerated and head and shank were removed, giblets (liver, gizzard and heart) and spleen were dissected from the viscera and weighed. Each portion was expressed as a percentage of live body weight. Blood samples were taken from the 5 broiler chicks from each treatment in tubes containing EDTA. Plasma was obtained from the blood samples by centrifugation for 15 min. at 3500 rpm and frozen. The frozen plasma was allowed to thaw prior analysis. Plasma total lipids, triglyceride total cholesterol, LDL and HDL were determined by colorimetric methods using available commercial kits.

8- Statistical Analysis:

Results obtained were statistically analyzed according to experimental design and analysis of the factorial direction of variance application program using the linear model GLM ***(SAS, 2001)***. Variables having significant differences were compared using Duncans multiple range test ***(Duncan, 1955)***.

RESULTS AND DISCUSSION

Chemical Composition of Raw and Treated Algae:

Results represented in Table (1) showed the chemical analysis and the minerals content of raw brown algae (*Sargassum spp*) as affected by different treatments. Values of the proximate analysis and the minerals content of tested materials were approximately equals. It may be due to thermal possessing did not change their contents of nutrients, except the color of algae differed due to thermal processing and tended to be more dark for algae treated by autoclaving followed by algae treated by boiling process. The metabolizable energy values (ME kcal/kg) were approximately equal for different samples which ranged between 1726 and 1774 kcal/kg. Also, results indicated that algae have higher percentage of sodium bieng 4.02, 4.01 and 4.05 % for raw, boiled and autoclaved algae, respectively. Results of Table (1) explained that raw or treated brown algae contained 47.15, 48.31 and 47.65% ash, that may be due to the existence of these algae in the Red Sea environment which is characterized by high salts, and this is consequently reflected on the components and the concentration of mineral salts in cells and particularly sodium element.

The acid hydrolysis for amino acids content, chemical score (CS), essential amino acid index (EAAI) and limiting amino acids (LAA) for raw and treated algae are presented in Table (2). The results showed that raw and treated algae are rich in amino acids. The thermal treatments had no effect on the algae content of amino acids. The chemical score of raw, boiled and autoclaved algae were 41.67, 41.67 and 31.25%, respectively. The essential amino acid indexes of raw, boiled and autoclaved algae were 72.59, 81.50 and 72.80 %, respectively. Based on the calculated values of CS, it is clear that, methionine, histidine and lysine were the first, second and third limiting amino acid, respectively, for the studied samples.

Palmitic acid was the major constituent of the saturated fatty acids for raw, boiled and autoclaved algae (25.89, 22.12 and 26.60%, respectively), Table (3). It was observed that both of raw and autoclaved algae were contained the highest percentage of total saturated fatty acid (35.869 and 35.332%, respectively). The total percentages of unsaturated fatty acids were higher in all samples (64.101, 67.097 and 64.668 for raw, boiled and autoclaved samples, respectively) comparing to saturated fatty acids percentages and the ratio of total unsaturated fatty acid to saturated fatty acids were 1.79, 2.06 and 1.83 for the same samples, respectively. However, oleic acid was the major constituent of total unsaturated fatty acids (27.338, 28.690 and 27.086% for raw, boiled and autoclaved samples, respectively), followed by linoleic acid (22.158, 25.438 and 24.474 % for the same samples, respectively). The results revealed that raw, boiled and autoclaved algae are rich in omega fatty acids content. Nearly, similar results were found by ***Sim et al. (2004)*** who confirmed that chemical compounds of brown algae *Eckalonia acva kjellman, Kjellmaniella crassfolia* and *Hizikia fusiforme* were 10.49% protein, 0.73% fat, 36.41% fiber, 27.23% ash, 10.6% sodium chloride and ME 1849 kcal/kg and the average values of 13 amino acids was about 32%. In this respect, seaweed are generally poor in energy and fat content, while it has high content of mineral elements, especially Mg, Ca, P, K, and I, and vitamins (***Jimenez-Escring and Goni, 1999***). In previous studies demonstrated by ***El-Sayed (1982)*** found that *Cystoseira myrica, Sargassum sub cpandum, Digenia simplex* and *Laurencia papillosa* brown algae was the most important marine algae diversified and widespread on the north coast of Jeddah (the Red Sea) and the concentration of mannitol is 25-39 mg / g brown algae. Carbohydrates ranged from 68.66 to 90.83%, protein 6.35 to 25.34% and fat 1.13 - 7.46%. He found also that brown seaweed *Trubinaria murrayana* contains 3.2% laminaran, 4.7% fucans and 22.6% alginic acid. ***Khalil and El Tawil (1982)*** conducted reviews on the chemical components for some marine algae species from the coast city of Jeddah, and found that the algae is free of alkaloids and flavonoids and has traces of terpenoids and steroids. They pointed out that the content of algae is often poor in protein and has an inverse relationship with the content of fat. Iodine is important and its concentration is up to 45 mg / g, as well as the concentration of phosphorus is high. ***Wong and Cheung (2001)*** found that algae content of crude fiber ranged from 50.30% to 55.4% and salts 21.3 to 22.8% on dry basis and found that fat is very low, ranged between 1.42 - 1.64%. ***Mohd. et al. (2000)*** found that *G. changgi* algae contains a high amount of unsaturated fatty acids 74%, especially omega fatty acids and 26% of saturated fatty acids, especially palmitic acid, as well as their content is high in calcium and iron. ***Wong and Cheung (2001)*** indicated that major amino acid components of the red seaweed were glycine, arginine, alanine and glutamic acid. Also, among the essential amino acids (EAAs), lysine with a chemical score of 53% was the most limiting when compared to the essential amino acid pattern of egg protein. ***Lipstein and Hurwitz (1983)*** found large variation in the ME content (from 900 to 2782 Kcal/kg) for eight algae samples using young chick. Many researchers reported that the algae highest content of mineral salts may be due to the types of algae, geographical location, season and environmental factors, physiological and other ***(Yoshie et al., 1994). Rizvi and Shameel (2004)*** explained that the brown algae often contain many minerals such as Ca, Cd, Cr, Cu, K, Fe, Mg, Na, Pb and Zn. ***David (2001)*** stated that vitamins A (retinal), B_1, B_2, B_3, B_{12}, folic acid and C content of 100g dry matter of *Ulva sp* were 960 IU, 0.06, 0.03, 8.0, 6.3, 11.8 mg and 10.0 mg, respectively and 100g dry matter of *Gracilaria* content of vitamins B_1, B_2, B_3, B_{12}, folic acid and C were 0.4, 0.4, 14.4, 2.8 and 1.1mg, respectively. Also, ***Ruperez et al. (2002)*** explained that the content of brown algae is high in mineral salts by 30.1 - 39.3% comparing to the red algae. ***Al Homaidan (2006)*** measured the concentration of cadmium, copper, iron, lead and zinc in four species of brown algae in the areas of Khafji and Dammam on the Saudi coast of the Arabian Gulf. He demonstrated that the concentrations of cadmium, copper and zinc were within normal limits for such environments, and ranged between 0.62 and 1.95 µg/g for cadmium, 3.95 and 11.23 µg/g for copper and 15.70 and 75.50 µg/g of zinc. Also, high concentrations of iron and lead were found in the two regions, ranging from the 161 and 1466 µg/g of iron, and 8.84 and 18.60 µg/g of lead.

