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EFFECTS OF KELP SEAWEED (*ASCOPHYLLUM NODOSUM*) ON GROWTH PERFORMANCE DURING THE GROWING PERIOD OF AN IMPORTED HEAVY-WEIGHT-LINE OF BROAD BREASTED BRONZE TURKEYS

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ABSTRACT: The study was investigated to evaluate the potentials of using *Ascophyllum nodosum* (Kelp meal, a Canadian commercial product form of that seaweed) as a natural feed additive through evaluating its effect on the growth performance, blood parameters, and meat quality of Broad Breasted Bronze (BBB a heavy strain selected line) commercial turkeys. Thirty-four imported BBB turkeys at 10 weeks of age were divided randomly into three treatments with two replicates (with unequal numbers in some of these replicates). All birds were fed a basal diet (Control, C) and two groups (*i.e.* treatments 2& 3) were having their diets additionally supplemented with *A. nodosum* (Kelp) at 1% and 2% from 10 until marketing at 21wks. of age.

Body weight, gain in weight and feed conversion have been generally improved, but feed intake has been slightly decreased by feeding those turkey broilers on the Kelp supported diets. Feeding on the tested seaweed diet improved significantly *(*$P \leq 0.05$) the percentage of eviscerated weight. Diets supported additionally with *A. nodosum* recorded generally the best blood parameters and meat quality measures compared to control. Both levels of Kelps seaweed supplementation (*i.e.* treatments 2& 3) recorded the lowest blood figures, in varying degrees, of total proteins, AST, ALT, triglycerides, cholesterol and creatinine levels; while recorded the highest blood values, at miscellaneous extents, of albumin and globulin. Significant treatment effects *(*$P \leq 0.05$ or $P \leq 0.01$) were detected on liver and blood uric acid and meat color quality (*i.e.* thigh meat lightness, thighs and breast meat redness and yellowness colors).

It seemed from the results that Kelp meal (*A. nodosum*) supplementation up to 2%, (*i.e.* treatments 2& 3), to basal diets would beneficially support growth performance, blood parameters, and meat quality of BBB turkey broilers. These effects are likely to make *A. nodosum* acts as promising potential growth promoter.

Key words:*Ascophyllum nodosum*; BBB Turkeys; Growth performance; Blood parameters, Meat quality

INTRODUCTION

Intensive turkey production in Egypt depends largely on imported commercial strains for many economic perspectives. Nutritional and environmental conditions are usually regarded to be most effective industrial themes in this industry.

Herbs, Medicinal and aromatic plants are now preferable, for poultry producers, as growth-promoters-feed-additives mainly for trustworthy and quality improvements of many productive traits (El-Kaiaty *et al.,* 2002; Al-Harthi, 2002 and El-Mallah *et al.,* 2005) and for its effects of initiating health benefits and positive immunity and viability (Soliman *et al.,* 1995 and Soliman *et al.,* 1999). However, Wang *et al.* (2013) reported that seaweeds can likewise be used to improve immune status, decrease harmful microbial load in the digestive tract, gut health and for its anticipated beneficial effect on poultry meat and egg quality

Ascophyllum nodosum is a large common, brown algae, of the class *Phaeophyceae*. It is a northern-Atlantic-Ocean-seaweed, also known as Norwegian Kelp. It is very common (http://en.wikipedia.org/wiki/Ascophyllum_nodosum) on the northwestern coast of Europe (from Svalbard to Portugal). A commercial product of the seaweed (ANOD) is often used as an ingredient in supplements in place of vitamins, minerals and amino acids sources. Kasapidou *et al.* (2015) noted that dietary *A. nodosum* could be used up to 2% in broiler chicken diets, without adverse effects on performance and meat lipid oxidation in refrigerated storage. Sharp (2005) showed that ANOD can be used (as an animal feed meal) up to 5% in poultry diet, sheep, cattle, pigs, and horses. Neeb and Jensen (1965) reported that trace elements and vitamins of ANOD have affected chickens' egg color, sheep wool appearance as well as cattle growth and milk production.

ANOD is composed of 10% fucoidan as a biologically active compounds (Baardseth, 1970), a complex sulfated polysaccharide that has been shown to boost cellular immunity and gut microbiota (Maruyama *et al.,* 2003). ANOD is a seaweed that, in addition, has anti-viral and anti-bacterial activity (Chonigeat *et al.,* 2004). Cole (1998) showed that ANOD have positive effects in response to transport disturbance by retaining electrolyte balance and alleviating the magnitudes of transportation stress. Ordinarily, transport is accompanied with decreased blood pH, glucose concentration, and interstitial water, together with momentous increases in serum chloride, hemoglobin and urine sodium. It is ascertained, however, that infusing electrolyte solutions attenuate greatly these changes (Schaefer *et al.,* 1997).

The study aimed to estimate the effects of adding two levels of *Ascophyllum nodosum* as a natural seaweed to the basal diet of Broad Breasted Bronze (BBB-a selected heavy strain) turkeys, on the productive performance, slaughter parameters, plasma constituents and meat physical characteristics.

