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The Use of Quinoa Seeds Extract as a Natural Antioxidant in Broilers' Diets and its Effect on Chickens' Performance and Meat Quality

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ABSTRACT

The present experiment was conducted to evaluate the effect of dietary inclusion of quinoa seeds extract (QSE) as a natural antioxidant on broiler chicken performance, economical efficiency, meat quality and oxidative parameters of chickens' meat under refrigerated storage conditions. The extract was prepared and subjected to different analysis prior to use in broiler diets. A total number of 135 one-day old chickens of Ross strain were randomly allotted to three dietary treatments and each treatment contained 45 birds of 3 replicates each. The control group was fed a basal diet without supplementation while QSE was supplemented at a rate of 10 and 30 g/100 Kg diet to compose the other two experimental diets (T1 and T2), respectively. The results showed that QSE contains several phytochemical compounds with potential antioxidant activity. Those results were further confirmed by determining the total antioxidant capacity, total phenolic content and the radical scavenging activity of the extract. The dietary inclusion of QSE in broilers' diet showed that group T2 had significantly ($p<0.05$) higher body weight, weight gain and feed intake compared to T1 and control group. The proximate analysis results of chickens' meat showed that breast and thigh meat of the chickens in treatment T2 recorded significantly ($p<0.05$) higher protein content as compared to the other two groups. Regarding the antioxidant properties, the addition of quinoa seeds extract in broilers' diet resulted in a significant ($p<0.05$) improvement of the antioxidative properties of chicken meat. The oxidative stability of chicken meat under refrigerated storage conditions was evaluated at different storage days (1, 4 and 7) and it was shown that the dietary addition of QSE into broilers' diet succeeded in delaying the lipid oxidation of broilers' meat up to 7 days of refrigerated storage. The chicken meat of groups T1 and T2 showed no significant ($p>0.05$) reduction in their free radical scavenging activities at day 7 of storage compared to control group. From the present study, it can be concluded that the dietary inclusion of quinoa seeds extract in broilers' diet as a natural antioxidant have a positive effect on broilers performance, meat quality and also improved the chicken meat oxidative stability during refrigerated storage up to 7 days.

Keywords: Quinoa; antioxidant; broilers; meat quality; lipid oxidation; refrigerated storage

INTRODUCTION

Chicken meat is the very popular protein source in almost all Egyptian houses. Chickens are usually preferred over other protein sources for their taste, texture and most important for their lower prices. Chicken meat is usually subjected to quality deterioration by lipid oxidation during storage because of its high content of polyunsaturated fatty acids and low natural antioxidants (Aziza *et al.,* 2010). Antioxidants have been widely used in poultry diets in order to prevent the lipid oxidation in meat and its products (Avila-Ramos *et al.,* 2013). Antioxidants protect the biological cells from oxidative reactions caused by reactive oxygen species; they delay or inhibit oxidation of other substances by inhibiting the initiation of oxidizing chain reactions (Velasco and Williams, 2011). The commonly used synthetic antioxidants include ethoxyquin, santuquin, butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and others (Avila-Ramos *et al.,* 2013 and Marzoni *et al.,* 2014). The application of these synthetic antioxidants has been banned by several countries because of their toxicological effects and suspected carcinogenic potential (Spigno and De Faveri, 2007).

For these reasons, the researches concern by the use of natural antioxidants especially derived from plants have greatly increased recently. Plant extracts contain several bioactive compounds with potential health benefits to humans and several plant extracts were proved to have very effective antioxidant activities compared to synthetic antioxidants (Zeković *et al.,* 2014). Moreover, several plant extracts were used in poultry diets to improve meat oxidative stability upon storage.

Quinoa seeds have been traditionally used as food in many countries. The scientific name of quinoa is *Chenopodium quinoa* and it belongs to the *Chenopodiaceae* family (Letelier *et al.,* 2011). Quinoa is cultivated in saline soils in Upper Egypt as the winter climate in Egypt favors good production of quinoa (Elhamy *et al.,* 2014). Quinoa seeds are considered as a good source of bioactive polyphenols with potential antioxidant properties and several health benefits (Brend 2012).

In the present study, quinoa seeds extract was investigated as a natural antioxidant in broilers diets. The aim of the study was to evaluate the effect of dietary inclusion of quinoa seeds extract on broilers' performance, feed conversion, economical efficiency, meat quality and oxidative parameters of chicken meat under refrigerated storage conditions.

MATERIALS AND METHODS

Preparation of Quinoa seed extract (QSE)

Quinoa seeds were purchased from local market. The extraction was done by maceration method (Kenari *et al.,*, 2014). The seeds were ground into fine powder and extracted by soaking overnight in ethanol solution (90%). The extract was filtered and the solvent was allowed to evaporate. The powdered extract was then collected and stored for further use.