Broiler Growth Performance:

Using different levels of algae significantly affected on final BW Table (5). At the end of the experiment (39 days old), the highest broiler BW (2164.72 g) was recorded for those fed control diet comparing to the other experimental groups. The influence of thermal treatment clearly indicated that the broiler fed raw algae recorded the significant highest BW than broiler fed boiled or autoclaved algae in their diets. Generally, the lowest broiler BW was recorded for those fed autoclaved algae in their diets comparing to the other treatments. Regardless of levels or the thermal treatments, the enzymatic treatments significantly decrease broiler BW comparing to the broiler groups fed untreated diets. The interaction results indicated that there were significant differences in final broilers BW (Table 6).

The final BWG of broiler was significantly affected by feeding different treated or untreated levels of algae (Table 6). Regardless of thermal and enzymatic treatments, the broiler fed the control diet (0% algae) had the highest significant BWG (1542.58g) comparing to the other treatments groups and the lowest overall BWG (1465.93g) was observed for those fed 6% algae in their diets. The influence of thermal treatment carried out indicated that broiler fed raw algae had the highest BWG (1514.56 g) comparing to the other treatment groups and the lowest BWG (1490.52 g) was observed for those fed autoclaved algae in their diets regardless of levels or enzymatic treatment. The broiler fed untreated algae with enzymes had the highest BWG comparing to the broiler fed treated algae at the end of experimental period (1504.28g), regardless of thermal treatment or algae levels. These results agree in part with those reported by ***El Deek and Brikaa (2009)*** who found that the levels (0, 4, 8, 12 %) of seaweed did not affect the performance of the ducks. ***Ross and Dominy (1990)*** found that the growth of the chicks fed diets containing up to 6.0 % of *Spirulina* was not different from that of the chicks receiving the control diet (0.0%) and the birds receiving 12% *Spirulina* in their diet grew significantly slower than the chicks fed the other *Spirulina* diets. ***Carrillo et al. (1990)*** demonstrated that feed intake was insignificantly different (from 1 day to 8 wks of age) for broilers fed sorghum–soybean diets contained 0, 5, 10, 15% seaweed (*Macrocystis pyrifera*), while growth significantly decreased gradually with increasing seaweed level. However, ***Ernest and Warren (1990)*** observed that the performance of Hubbard male broiler chickens was not significantly affected by incorporation of blue-green algae up to 6% in the diet.

Feed Utilization:

The total FI and FCR were significantly affected by different levels of algae, thermal and enzymatic treatments and their interaction Table (5). In respect of algae levels, the lowest total FI (2839.02 g) and the best FCR (1.88) were recorded for the broiler fed control diet (0.0% algae). However, the highest total amount of FI was recorded for broiler fed 6% algae (2981.33 g) accompanied with the worst FCR (2.09) for the same group. These results indicated that using different levels of algae in broiler finisher diet increased the amount of FI but did not improved the FCR comparing to control treatment Table (5). Moreover, using boiled or autoclaved algae in broiler finisher diets increased the total amount of FI and not improve the FCR comparing to those fed raw algae in there diet. Also, FI for broiler fed diet containing boiled algae and enzymes mixture was significantly increased, while FCR was significantly improved as comparing to those fed untreated algae in there dies Tables (5). Many researchers indicated that FI or FCR were unaffected by addition of sea grass to broiler, quail and ducks diets (***El Deek et al., 1987*** and ***El Deek and Brikaa 2009***). ***Venkataraman et al. (1994)*** found that feed efficiency and performance in general were not affected by the addition of dried *Spirulina* algae powder to broiler diet. ***Schaivone et al. (2007)*** found that using of 5 g algae / kg feed insignificantly affect on the performance of the Muscovy ducks.