MATERIALS AND METHODS

The experimental work of this study was conducted at the poultry farm, Animal Production Department, College of Agriculture, Suez Canal University, Ismailia, Egypt during the period from September to November, 2014.

Data were obtained on a total of thirty-four Broad Breasted Bronze (BBB-at 10 wks. of age selected heavy strain autosex-identified turkeys). The experimental work lasted to marketing at 21 weeks of age. Each group of birds (*i.e.* replicate) were kept in a separate 3 X 2 meters floor pens in an open-sided housing system. Birds were assigned randomly into 6 groups (Three treatments in two replicates with approximately 6 birds/replicate). Birds' average-initial-body-weight at the start of the experiment was nearly 2567±39.10 g.

All birds were reared under the same managerial, hygienic and environmental conditions. Feeds and clean, fresh water were provided *ad libitum.*

Three different iso-caloric iso-nitrogenous experimental diets, {0; 1 and 2% Kelp (*Ascophyllum nodosum*) seaweed were formulated to represent control, treatments 1& 2; respectively. *Ascophyllum nodosum* was purchased from the Golden company for Animal Production according to Acadian Seaplants Limited , 30 Brown Avenue , Dartmouth, Nova Scotia, Canada, B3B 1X8). The chemical composition of *Ascophyllum nodosum* was (Moisture, 10.12% ; Dry matter, 89.88% ; Organic matter, 67.70% ; Crude protein, 6.87% ; Ether extract, 2.40% ; Crude fiber, 6.50% ; Ash, 22.18% and Nitrogen free extract (NFE), 51.93%). Experimental diets were formulated accordingly on two age stages (the first growing stage from 10 to 12 wks. of age and second stage from 13th wks. till marketing). The experimental diets were adjusted according to the turkeys requisites of NRC, 1994 (Table 1).

Body weight (BW) was recorded to the nearest gram, for each individual bird every week from 10 to 21 weeks of age. Gain in weight was computed, as the difference in weight between every two consecutive periods. Feed consumption was recorded weekly and then feed conversion ratios were determined by dividing feed intake on gain in weight for each replicate at a certain period. At the end of the experiment, at least one bird per replicate of different treatments was slaughtered to obtain slaughter parameters. Carcass organs and viscera (Gut Mass); were weighed afterward. Relative organs weights were calculated based on the basis of their respective-bird-live-body-weight.

At slaughter, blood samples were collected from each bird in heparinized centrifuge tubes and centrifuged at 3000 rpm for 20 min. The clear plasma samples were drawn, transferred to small glass bottles and stored at < -20^{o} C in a deep freezer until the time of chemical determination.

Blood plasma was analyzed for total cholesterol, (g/100 ml) according to Richmond (1973); Triglycerides, (mg/100 ml) (Bernd and George, 1977); Creatinine concentration (Bartels *et al.,* 1972); Total proteins (g/100 ml) (Weichselbaum, 1946); Albumin, (g/100 ml) (Doumas *et al.,* 1971) , globulin (g/100 ml) as the difference between total proteins and albumin concentrations , Alanine transaminase (ALT U/L, Formerly sGPT) and Aspartate transaminase (AST U/L, Formerly sGOT) (Tietz, 1995). Biochemical characteristics of blood plasma were determined colorimetrically using commercial kits purchased from the Egyptian American Company of Laboratory Services and El-Nasr Pharmaceuticals Chemical Company, Cairo, Egypt.

The randomly selected slaughtered BBB turkey-broiler birds (2 birds/treatment at

21st week of age) were used once again to obtain muscles meat physical and chemical characteristics. Meat physical traits (*i.e.* color, pH, water holding capacity and tenderness of thigh and breast meat samples) were measured directly after slaughter while other traits (uric acid in blood plasma, liver and meat) were measured, after a period of preserving in refrigerator. Tenderness and water holding capacity (WHC) were assessed as stated by Jauregui *et al.* (1981); pH value (Jeacocke,1977) and color intensity (International Commission on Illumination- CIE, 1978). Uric acid contents in liver, muscle and blood plasma, were enzymatically determined according to Kageyama (1971).

Data of BBB turkeys were statistically analyzed using the general linear model procedure; PROC GLM of SAS package (SAS, 1998). Differences among treatment means were tested for significances using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight and gain in weight

The effect of Kelp treatments on body weight was generally significant ($P \leq 0.05$, $P \leq 0.01$, $P \leq 0.001$ or $P \leq 0.0001$) at most studied ages along with gain in weight at 10-11; 12-13; 19-20 and 10-21 weeks of age periods (Table 2 and 3).

In this respect, Eisa and Sohar (2003) and Wiseman (2012) noticed an increased broiler body weight due to supplementation of *A. nodosum* to water or diet. Turner *et al.* (2002) indicated increased swine body weight by supplementation of *A. nodosum*. Also, supplementation of Brown Seaweeds to basal diet increased gain in weight in chickens, (Asar, 1972), commercial ducks (El-Deek and Brikaa, 2009) and swine (Turner *et al.*, 2002 and Álvaro *et al.*, 2018). However, Kasapidou *et al.* (2015) reported no significant effect on broiler body weight by supplementation of *Ascophyllum nodosum* to their diets.