Analysis of quinoa extract

Gas Chromatography/Mass analysis of quinoa seeds extract was performed using SHIMADZU GC/MS-QP5050 A system and the main constituents of

the extract were identified by comparing their retention times and mass fragmentation patterns with the GC/MS spectral database library.

The total antioxidant activity of quinoa seeds extract was determined by the "phosphomolebdenum assay" using butylated hydroxianisol (BHA) as a standard antioxidant. The procedure described by Prieto *et al.,* (1999) was followed and the total antioxidant activity was expressed as mg BHA equivalent/ 100 g extract.

Total phenolic content (TPC) of the extract was determined according to the Folin-Ciocaleau method (Singleton *et al.,* 1999); Gallic acid (GA) was used as a standard and the results were expressed as mg gallic acid equivalent (mg GAE)/ 100 g extract.

The free radical scavenging activity of quinoa extract on the stable radical 1, 1-diphenyl-2-picrylhydrazyl (DPPH) was also evaluated as earlier reported by Aliyu *et al.,* (2013). Different extract concentrations were tested and the IC_{50} defined as the amount of antioxidant material required to scavenge 50% of free radical in the assay was calculated as mg/ml.

Broilers' growth experiment

A total number of 135 one- day old Ross broiler chicks were randomly divided into three groups (control, T1 and T2) of three replicates each. The chicks were fed for 36 days a corn–soybean basal diet. The control diet was not supplemented with QSE; the experimental group referred to as T1 was fed basal diet supplemented with 10 g QSE/ 100 Kg diet, whereas the T2 was fed the same basal diet supplemented with 30 g QSE/ 100 Kg diet. The diets were formulated according to the Ross management guide (Aviagen 2002) to cover the chicks' requirements during each of the three phases of growth. The diets used during the experiment are shown in Table (1). Feed and water were provided *ad-libitum* during the entire growth period.

Table (1): Formulation and analysis of starter, grower and finisher Ross diets used in the study from 1-36 days of age

Ingredients	Starter (23% protein, 3000 Kcal. ME/ Kg)	Grower (21.5% protein, 3100 Kcal. ME/Kg)	Finisher (19% protein, 3200 Kcal. ME/ Kg)
Yellow Corn 8.1%CP	56.500	56.850	59.000
Soybean meal (46%)	28.500	28.500	32.000
Corn gluten meal (61%)	8.735	6.395	-
Corn oil	1.540	3.700	5.135
Di-Calcium phosphate	2.030	2.030	1.600
Calcium carbonate (38%Ca)	1.140	1.140	1.000
Premix *	0.400	0.400	0.400
NaCl	0.300	0.300	0.300
Choline (70%)	0.075	0.075	0.075
Dl-Methionine	0.320	0.280	0.320
L-Lysine HCl	0.460	0.330	0.170
Total	100.00	100.00	100.00
Calculated analysis (as fed: NRC,1994)			
Crude protein %	23.795	22.226	19.989
Metabolizable energy Kcal/Kg	2999	3132	3184
Calcium %	0.96	0.97	0.80
Available phosphorus%	0.50	0.49	0.40
Determined analysis (DM basis: AOAC,2006)			
Crude protein%	23.3	21.2	19.3
Calcium%	1.15	1.08	0.93
Total phosphorus%	0.77	0.74	0.68
Ether extract%	3.66	4.15	4.30
Ash%	6.6	5.5	5.35
Crude fiber%	3.2	3.28	3.16

(*)Premix supplied per Kg of diet: Vit. (A), 12000 I.U., Vit.(D_3), 2000I.U. ; Vit.(E), 10mg ;Vit.(K_3) , 2mg; Vit.(B_1), 1 mg; Vit.(B_2), 5 mg; Vit.(B_6), 1.5 mg; Vit.(B_{12}), 10 ug; Biotin, 50ug; Choline chloride,500mg; Pantothenic acid , 10 mg; Niacin,30mg; Folic acid,1mg; Manganese,60mg; Zinc,50mg; Iron,30mg; Copper,10mg; Iodine,1mg; Selenium,0.1mg and Cobalt,0.1mg.

Average live body weight, body weight gain , feed consumption and feed conversion ratio were calculated at 15, 28 and 36 days of age.

Broiler Processing

At the end of the growth period, (36 days old), six chickens per replicate were randomly selected, slaughtered and manually eviscerated. The carcasses were cut and breast and thigh parts were separated. Breasts and thighs were placed in plastic bags and kept refrigerated at 4°C.