Carcass Characteristics:

Regardless of thermal or enzymatic treatments, using different levels of algae in broiler finisher diets had insignificant effect on dressing percentages (ranged between 73.1 to 73.8%) at 39 days of age (Table 6). Also, the overall mean of broiler dressing percentages was insignificant affected by thermal treatments (ranged between 73.8 to 74.5%) comparing to those fed raw algae (untreated algae). On the other hand, adding mixture of enzyme in broiler finisher diets significantly decreased the dressing percentage, regardless of levels or thermal treatments (Table 6).

Using different levels of algae in broiler finisher diets had insignificant effect on gizzard and spleen percentages (ranged between 2.12 to 2.35% and 0.12 to 0.15%, respectively), regardless of thermal or enzymatic treatments (Table 6). Also, the overall mean of broiler gizzard and spleen percentages were insignificant different among treatments (ranged between 2.18 to 2.33% and 0.13 to 0.14%, respectively) due to thermal treatments comparing to those fed raw algae (untreated algae). Generally, addition of enzyme mixture to broiler finisher diets significantly decreased the gizzard and spleen percentages regardless of levels or thermal treatments (Table 6). On the other hand, addition of algae by different levels or algae treated with thermal or enzymatic treatments to broiler finisher diets had insignificant effect on liver percentages (Table 6). ***Gu et al. (1988)*** concluded that 2% of marine algae meal improved broiler performance and dressing percentage. ***El Deek et al. (1987)*** and ***El Deek and Brikaa (2009)*** found that using different levels of seaweed had insignificant effect on ducks carcass quality. ***Venkataraman et al. (1994)*** found that broiler dressing percentage and the weights of different organs were not affected by the addition of *Spirulina* algae dried powder to broiler diet. ***Schaivone et al. (2007)*** found that using of 5 g algae / kg feed insignificantly affected on the slaughter characteristics, chemical structure, color and stability of oxidation properties and sensory of the Muscovy ducks.

Blood Constituents:

Incorporation of different levels of brown alga in broiler finisher diet had significant effected on HDL and LDL values, those values fluctuated and did not show regulars trend. Also thermal treatment showed the same fluctuations while, they were not affected by enzymatic treatments (Table 7). Plasma triglycerides (TG) concentration was significantly affected by using different levels of algae and it is ranged between 112.47 to 119.32 mg / dl. The highest concentration was recorded for the broilers fed 2% algae in their diets (119.32 mg / dl) and the lowest concentrations was recorded for those fed 6% algae in their diets (114.70 mg / dl). Incorporation of boiled algae in finisher broiler diets significantly increased plasma TG concentration (120.35 mg / dl) as compared to those fed the control or diets containing autoclaved algae (114.65 and 114.45 mg / dl, respectively) Table (7). Addition of enzymes had no effect on plasma TG concentration. In this respect, several researches reported that addition of algae meal to human and animal diet significantly improved lipid profile as reported by ***Venkataraman et al. (1994)*** and ***Schaivone et al. (2007).***

Using different levels of algae significantly affected on plasma total cholesterol concentration (TCh) and it is ranged between 121.00 to 125.8 mg/dl, the lowest concentration was recorded for the broiler fed 2 and 6% algae (121.0 and 122.7 mg/dl, respectively). Thermal treatment had insignificant effect on plasma TCh concentration, but it is clear that incorporation raw algae in broiler finisher diets significantly decreased plasma TCh concentration as compared to the incorporation of boiled or autoclaved algae. However, adding enzymes had no effect on plasma TCh concentration (Table 7).

Plasmas total lipid (TLp) concentrations were significantly increased by increasing level of algae in broiler diets from 2% to 4% and 6% (268.5 and 297.3 and 301.3 mg / dl, respectively) comparing to the control (225.3 mg / dl), while no significant difference were observed between those fed the high levels (4% and 6%) of algae. Also, thermal treatment had a significant effect on TLp concentration, since the incorporation of boiled algae in broiler finisher diets significantly decreased TLp concentration comparing to the incorporation of raw or autoclaved algae. However, enzymatic treatments had insignificant effect on TLp concentration (Table 7). In this respect, ***Keskin et al. (1995)*** found slightly higher plasma total lipid for Japanese quails after 1 wk feeding on 1% Maxicrop, an extract from the seaweed *Ascophyllum nodosm.* ***Schaivone et al. (2007)*** reported that algae powders increased of total lipids as compare to the control.

In conclusion, using brown algae in finisher broiler diet improve plasma profiles and had insignificant effect on carcass characteristic. However, further investigations are recommended to improve the nutritional value of brown algae as an untraditional poultry ingredient.

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Table 1. Chemical analysis of raw, boiled and autoclaved algae used in formulating experimental diet.