Generally, the highest values of body weight and gain in weight have been prominent for *Ascophyllum nodosum* 2%, followed by 1% and then the least was for the control group. Kelp exhibit a distinguished collection of microelements and vitamins that are expected to assist massively birds' metabolism and immunity. Therefore, this enhancement in body weight and gain in weight traits in response of adding the seaweed *A. nodosum* to the diet of growing turkeys may be due to some or a sort of combined effects of these biologically active, gut microflora enhancer, anti-inflammatory, anti-bacterial and natural antioxidants (as provokers of free radical scavenging effect) besides its characteristics as a cellular immunity boosting and for maintaining trace-elements electrolyte balance.

These universal positive effects of seaweeds may be due to their role as anti-bacterial and anti-viral activities characteristics (Vacca and Walsh, 1954 and Chonigeat *et al.*, 2004); reduced free radicals effects (Neeb and Jensen, 1965); positive effects of maintaining electrolyte balance (Cole, 1998); antioxidants features and qualities (Miller and Brzezinski-Slebodzinska, 1993); many biologically-active-compounds, (Baardseth, 1970); increased cellular immunity (Maruyama *et al.*, 2003).

Feed intake and conversion

Significant treatment effects ($P \leq 0.05$, $P \leq 0.01$) on feed intake traits were detected only during the periods of 11-12 and 19- 20 weeks of age but no significant effect was detected on feed conversion ratios during all studied

periods (Table 4 and 5). Afterall, the lowest visible values of feed intake (from 17 to 21 weeks and interval 10-21 weeks of age) and the best values of feed conversion ratios (during most studied ages and interval from 11-21) were recorded for birds having *A. nodosum* at 2%, and 1% followed by controls, respectively. The reduction in feed intake by adding *A. nodosum* to the diet, if true, may be due to gut health, the increased efficiency of nutrition absorption and/or utilization. The improvement in feed conversion ratios may be due to the presence of many biologically active, anti-bacterial, natural antioxidants and cellular immunity boosting characteristics of Kelp meal. Álvaro *et al.* (2018) with pigs reported a decrease feed intake of the diets supplemented with seaweed extracts compared to control.

In this respect, Tomova *et al.* (1981) and Kasapidou *et al.* (2015) reported that using seaweed meal as an ingredient in broiler chickens' diets had no adverse effect on feed conversion. As well, Inal *et al.* (1995) showed that supplementing maxicrop, an extract from the Brown Seaweed *Ascophyllum nodosum* to Japanese quails diet significantly improved feed conversion. However, El-Deek *et al.* (1987) with chickens, and El-Deek and Brikaa (2009) with duck reported non-significant differences in feed intake and feed conversion ratios due to supplementing different levels of seaweeds in bird diets.

Slaughter parameters

Significant treatments differences ($P \leq 0.05$; $P \leq 0.01$) were detected on eviscerated, abdominal fat and blood relative percentages (Table 6). These results showed that supplementing *A. nodosum* at 1% and 2% lowered the percentage of blood and abdominal fat and improved the percentage of eviscerated weight relative percentages. The improvement in eviscerated weight relative percentages due to brown seaweed treated diet may be interconnected with the increase in birds body weight.

In this connection, Tomova *et al.* (1981) with broilers, Inal *et al.* (1995) with Japanese quails and El-Deek and Brikaa (2009) with ducks reported non-significant effects due to supplementing extract or different levels of seaweed treatments on carcass characteristics. On the contrary, El-Ansary *et al.* (1986) reported that liver weight of chicks decreased significantly by adding seaweeds to diet while the increase was significant for intestinal and caecal lengths.

Plasma constituents

The effect of Kelp treatments on plasma components was not significant for all blood plasma parameters (Table 7) largely due to the miniature sample size and the discrepancy of within group variability (elevated CV% & SE for some of them).

Though of discredit of detecting significance, the results apparently revealed that ALT, AST, triglycerides, cholesterol and creatinine levels in the two *Ascophyllum nodosum* treatments were reduced, entail more evidences, compared with controls. *A. nodosum* at 2% recorded seemingly the highest total proteins, albumen (A) and globulin (G) values, while *A. nodosum* at 1% attained the highest A/G ratio. The higher concentration of globulins may indicate better immunity with the *A. nodosum* 2% level. Archer *et al.* (2007) reported significant decreased plasma protein, albumin, blood urea nitrogen values with

increased levels of *Ascophyllum nodosum* in lamb diet.

Meat physical and Meat, liver and blood chemical characteristics:

Significant (P≤ 0.05 or P ≤ 0.01) treatments effect were detected on the color lightness of thigh, redness of thigh and breast, yellowness of thigh and breast, uric acid in the liver and blood traits (Table 8).