Nutrients (%)	Raw	Boiled	Autoclaved
Dry Matters	94.20	94.40	94.70
Crude protein	7.54	7.77	7.61
Ether Extract	0.45	0.47	0.41
Ash	47.15	48.31	47.65
Nitrogen Free Extract	31.19	29.95	31.38
Crude Fiber	7.77	7.90	7.65
Neutral detergence fiber	27.95	30.21	28.91
Acid detergence fiber	21.54	23.54	21.18
Hemicelluloses	6.41	6.67	7.73
Tannin (mg/g protein)	0.775	0.733	0.815
ME (K cal/Kg)	1767	1726	1774
Minerals contents			
Calcium %	0.144	0.144	0.139
Phosphorus %	0.239	0.239	0.255
Sodium %	4.010	4.010	4.050
Zinc PPm	330	330	345
Manganese PPm	270	270	265
Iodine PPm	12.72	12.72	13.18
Irion PPm	11.495	11.495	11.212
Copper PPm	4.79	4.79	4.60
Lead PPm	0.002	0.002	0.001

Table 2. Amino acids analysis and ammonia contents of raw, boiled and autoclaved algae used in formulating experimental diet.

Amino acids g/100g samples	Raw %	Boiled %	Autoclaved%	NRC (1994) Requirements%
Alanine	0.87	0.64	0.87	
Arginine	0.71	0.77	0.74	0.70+1.25
Aspartic acid	1.61	1.54	1.80	
Cysteine	0.07	0.10	0.05	
Glutamic acid	1.98	2.01	2.22	
Glycine + Serine	0.77+0.59	0.71+0.60	0.72+0.73	
Histidine	0.18	0.43	0.21	0.17-0.35
Isoleucine	0.478	0.49	0.57	0.65-0.85
Leucine	0.92	0.88	0.96	0.82-1.20
Lysine	0.40	0.40	0.30	0.96-1.10
Methionine	0.17	0.25	0.18	0.30-0.50
Phenylalanine+Tyrosine	0.70+0.52	0.64+0.40	0.80+1.00	0.83-1.40
Proline	0.53	0.72	1.26	
Threonine	0.63	0.65	0.74	0.48-0.80
Valine	1.03	1.00	0.94	0.70-0.90
Ammonia	0.28	0.16	0.19	
Total	12.41	12.48	14.29	
EAAI[1]	72.59	81.50	72.80	
CS[2]	41.67	41.67	31.25	
FLAA[3]	Methionine	Methionine	Methionine	
SLAA[4]	Histidine	Histidine	Histidine	
TLAA[5]	Lysine	Lysine	Lysine	

1: Essential Amino Acid Index. 2: Chemical Score. 3: First Limiting Amino Acid.
4: Second Limiting Amino Acid. 5: Third Limiting Amino Acid.

Table 3: Fatty acids percentages of raw, boiled and autoclaved dried brown algae used in formulating experimental diet.

Fatty Acids		Raw %	Boiled %	Autoclaved%	NRC(1994) Req %
Lauric	$C_{(12:0)}$	1.049	0.521	0.726	
Myristic	$C_{(14:0)}$	3.453	1.822	3.047	
Palmitic	$C_{(16:0)}$	25.899	22.119	26.602	
Heptadecanoic	$C_{(17:0)}$	1.511	1.822	1.451	
Stearic	$C_{(18:0)}$	2.878	5.738	2.539	
Arachidic	$C_{(20:0)}$	1.079	0.521	0.967	
Palmitoleic	$C_{(16:1)}$	6.115	6.379	7.255	
Oleic	$C_{(18:1)}$	27.338	28.690	27.086	1.00
Linoleic (ώ6)	$C_{(18:2)}$	22.158	25.438	24.474	
Alpha Linolenic (ώ 3)	$C_{(18:3)}$	5.612	4.996	4.401	
Eicosapentaenoic	$C_{(20:5)}$	2.878	1.594	1.452	
Saturated Fatty Acid (SFA)		35.869	32.543	35.332	
Mono Unsaturated Fatty Acids (MUFA)		33.453	35.069	34.341	
Poly Unsaturated Fatty Acids (PUFA)		30.648	32.028	30.327	
Total Unsaturated Fatty Acid (TUSFA)		64.101	67.097	64.668	
TUSFA / SFA		1.79	2.06	1.83	

Table 4. Composition and calculated analysis of the broiler experimental diet fed during 18-39 days of age.