The highest values of thigh and breast tenderness, thigh and breast pH, uric acid in the liver, blood and meat were recorded of control group while the premier value of water holding capacity (WHC) were detected for the *various A. nodosum* treatments. Largely, the best values of meat color measurements were generally recorded by the groups fed on treated diets containing diverse *A. nodosum* levels compared with controls, except that for thigh lightness. The meat color of the growing BBB turkey strain fed diets containing *A. nodosum* tend to give degrees from bright, redness and yellowish more/better than that of the control group (*i.e.* improved meat quality). Water holding capacity (WHC) is thought to be a reflect of meat containing a relatively higher protein, since the later (higher protein meat) is capable to holding higher quantity of water than that of the inferior protein meat. The results showed correspondingly that diets containing *A. nodosum* had no adverse-/but-virtuous-effects on turkey meat and do not restrict the edibility or use of turkey meat on behalf of its favorable product-added-value.

Cornforth (1994) showed that meat is appearing darker with the high pH which could further induce higher water binding capacity. When the pH of the meat is above the iso-electric point of the myofibril proteins in the meat and water molecules are tightly bound, meat may appear darker and versatile in color (Kauffman and Marsh, 1987 and Cornforth, 1994). On the other hand, Allen *et al.* (1997) concluded that due to differences in pH, broiler breast meat cuts may have diverse dissimilar (not stable) colors more than that shelf-life may produce. El-Sharkawy (1984) showed that meat containing a relatively higher protein is capable to holding lot water than lower protein meat.

In this respect, meat would generally be appearing lighter/brighter, cheerier to consumers, with the low pH values which possibly will provoke lower binding of myofibril-protein-molecules with water-molecules-binding-capacity (WBC). However, these collective muscles' high show rating and caliber quality is supposed to be owing to the antioxidant influence and a explicit consequence of the supplemental Kelp meal.

CONCLUSION

Supplementing Kelp meal (a commercial form of *Ascophyllum nodosum* seaweed) to growing Turkeys' basal diets would improve, with no detectable adverse effects, growth and meat quality characteristics. *A. nodosum* could be useful in the scope of evolving a sort of added value exploitation in turkey/poultry feed industry as bio-stimulant feed-additive agent, being not only economically advantageous (i.e. growth promoting& immune boosting capabilities), but also environmentally friendly (natural) feed additive.

Table (1): Composition and determined analysis of grower (10-12 weeks) and finisher (13-21 weeks) experimental turkey diets.

Ingredient	First stage (grower)			Second stage (Finisher)		
	Control	*Ascophyllum nodosum*		Control	*Ascophyllum nodosum*	
		1%	2%		1%	2%
Yellow corn	61.60	60.60	59.60	68.80	67.80	66.80
Soya bean (44 %)	26.00	26.00	26.00	18.50	18.50	18.50
Broiler concentrate	10.00	10.00	10.00	10.00	10.00	10.00
Animal fat	1.50	1.50	1.50	2.00	2.00	2.00
Di-Calcium phosphate	0.30	0.30	0.30	0.10	0.10	0.10
NaCl	0.50	0.50	0.50	0.50	0.50	0.50
Dl-Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Ascophyllum nodosum (Kelp)	0.00	1.00	2.00	0.00	1.00	2.00
Determined analysis						
Crude protein, %	21.62	21.34	21.55	18.86	18.91	18.89
Moisture, %	10.52	10.28	10.45	10.22	10.30	10.16
Ether extract, %	2.57	2.63	2.65	2.65	2.67	2.67
Crude fiber, %	3.22	3.40	3.32	3.15	3.20	3.25
Ash, %	6.44	6.74	6.81	6.18	6.42	6.52
ME (Kcal/kg)	3025	3004	2983	3143	3122	3101

(vitamin and minerals mixture premix were added at the ratio of 3 kg per ton as a part of the Broiler concentrate): Each 3 kg of vitamin and minerals mixture contained 12,000,000 IU Vit. A; 2,000,000 IU Vit. D_3; 10,000 mg Vit. E; 2,000 mg Vit. K_3; 1,000 mg Vit. B_1; 5,000 mg Vit. B_2; 1,500 mg Vit. B_6; 10 mg Vit. B_{12}; 10,000 mg pantothenic acid; 30,000 mg Nicotinic acid, 1,000 mg Folic acid; 50 mg Biotin; 250,000 mg choline chloride, 10,000 mg Cu, 1,000 mg I; 30,000 mg Fe; 50,000 mg Zn, 60,000 mg Mn, 100 mg Co and 100 mg Se.

Table (2): Least square means, standard errors (SE) and coefficients of variations (CV%) of different *A. nodosum* treatments affecting body weight (g.) of Imported Broad Breasted Bronze turkeys at different ages (from 10-21 wks. of age).