INGREDIENTS	Control	Raw			Boiled			Autoclaved		
		2%	4%	6%	2%	4%	6%	2%	4%	6%
Corn Grain	55.64	53.11	50.58	47.72	53.09	50.54	47.66	53.09	50.53	47.66
Soybean Meal (44%)	36.06	36.19	36.33	36.53	36.2	36.35	36.55	36.21	36.36	36.56
Palm Oil	4.81	5.42	6.03	6.75	5.42	6.04	6.78	5.42	6.04	6.77
Dical Phos	1.47	1.45	1.44	1.43	1.45	1.44	1.43	1.45	1.44	1.43
Limestone	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Common Salt	0.46	0.26	0.05	0	0.26	0.05	0	0.26	0.05	0
Vitamin Premix[1]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mineral Premix[2]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DLMethionine	0.2	0.2	0.2	0.2	0.21	0.21	0.21	0.2	0.21	0.21
Choline Cl70	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Algae meal	0	2	4	6	2	4	6	2	4	6
Total	100	100	100	100	100	100	100	100	100	100
NUTRIENTS ANALYSIS										
ME kcal/kg	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100
CP %	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Ether extract%	7.28	7.81	8.33	8.96	7.81	8.34	8.98	7.81	8.34	8.98
Crude Fiber%	2.63	2.59	2.55	2.50	2.73	2.84	2.93	2.74	2.84	2.94
Lysine %	1.21	1.22	1.22	1.23	1.22	1.22	1.22	1.22	1.22	1.23
Methionine %	0.54	0.54	0.54	0.55	0.54	0.55	0.55	0.54	0.54	0.55
Methionine+Cystine%	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Linoleic acid %	1.81	2.32	2.82	3.34	2.30	2.79	3.28	2.32	2.83	3.35
Calcium %	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Ava. Phosphorus %	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Sodium %	0.2	0.2	0.2	0.259	0.2	0.2	0.261	0.2	0.2	0.26
Ioden ppm	0	0.274	0.549	0.823	0	0	0	0.27	0.54	0.81

[1]Provided the following per kg of diet: vitamin A, 12,000 IU; vitamin D_3, 7,200 ICU; vitamin E, 20 IU; vitamin B_1, 2.5 mg; vitamin B_2, 5 mg; vitamin K, 3 mg; vitamin B_{12}, 10 mg; pyridoxine, 1.5 mg; pantothenic acid, 10 mg; niacin, 35 mg; folic acid, 1.5 mg and biotin 125 mg.

[2]Provided the following per kg of diet: Mn, 90 mg; Cu, 7.5 mg; Zn, 65 mg; Fe, 50 mg; Se and 0.1 mg.

Table 5: Effect of different levels of raw, boiled and autoclaved brown algae meal with or without enzyme addition on broiler performance at the end of experiment.

Treatments (Treat)	Item	BW Begin. (18days)	BW Final 39 days	BWG 18-39 days	FI 18-39 days	FCR 18-39 days
Levels % (L)	0	622.14	2164.72^{a}	1542.58^{a}	2839.02^{d}	1.88^{d}
	2	622.62	2136.73^{b}	1519.31^{b}	2873.16^{c}	1.91^{c}
	4	624.85	2105.15^{c}	1485.72^{c}	2910.62^{b}	1.99^{b}
	6	624.25	2092.78^{d}	1465.93^{d}	2981.33^{a}	2.09^{a}
Thermal Treat. (Thr)	Raw algae	647.84	2142.40^{a}	1514.56^{a}	2880.51^{c}	1.93^{b}
	Boiled algae	623.82	2117.29^{b}	1505.07^{b}	2934.71^{a}	1.99^{a}
	Autoclaved algae	624.53	2114.85^{c}	1490.52^{c}	2887.88^{b}	1.98^{a}
Enzymatic Treat. (Ez)	Untreated	624.70	2127.55^{a}	1504.28^{a}	2891.76^{b}	1.98^{a}
	Treated	624.75	2122.15^{b}	1497.40^{b}	2910.31^{a}	1.95^{b}
Significant	Levels (L)	NS	**	**	**	**
	Thr	NS	**	**	**	**
	Ez	NS	**	**	**	**
	L X Thr	NS	**	**	**	**
	L X Ez	NS	**	**	**	**
	Thr X Ez	NS	**	**	**	**
	L X Thr X Ez	NS	**	**	**	**

Means within the same column with different superscript are significantly different.
** Significantly at 0.01 NS: No significant

Table 6: Effect of different levels of raw, boiled and autoclaved brown algae meal with or without enzyme addition on some carcass broiler characteristics.

Treatments (Treat)	Item	Dressing %	Gizzard %	Spleen %	Liver %
Levels % (L)	0	73.6	2.29	0.15	1.52
	2	73.8	2.12	0.14	1.45
	4	73.1	2.24	0.12	1.51
	6	73.7	2.35	0.13	1.53
Thermal Treat (Thr)	Raw algae	74.5	2.33	0.14	1.49
	Boiled algae	74.4	2.24	0.13	1.49
	Autoclaved algae	73.8	2.18	0.14	1.52
Enzymatic Treat (Ez)	Untreated	74.0^{a}	2.18^{b}	0.12^{b}	1.49
	Treated	73.1^{b}	2.30^{a}	0.15^{a}	1.51
Significant	Levels (L)	NS	NS	NS	NS
	Thr	NS	NS	NS	NS
	Ez	NS	*	*	NS
	L X Thr	NS	NS	NS	NS
	L X Ez	NS	*	*	NS
	Thr X Ez	**	NS	*	NS
	L X Thr X Ez	**	**	*	NS

Means within the same column with different superscript are significantly different.
NS: No significant * Significantly at 0.05 ** Significantly at 0.01.

Table 7: Effect of different levels of raw, boiled and autoclaved brown algae meal with or without enzyme addition on lipid profiles of broiler at end of experiment (39 days).