Age (wks.)	Item	Treatments				Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%	Sig.	
10	Mean	2558.00	2557.14	2550.00	NS	2555.29
	SE	72.66	101.28	124.45		57.709
	CV%	8.98	14.82	15.43		13.16
11	Mean	2978.00^{b}	3103.57^{a}	3176.00^{a}	***	3087.94
	SE	78.97	106.43	137.31		63.48
	CV%	8.38	12.83	13.67		11.98
12	Mean	3605.00^{b}	3809.28^{a}	3840.00^{a}	****	3758.23
	SE	80.37	123.44	167.01		74.35
	CV%	7.05	12.12	13.75		11.53
13	Mean	4174.00^{b}	4524.28^{a}	4549.00^{a}	***	4428.52
	SE	122.34	147.46	210.09		95.33
	CV%	9.26	12.19	14.60		12.55
14	Mean	4921.00^{b}	5306.42^{a}	5360.00^{a}	**	5208.82
	SE	161.46	161.94	257.39		112.78
	CV%	10.37	11.41	15.18		12.62
15	Mean	5824.00^{b}	6203.21^{a}	6225.00^{a}	*	6098.08
	SE	182.64	191.28	279.663		125.84
	CV%	9.91	11.53	14.20		12.03
16	Mean	6573.00^{b}	7017.85^{a}	7100.00^{a}	**	6911.17
	SE	207.37	220.55	306.42		142.65
	CV%	9.97	11.75	13.64		12.03
17	Mean	7328.00^{b}	7785.71^{a}	7934.00^{a}	**	7694.70
	SE	237.87	264.58	332.52		163.02
	CV%	10.26	12.71	13.25		12.35
18	Mean	7964.00^{b}	8549.64^{a}	8653.00^{a}	**	8407.79
	SE	250.49	293.77	370.41		180.50
	CV%	9.94	12.85	13.53		12.51
19	Mean	8512.00^{b}	9105.71^{a}	9269.00^{a}	**	8979.11
	SE	280.40	326.83	413.99		200.69
	CV%	10.41	13.43	14.124		13.03
20	Mean	8910.00^{b}	9587.14^{a}	9821.00^{a}	**	9456.76
	SE	336.17	367.36	460.69		228.12
	CV%	11.93	14.33	14.83		14.06
21	Mean	9307.00^{b}	9989.28^{ab}	10290.00^{a}	**	9877.05
	SE	361.49	401.69	517.34		250.39
	CV%	12.28	15.04	15.89		14.78

$^{a, b}$, ... Treatment means having different superscript litters within the same row are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Table (3): Least square means, standard errors (SE) and coefficients of variations (CV%) of different *A. nodosum* treatments affecting gain in weight (g.) of Imported Broad Breasted Bronze turkeys at different ages (from 10-21 wks. of age).

Period (Wk.)	Item	Treatments			Sig.	Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%		
10-11	Mean	420.00[b]	546.42[a]	626.00[a]	***	532.64
	SE	35.30	23.64	40.53		22.70
	CV%	26.58	16.18	20.47		24.85
11-12	Mean	627.00	705.71	664.00	NS	670.29
	SE	34.32	33.83	54.51		23.47
	CV%	17.31	17.93	25.96		20.42
12-13	Mean	569.00[b]	715.00[a]	709.00[a]	*	670.29
	SE	55.68	39.84	58.64		30.19
	CV%	30.94	20.85	26.15		26.26
13-14	Mean	747.00	782.14	811.00	NS	780.29
	SE	59.44	32.14	60.78		27.67
	CV%	25.16	15.37	23.70		20.67
14-15	Mean	903.00	896.78	865.00	NS	889.26
	SE	110.04	41.13	34.61		36.73
	CV%	38.53	17.16	12.65		24.08
15-16	Mean	749.00	814.64	875.00	NS	813.08
	SE	48.79	40.37	51.96		27.25
	CV%	20.60	18.54	18.78		19.54
16-17	Mean	755.00	767.85	834.00	NS	783.52
	SE	61.75	55.01	48.51		31.91
	CV%	25.86	26.80	18.39		23.75
17-18	Mean	636.00	763.92	719.00	NS	713.08
	SE	44.67	48.57	55.34		29.56
	CV%	22.21	23.79	24.34		24.17
18-19	Mean	548.00	556.07	616.00	NS	571.32
	SE	55.99	47.64	63.23		31.07
	CV%	32.31	32.05	32.46		31.72
19-20	Mean	398.00[b]	481.42[ab]	552.00[a]	*	477.00
	SE	66.88	51.97	63.92		32 .08
	CV%	53.13	40.39	36.62		42.82
20-21	Mean	397.00	402.14	469.00	NS	420.29
	SE	37.80	47.63	66.42		29.44
	CV%	30.11	44.32	44.78		40.84
10-21	Mean	6749.00[b]	7432.14[ab]	7740.00[a]	**	7321.76
	SE	320.61	327.22	462.06		217.65
	CV%	15.02	16.47	18.87		17.33

[a, b,] ... Treatment means having different superscript litters within the same row are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Table (4): Least square means, standard errors (SE) and coefficients of variations (CV%) of different Kelp treatments affecting per bird weekly/overall feed intake (g.) of Bronze turkeys (from 10-21 wks. of age periods).