Treatments (Treat)	Item	HDL mg/dl	LDL mg/dl	TG. mg/dl	TCh. mg/dl	TLp. mg/dl
Levels % (L)	0	90.7^{b}	17.5^{b}	116.78^{b}	124.0^{a}	225.3^{c}
	2	103.0^{a}	16.2^{b}	119.32^{a}	121.0^{b}	268.5^{b}
	4	70.7^{c}	19.0^{a}	112.47^{d}	125.8^{a}	297.3^{a}
	6	91.7^{b}	13.7^{c}	114.70^{c}	122.7^{b}	301.3^{a}
Thermal Treat (Thr)	Raw algae	91.0^{b}	17.4^{a}	114.65^{b}	119.7^{b}	245.2^{c}
	Boiled algae	99.4^{a}	15.5^{b}	120.35^{a}	124.6^{a}	204.7^{b}
	Autoclaved algae	80.6^{c}	19.9^{a}	112.45^{b}	125.7^{a}	269.4^{a}
Enzymatic Treat. (Ez)	Untreated	90.2	16.2	115.63	123.5	272.4
	Treated	90.5	16.9	116.00	123.2	273.8
Significant	Levels (L)	**	**	**	*	**
	Thr	**	*	*	*	**
	Ez	NS	NS	NS	NS	NS
	L X Thr	*	*	*	*	**
	L X Ez	NS	NS	NS	*	**
	Thr X Ez	NS	*	NS	NS	**
	L X Thr X Ez	**	**	**	**	**

Means within the same column with different superscript are significantly different.
NS: No significant * Significantly at 0.05 ** Significantly at 0.01
HDL: high density lipoprotein. LDL: low density lipoprotein TG : Triglycerides.
TCh : Total Cholesterol TLp : Total Lipids.

REFERENCES

Abdel-Wahab, M. A.; Ahmed, H. H.; and Hagazi, M. M (2006). *Prevention of aflatoxin B_1 initiated hepatotoxicity in rat by marine algae extracts. J. of Applied toxicology. 26: 229-238.*

Al Homaidan, A. A. (2006). *Brown Algae as biomonitors of heavy metal pollution along the Saudi Coast of the Arabian Gulf. Saudi J. of Biological Sciences 13:99-103.*

Asar, M. (1972). *The use of some weeds in poultry nutrition. M.Sc. Thesis. Alexandria University.*

Association of Official Analytical Chemists, AOAC. (1985). *Official methods of analysis. 14th Edn. Published by the A.O.A.C, Washington, D.C., U.S.A.*

Becker, W. (2004). *Microalgae in human and animal nutrition, p. 312- 351. In Richmond, A. (ed). Handbook of microalgal culture. Blackwell, Oxford.*

Breikaa, A. Mervat (1993). *Nutritional and biological evaluation of marine seaweed containing diets offered as mash vs pellets in the nutrition of ducks. Fac. Of Agric. Alex. Univ. PhD Thesis.*

Carpenter, K. J. and Clegg, K. M. (1956). *The metabolizable energy of poultry feeding stuffs in relation to their chemical composition. J. Sci. Food Agri., 7:45-51.*

Carrillo, D.S., Casas, V. M. M.; Castro, G. M. I.; Perez, G. I.; and Garcia, V. R. (1990). *The use of Macrocystis pyrifera seaweed in broiler diets. Investigation Agraria Production Sanidad Animals, 5: 137142.*

David (2001). *Overview of Sea Vegetable Chemical Composition. www. surialink.com.*

Duncan, D.B. (1955). *Multiple range and Multiple Test. Biometrics, 11: 1-42.*

El-Deek A. A. and Mervat A. Brikaa, (2009). *The effect of different levels of seaweed in starter and finisher diets in pellet and mash form on performance and carcass quality of ducks. Int. J. of Poult. Sc., 8(10) 1014-1021.*

El-Deek, A. A., Asar M. A.; Safaa Hamdy, M. A.; Kosba, M. A.; and Osman, M. (1987). *Nutritional value of marine seaweed in broiler diets. J. Agric., Sci. Mansoura Univ., 12: 707 – 717.*

El-Deek, A.A., Isshak, N. S.; Hamdy, S.; Badawy, N.; and Asar, M. A. (1985). *Performance of two strains of laying hens fed on practical diets containing levels of Seaweed during the rearing and laying stages. Egypt. Poult. Sci. 5: 1-11.*

Ernest R, and Warren D. (1990). *The nutritional value of dehydrated, Blue-Green algae (Spirulina Plantensis) for poultry. Poult. Sci. 69 : 794-800.*

El-Sayed, M. M. (1982). *The polysaccarides of the brown seaweed Trubinaria murrayana. Carbohydrate Research 110: 277 – 282.*

Gu, H. Y.; Liu, Y.G.; and Shu, Z. Z. (1988). *Nutrient composition of marine algae and their feeding on broilers. Chinese J. Anim. Sci., 3: 12-14. Inal, F., B. Coskun, I. Celik, S. Inal, Gulsenn and Z.*

Jimenez-Escring, A.; and Goni, C. I (1999). *Nutritional evaluation and physiological effects of edible seaweeds. Arch. Latinoam. Nutr. 49: 114-120.*

Keskin E; Durgun Z.; and Kocabatmaz M. (1995). *The haematological influences of saeweed extract on growing Japanese qualils. Veteriner Bilimleri Dergisi. 11:1, 105110.*

.Khalil, A. N.; and El-Tawil, B. A. (1982). *Phytochemical studies on marine algae from Jeddah, Red sea. Bull. Fac. Sci., K.A.U., Jeddah. 6:49 – 60.*

Lipstein, B.; and Hurwitz, S. (1983). *The nutritional value of sewage-grown samples of Chlorella and micractinium in broiler diets. Poult. Sci. 62: 1254-1260.*

McDonald P.; Edwards, R. A.; and Greenhalgh, J. F. D. (1973). *Animal Nutrition. 2nd Edition. Longman, New York. U.S.A.*

Mohd., H., Ching Chio Yen and C.Y. Ching, (2000). *Nutritional composition of edible seaweed Gracilaria changgi. Food Chem. 68: 69-76.*

National Research Council, N.R.C. (1994). *Nutrient Requirements of Poultry. 9th Rev. Edn. National Academy Press, Washington, DC.*

Nimruzi, R. (2000). *A new natural source of corotenoids for poultry. Poultry International. September, p: 50-51.*

Radwan, S. S. (1978). *Coupling of two dimension thin layer chromatography with gas chromatography for the quantitative analysis of lipids glasses and their constituent fatty acids. J. Chromatography Sci., 16:538-542.*

Rimber Ir. Indy (2007). *Why is seaweed so important? M.Sc thesis Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Jln. Kampus Bahu, Manado 95115, Indonesia*

Rizvi, M.A. and Shameel, S. (2004). *Studies on the bioactivity and elementology of marine algae from the coast of Karachi, Pakistan. Phytotherapy Res. 18: 865-872.*

Ross, E. and Dominy, W. (1990). *The nutritional value of dehydrated, blue-*

green algae (Spirulina platensis) for poultry. Poult. Sci. 69: 794-800.

Ruperez, P.; Ahrazem, O.; and Leal, J. A. (2002). *Potential antioxidant capacity of sulfated polysaccharides from the edible marine brown seaweed Fucus vesiculosus. Journal of Agricultural and Food Chemistry. 50: 840-845.*

SAS, (2001). *SAS user's guide, Statistics, Version 10^{th} Edn. SAS institute Inc., Cary NC*

Schaivone, A.; Chiarini, R.; Marzoni, M.; Castillo, A.; Tassone, S.; and Romboli, I. (2007). *Breast meat traits of Muscovy ducks fed on a microalgae (Crypthecodinium cohnii) meal supplemented diet. Brit. Poult. Sic. 48:573-579.*

Sim. J. M., Kang, C. W.; Kim, S. K.; Kwon, S.K.; An, B. K.; Park, K. K.; and Her, E. (2004). *Nutritional evaluation of brown marine algae and lection extract residue for poultry feeding. XXII World's Poultry Congress, WPSA, June 8-12, Istanbul, Turkey.*

Taher, M. Osman. (1986). *The use of marine seaweed in broilers nutrition. MSc. Theis. Alexandria Univ. Egypt.*

Tzovenis, I.; De Pauw, N.; and Sorgeloos, P. (2003). Optimisation of T-Iso biomass production rich in essential fatty acids. *I. Effect of different regimes on growth and biomass production. Aquaculture, 216: 203-222.*

Venkataraman, L.V., Somasekaran, T.; and Becker, E. W. (1994). *Replacement value of blue green algae (Spirulina platensis) for fish meal and a vitamin-mineral premix for broiler chicks. Brit. Poult. Sci. 35: 373-381.*

Wong, K. H. and Cheung, P. C. K. (2001). *Nutritional evaluation of some subtropical red and green seaweeds: Part I proximate composition, amino acid profiles and some physicochemical properties. Food Chem., 71: 475-482.*

Woodham, A. A.; and Deans, P. S. (1977). *Nutritive value of mixed proteins. 1. In cereal-based diets for poultry. Br. J. Nut. 37: 289.*

Yamaguchi, K. (1997). *Recent advances in microalgal bioscience in Japan, with special reference to utilization of biomass and metabolites: a review. J. Appl. Phycol., 8: 487-502.*

Yoshie, Y.; Suzuki, T.; Shirai, T.; and Hirano, T. (1994). *Changes in the contents of dietary fibers, minerals, free amino acids, and fatty acids during processing of dry Nori. Nippon Suisan Gakkaishi, 60:117-123.*

الملخص العربي

استخدام مسحوق الطحالب البنية البحرية فى الأعلاف الناهية لكتاكيت اللاحم

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تم توزيع عدد ٦٧٢ كتكوت اللاحم عمر ١٨ يوم الى ٢٤ معاملة بكل معاملة ٤ مكررات وبكل مكررة ٧ كتاكيت وذلك لتقدير القيمة الغذائية و النسبة المثلى من الطحالب البنية (*Sargassum*) فى صورتها الخام او المعاملة (الغليان ، التعقيم او المضاف اليها مخلوط الأنزيمات) و ذلك كمكون علف غير تقليدى يمكن استخدامة فى العلف الناهى لكتاكيت اللحم. تم ادخال الطحالب فى صورتها الخام او المعاملة فى العلف الناهى المتماثل فى محتواة من الطاقة والبروتين الخام وذلك بنسبة صفر و ٢ و ٤ و ٦ %. تم تقديم العلف والماء لكتاكيت بصورة حرة خلال فترة الدراسة (١٨ الى ٣٩ يوم).