Period (Wk.)	Item	Treatments				Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%	Sig.	
10-11	Mean	1408.00	1485.50	1443.50		1445.66
	SE	66.00	14.50	11.50	NS	22.67
	CV%	6.62	1.38	1.12		3.84
11-12	Mean	1659.50^{ab}	1770.00^{a}	1585.50^{b}		1671.66
	SE	1.500	13.00	44.50	*	35.95
	CV%	0.12	1.03	3.96		5.26
12-13	Mean	1972.50	2028.00	2044.00		2014.83
	SE	83.50	8.00	82.00	NS	33.24
	CV%	5.98	0.55	5.67		4.04
13-14	Mean	2315.00^{a}	2228.50^{ab}	1955.50^{b}		2166.33
	SE	125.00	5.50	53.50	NS	77.00
	CV%	7.63	0.34	3.86		8.70
14-15	Mean	2582.50^{a}	2586.00^{ab}	2515.00^{b}		2561.16
	SE	12.50	0.00	24.00	NS	16.19
	CV%	0.68	0.00	1.35		1.54
15-16	Mean	2918.50	2950.00	2970.00		2946.16
	SE	36.50	21.00	71.00	NS	23.32
	CV%	1.76	1.00	3.38		1.93
16-17	Mean	3242.00	3183.00	3129.50		3184.83
	SE	110.00	6.00	113.50	NS	45.71
	CV%	4.79	0.26	5.12		3.51
17-18	Mean	3613.00	3451.50	3368.00		3477.50
	SE	345.00	5.50	22.00	NS	100.18
	CV%	13.50	0.22	0.92		7.05
18-19	Mean	3565.50	3611.50	3328.50		3501.83
	SE	127.50	5.50	55.50	NS	66.07
	CV%	5.05	0.21	2.35		4.62
19-20	Mean	3870.50^{a}	3748.50^{a}	3376.00^{b}		3665.00
	SE	42.50	5.50	24.00	**	94.92
	CV%	1.55	0.20	1.00		6.34
20-21	Mean	4051.00	3938.00	3786.50		3925.17
	SE	176.00	61.00	69.50	NS	70.60
	CV%	6.14	2.19	2.59		4.40
10-21	Mean	31197.00	30980.50	29502.00		30559.83
	SE	1039.00	64.50	304.00	NS	438.03
	CV%	4.71	0.29	1.45		3.51

$^{a, b,}$ ... Treatment means having different superscript litters within the same row are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Table (5): Least square means, standard errors (SE) and coefficients of variations (CV%) of different Kelp treatments affecting feed conversion (g.) of Imported Broad Breasted Bronze turkeys (from 10-21 wks. of age periods).

Period (Wk.)	Item	Treatments				Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%	Sig.	
10-11	Mean	3.30	2.72	2.32	NS	2.783
	SE	0.38	0.07	0.09		0.208
	CV%	16.47	3.64	5.77		18.29
11-12	Mean	2.69	2.51	2.39	NS	2.532
	SE	0.17	0.11	0.14		0.080
	CV%	8.93	6.19	6.20		7.75
12-13	Mean	3.41	2.84	2.90	NS	3.053
	SE	0.28	0.15	0.18		0.150
	CV%	11.80	7.70	8.77		11.99
13-14	Mean	3.12	2.85	2.41	NS	2.795
	SE	0.26	0.01	0.09		0.150
	CV%	11.99	0.49	5.28		13.16
14-15	Mean	3.09	2.91	2.88	NS	2.963
	SE	0.62	0.27	0.14		0.185
	CV%	28.55	13.12	7.10		15.25
15-16	Mean	3.93	3.64	3.36	NS	3.645
	SE	0.19	0.29	0.18		0.146
	CV%	6.83	11.44	7.57		9.78
16-17	Mean	4.36	4.15	3.71	NS	4.077
	SE	0.40	0.17	0.12		0.170
	CV%	13.12	5.95	4.57		10.20
17-18	Mean	5.61	4.54	4.69	NS	4.952
	SE	0.27	0.36	0.07		0.243
	CV%	6.92	11.35	2.25		12.02
18-19	Mean	6.49	6.54	5.49	NS	6.178
	SE	0.18	0.56	0.27		0.275
	CV%	4.02	12.20	7.07		10.88
19-20	Mean	9.65	8.03	6.28	NS	7.988
	SE	0.59	1.39	0.53		0.742
	CV%	8.71	24.48	11.93		22.76
20-21	Mean	10.16	10.03	8.10	NS	9.433
	SE	0.27	1.47	0.27		0.575
	CV%	3.82	20.72	4.79		14.94
10-21	Mean	4.64	4.19	3.81	NS	4.213
	SE	0.22	0.28	0.02		0.177
	CV%	6.70	9.45	0.74		10.31

Table (6): Least square means, standard errors (SE) and coefficients of variations (CV%) of different *A. nodosum* treatments affecting slaughter constituents (%) of Imported Broad Breasted Bronze turkeys at marketing (after 21 weeks of age).