اوضحت نتائج التحليل الكيميائى للطحالب فى صورتها الخام او المعاملة بالحرارة (غليان و تعقيم) أن محتواها من العناصر الغذائية كان متماثل تقريبا وأن المعاملات الحرارية لم تغير فى تحليلها الكيميائى. كذلك فان محتوى الطاقة الميتابولزمية كانت متماثلة تقريبا لمختلف العينات وكانت تتراوح مابين ١٥٢٣ و ١٥٤٣ كيلو كالورى / كجم . تحتوى الطحالب الخام و المعاملة على نسبة مئوية عالية من الصوديوم وتصل الى حوالى ٤.٠٢ و ٤.٠١ و ٤.٠٥ % وذلك للطحالب الخام و المعاملة بالغليان و المعاملة بالتعقيم على التوالى. اوضحت النتائج ان المعاملة الحرارية لم يكن لها تأثير على محتوى الطحالب من الأحماض الأمينية. كانت قيم المعيار الكيميائى ٤١.٦٧ و ٤١.٦٧ و ٣١.٢٥ % و دليل الأحماض الأمينية الأساسية ٧٢.٥٩ و ٨١.٥٠ و ٧٢.٨٠% وذلك للطحالب الخام و المعاملة بالغليان والمعاملة بالتعقيم ، على التوالى. اوضحت النتائج ان المثيونين و الهستيدين و الليسين هى الأحماض الأمينية المحددة الأولى والثانى و الثالثة وذلك على الترتيب. حمض البالمتيك كان له اكبر تركيز وذلك للأحماض الدهنية المشبعة وذلك للطحالب فى صورتها الخام او المعاملة بالغليان او التعقيم (٢٥.٨٩٩ و ٢٢.١١٩ و ٢٦.٦٠٢ % على التوالى). كانت النسبة المئوية الكلية للأحماض الدهنية الغير مشبعة كانت مرتفعة وذلك لجميع العينات (٦٤.١٠١ و ٦٧.٠٩٧ و ٦٤.٦٦٨ % على التوالى) وكانت النسبة مابين الأحماض الدهنية الغير مشبعة الى الأحماض الدهنية المشبعة ١.٧٩ و ٢.٠٦ و ١.٨٣ للطحالب الخام و المعاملة بالغليان والمعاملة بالتعقيم على التوالى. أوضحت النتائج ان الطحالب فى صورتها الخام او المعاملة بالغليان او بالتعقيم غنية فى محتواها من الأحماض الدهنية من النوع الأوميجا-٦.

سجل اعلى وزن جسم (٢١٦٤.٧٢جم) واعلى زيادة فى وزن الجسم لكتاكيت اللاحم التى غذيت على العليقة الكنترول بغض النظر عن جميع المعاملات. وسجلتا كتاكيت اللاحم التى غذيت على طحالب خام اعلى زيادة معنويه فى وزن الجسم مقارنة بالتى غذيت على طحالب معاملة بالغليان او بالتعقيم وذلك بغض النظر عن المستويات او المعاملات الأنزيمية. خفضت المعاملات الأنزيمية معنويا من وزن الجسم مقارنة بكتاكيت اللاحم التى غذيت على عليقة غير معاملة انزيميا. سجل أقل غذاء مأكول (٢٨٣٩.٠٢ جم) و أفضل كفاءة تحويلية للعلف (١.٨٨) لكتاكيت اللاحم التى غذيت على عليقة (كنترول) مقارنة (صفر% طحالب).أوضحت النتائج ان ادخال الطحالب بالمستويات المختلفة فى العلف الناهى لكتاكيت اللاحم تؤدى الى زيادة معنوية فى كمية العلف المستهلك و يخفض من الكفاءة التحويلية للعلف مقارنة بالمعاملة المقارنة (كنترول). لا تتأثر النسبة المئوية للتصافى و القونصة والطحال و الكبد معنويا بادخال الطحالب بالمستويات المختلفة فى العلف الناهى لكتاكيت اللاحم. وبصفة عامة فقد ادى اضافة مخلوط الأنزيمات الى العلف الناهى لكتاكيت اللاحم الى خفض معنوى فى نسبة التصافى ، وزيادة معنوية فى النسب المئوية للقونصة والطحال. لم يكن لأدخال الطحالب بالمستويات المختلفة او الطحالب المعاملة بالغليان او التعقيم او أضافة مخلوط الأنزيمات الى العلف الناهى لكتاكيت اللاحم اى تأثير معنوى على النسبة المئوية للكبد. ادى ادخال الطحالب بنسبة ٢.٠% الى زيادة معنوية فى الدهون العالية الكثافة بالبلازما و يخفض معنويا من تركيز الكوليسترول الكلى وذلك بغض النظر عن المعاملات الحرارية او الأنزيمية. وبصفة عامة فأن المعاملة الأنزيمية لم يكن لها تأثير معنوى على المعايير المقدرة فى بلازما الدم.

الخلاصة:- استخدام الطحالب البنية فى اعلاف الدواجن لا يؤثر على صفات الذبيحة ويؤدى الى تحسن فى معايير الدهون بالبلازما ، الا انة يلزم اجراء المزيد من الدراسات لتحسين القيمة الغذائية للطحالب البنية كمادة علف غير تقليدية فى أعلاف الدواجن .