Slaughter constituents (%)	Item	Treatments			Sig.	Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%		
Feather	Mean	6.06	5.85	5.48	NS	5.84
	SE	0.41	0.46	0.71		0.27
	CV%	15.24	13.59	22.31		15.58
Blood	Mean	5.59[a]	4.76[a]	3.04[b]	**	4.66
	SE	0.23	0.24	0.45		0.37
	CV%	9.16	8.78	25.42		26.10
Head	Mean	2.19	1.97	1.84	NS	2.03
	SE	0.25	0.06	0.14		0.12
	CV%	25.38	4.89	13.06		19.74
Abdominal Fat	Mean	0.28[a]	0.14[b]	0.16[b]	**	0.21
	SE	0.02	0.03	0.04		0.02
	CV%	15.91	34.75	40.62		38.85
Heart	Mean	0.31	0.32	0.22	NS	0.29
	SE	0.04	0.02	0.03		0.02
	CV%	28.45	11.57	23.43		26.68
Liver	Mean	0.95	0.87	0.83	NS	0.90
	SE	0.12	0.09	0.16		0.07
	CV%	27.49	16.87	33.74		25.06
Gizzard	Mean	1.24	1.15	0.99	NS	1.15
	SE	0.13	0.08	0.15		0.08
	CV%	23.95	12.79	25.62		22.10
Eviscerated weight	Mean	80.37[b]	82.45[ab]	84.79[a]	*	82.14
	SE	0.75	0.75	0.61		0.70
	CV%	2.09	1.58	1.26		2.83

[a, b], ..Treatment means having different superscript litters within the same row are significantly different at (P< 0.05) using Duncan's Multiple Range test.

Table (7): Least square means, standard errors (SE) and coefficients of variations (CV%) of different *A. nodosum* treatments affecting plasma constituents of Imported Broad Breasted Bronze turkeys at marketing (after 21 weeks of age).

Plasma constituents	Item	Treatments			Sig.	Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%		
Albumin (g/dl)	Mean	0.85	0.74	0.99		0.86
	SE	0.15	0.02	0.26	NS	0.09
	CV%	24.96	2.89	37.14		25.84
Globulin (g/dl)	Mean	3.15	2.22	3.26		2.88
	SE	0.55	0.44	0.01	NS	0.28
	CV%	24.69	27.77	0.43		23.60
A/G ratio	Mean	28.69	34.38	30.39		31.15
	SE	9.77	6.08	8.07	NS	3.78
	CV%	48.16	24.99	37.55		29.74
Total proteins (g/dl)	Mean	4.50	2.95	4.25		3.90
	SE	0.10	0.45	0.25	NS	0.33
	CV%	3.14	21.57	8.32		20.89
ALT(GPT) (UL)	Mean	8.20	4.85	4.70		5.92
	SE	1.80	0.15	0.30	NS	0.86
	CV%	31.04	4.37	9.03		35.75
AST(GOT) (UL)	Mean	118.75	115.35	111.55		115.22
	SE	1.35	1.15	0.55	NS	1.40
	CV%	1.61	1.41	0.70		2.98
Creatinine (mg/dl)	Mean	0.45	0.20	0.15		0.27
	SE	0.05	0.03	0.03	NS	0.06
	CV%	15.71	21.21	28.28		56.11
Triglycerides (mg/dl)	Mean	83.50	56.90	48.50		62.97
	SE	12.50	6.90	9.50	NS	8.01
	CV%	21.17	17.15	27.70		31.15
Cholesterol (mg/dl)	Mean	196.50	195.50	108.00		166.67
	SE	3.50	30.50	2.00	NS	20.18
	CV%	2.52	22.06	2.62		29.66

Table (8): Least square means, standard errors (SE) and coefficients of variations (CV%) of different *A. nodosum* treatments affecting meat physical and chemical parameters parameters of Bronze turkey at marketing (21 weeks of age).

Parameters	Item	Treatments				Overall mean
		Control	*Ascophyllum nodosum* 1%	*Ascophyllum nodosum* 2%	Sig.	
Tenderness (breast)	Mean	2.88	2.63	2.00		2.50
	SE	0.13	0.13	0.25	NS	0.18
	CV%	6.15	6.73	17.68		17.89
Tenderness (thigh)	Mean	3.38	2.63	2.25		2.75
	SE	0.13	0.13	0.25	NS	0.22
	CV%	5.24	6.73	15.71		19.92
W.H.C (Breast)	Mean	38.23	39.15	43.95		40.44
	SE	0.07	0.95	4.75	NS	1.68
	CV%	0.28	3.43	15.28		10.18
W.H.C (Thigh)	Mean	40.85	41.35	47.35		43.18
	SE	0.55	1.15	4.05	NS	1.72
	CV%	1.90	3.93	12.10		9.74
Breast pH	Mean	5.87	5.69	5.59		5.72
	SE	0.04	0.08	0.12	NS	0.06
	CV%	0.96	1.99	2.91		2.77
Thigh pH	Mean	5.76	5.62	5.54		5.64
	SE	0.04	0.10	0.11	NS	0.06
	CV%	1.11	2.52	2.81		2.45
Uric acid in meat	Mean	0.53	0.39	0.36		0.42
	SE	0.03	0.04	0.01	NS	0.03
	CV%	6.73	12.86	3.93		19.91
Uric acid in liver	Mean	2.55^{a}	2.15^{ab}	1.83^{b}		2.18
	SE	0.05	0.05	0.07	*	0.14
	CV%	2.77	3.29	5.81		15.23
Uric acid in blood	Mean	3.88^{a}	3.70^{a}	3.10^{b}		3.56
	SE	0.08	0.20	0.10	*	0.16
	CV%	2.74	7.64	4.56		11.04
lightness (thigh)	Mean	76.85^{a}	62.59^{b}	65.57^{ab}		65.34
	SE	0.87	2.02	0.83	*	0.85
	CV%	4.03	10.20	4.02		7.17
lightness (breast)	Mean	64.95^{b}	65.65^{ab}	68.24^{a}		66.28
	SE	1.77	0.92	0.83	*	0.74
	CV%	8.60	4.41	3.84		6.13
Redness (thigh)	Mean	3.36^{b}	4.84^{a}	4.68^{a}		4.29
	SE	0.20	0.68	0.44	**	0.30
	CV%	14.14	44.24	30.05		37.70
Redness (breast)	Mean	2.68^{b}	4.36^{a}	5.16^{a}		4.07
	SE	0,45	0.57	0.47	**	0.34
	CV%	53.40	41.65	28.65		45.62
Yellowness (thigh)	Mean	1.59^{b}	2.72^{ab}	4.01^{a}		2.77
	SE	0.67	0.56	0.81	*	0.42
	CV%	132.74	65.65	63.51		83.76
Yellowness (breast)	Mean	2.13^{b}	5.56^{a}	6.87^{a}		4.85
	SE	0.93	1.10	0.78	**	0.64
	CV%	137.79	62.47	35.76		72.62

[a, b]. Treatment means having different superscript litters within the same row are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

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الملخص العربي

تأثير استخدام الطحلب البحري *Ascophyllum nodosum* خلال فترة النمو علي أداء خط تجاري مستورد منتخب لثقل الوزن من الدجاج الرومي البرونز عريض الصدر

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أجريت هذه الدراسة بمزرعة الدواجن – قسم الإنتاج الحيوانى بكلية الزراعة – جامعة قناة السويس لتقييم تأثير استخدام العشب البحري أسكوفايلام نودوسوم *Ascophyllum nodosum* (تجاريا يطلق عليه الكيلب)، كمكمل غذائى في علائق الدجاج الرومي التجاري البرونز عريض الصدر (BBB سلاله تجارية منتخبة ثقيلة الوزن) علي أداء النمو، استهلاك العلف، وقياسات الدم، وجودة اللحم.

تم تقسيم عدد أربعة وثلاثون من دجاجات الرومي البرونز التجارية BBB عمر 10 أسابيع عشوائيا إلى ثلاث معاملات كل منها يحوى اثنين من المكررات (مع عدد غير متساوى من الطيور في مكررات المعاملات). وقد غذيت طيور المجموعة رقم (1) على عليقة قاعدية (معاملة المقارنة، C) ومجموعتين تجريبيتين غذيت بعلائق استكملت بإضافة الكيلب إلي العليقة القاعدية بنسبة 1٪ و2٪ (المعاملات 2 ، 3 على الترتيب)، وذلك خلال فترة النمو من عمر 10 حتى 21 أسبوعا من العمر(عمر التسويق).

تحسنت معنويا صفات وزن الجسم، والزيادة في وزن الجسم، الكفاءة التحويلية للغذاء وانخفضت كمية الغذاء المستهلك نسبيا عن طريق تغذية الدجاج الرومي خلال فترة النمو علي العلف المدعوم بالطحلب البحرى. بينما حسنت التغذية علي الأعشاب البحرية معنويا ($P\leq 0.05$) وبشكل ملحوظ النسبة المئوية من وزن الذبيحة المجوف (منسوبة للوزن الحى قبيل الذبح).

بالإضافة إلى ذلك فإن التغذية/المعاملة المدعمة بالطحلب البحرى سجلت أفضل قياسات للدم وأعلى مقاييس لجودة العرض للحم مقارنة بالعليقة الكنترول إشارة إلى الحالة الجسمانية الصحية الجيدة للطيور. وتفصيل ذلك فقد أظهر كلا من مستويات المكمل الغذائى/العشب البحري Kelp (اي المعاملات 2 ، 3) أنها حسنت نسبيا (خفضت) وبدرجات متفاوتة كل من الكوليسترول، الجليسريدات الثلاثية، نسب الكرياتينين، وإنزيمات ALT،AST، هذا بينما تحسنت نسبيا (ارتفعت) نسب البروتين الكلى، والألبيومين والجلوبيولين (البروتينات المناعية)، وانخفض معنويا ($P\leq 0.05$ أو $P\leq 0.01$) حمض اليوريك بالكبد والدم، وتحسنت نوعية/جودة اللحم لعضلات الفخذ والصدر.

ويبدو من النتائج أن استخدام الطحلب *Ascophyllum nodosum* كمكمل غذائى بنسب تصل إلى 2٪ إلى العليقة القاعدية دعم ظاهريا أداء النمو، ومقاييس الدم، وصفات الجودة اللونية/نوعية اللحم للدجاج الرومى البرونز BBB وهذه التأثيرات من المرجح ان تجعل من أسكوفايلام نودوسوم بمثابة مكمل غذائى محتمل وواعد للدجاج الرومى في مرحلة النمو حتى التسويق.

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