Chicken meat analysis

The proximate composition of breasts and thighs meat was assessed by determining: the moisture, fat, protein and ash composition according to AOAC (2006) methods.

The total phenols content of chickens' meat was determined as early described by (Jang *et al.,* 2008).

The antioxidative properties of chicken meat were determined at refrigerated storage days (day 1, day 4 and day 7). The lipid oxidation of the meat was estimated using the thiobarbituric acid reactant substances (TBARS) test following the procedure described by (Racanicci *et al.,* 2008). The DPPH (1,1-Diphenyl-2-picrylhydrazyl) radical scavenging activity of chicken meat was estimated with the aqueous supernatant prepared from breast and thigh meat samples according to the method reported by (Jang *et al.,* 2008).

Economical study

The economic efficiency is calculated from the input-output analysis by considering the growth rate and feeding cost. The feeding cost was estimated based on the price of diet ingredients at the time of experiment. The selling price of one Kg chicken at the time of experiment was (16 L.E). The economic efficiency was calculated as: (Net Revenue / Total feed cost) x 100. Finally, the relative economic efficiency of the treated groups was calculated by considering the economic efficiency of control as 100.

Statistical analysis

Data were statistically analyzed using the general linear model for analysis of variance of SAS (SAS,2004) and the significant differences between means were obtained by Duncan's multiple range test (Duncan, 1955) at 5% probability. The following model was used: $Y_{ij}=U+T_i+ E_{ij}$

Where Y_{ij} = Any observation, U= The overall mean, T_i=effect of dietary treatments (1,2,3,…) and E_{ij} = random error mean.

RESULTS AND DISCUSSION

Gas Chromatography/Mass analysis results

The main chemical constituents of quinoa seeds extract as obtained from GC/MS analysis are shown in Table (2). The results showed that quinoa seeds extract contains several bioactive compounds with therapeutic importance. The compounds identified included: biotin (vitamin H), cis-13-Octadecenoic acid a compound with anti-inflammatory, hypocholesterolemic and cancer preventive activities (Thampy *et al.,* 2014) and 3-Deoxy-d-mannoic lactone with antibacterial activity (Ghosh *et al.,* 2015).

The results in Table (2) indicate that quinoa seeds extract contain a variety of phytochemical compounds with potential antioxidant activities such as hydroxycinnamic acid and trans-2,3-Dimethoxycinnamic (Razzaghi-Asl *et al.,* 2013). Other antioxidants found in quinoa seeds extract were p-Allylphenol (Maestri *et al.,* 2006), 4-Vinylphenol and 4-Vinylguaiacol (Terpinc *et al.,* 2011), D-(+)-Gluconic acid δ-lactone, Kaempferol (Vellosa *et al.,* 2011) and Theobromine (Azam *et al.,* 2003).

Table (2): Chemical constituents of quinoa seeds extract

Retention time (min.)	Compound name
4.52	p-Allylphenol
4.79	Hydrocinnamic acid
5.047	trans-2,3-Dimethoxycinnamic acid
5.05	3-Deoxy-d-mannoic lactone
11.58	4-Vinylphenol
12.68	4-Vinylguaiacol
16.4	Ethyl α-d-glucopyranoside
18.01	D-(+)-Gluconic acid δ-lactone
20.134	Kaempferol
20.185	3-Deoxyestradiol
21.227	Biotin
21.25	7,8-Dihydro-α-ionone
21.9	cis-13-Octadecenoic acid
22.36	Theobromine
22.75	4-Androstene-3,17-dione
23.06	Cholesterol
23.5	Digitoxin
24.2	Betaine

Antioxidant activity of quinoa seeds extract

The total phenolic content of quinoa seeds extract was found to be 105.6±0.9 mg GAE/ 100g extract. The total antioxidant activity of quinoa seeds extract as determined by the phosphomolebdenum assay was found to be 1210 ± 1.4 mg BHA equivalent/ 100g extract. The antioxidant capability of the extract was further proven by its ability to scavenge DPPH free radical. The minimum concentration of quinoa extract needed to inhibit the DPPH by 50% was found to be IC_{50} =16mg/ml. These results suggest that quinoa seeds extract has potential antioxidant activity. The importance of antioxidant lies in their ability to act against the reactive oxygen species (ROS). Those ROS cause the initiation of oxidation reactions by reacting with lipids, proteins, sugars and vitamins to produce harmful compounds, destroy essential fatty acids, amino acids and vitamins and generate carcinogens (Oliveira *et al.,* 2008).

Growth performance

The results of broilers' growth parameters are given in Table (3).The addition of QSE did not significantly affect the broilers' performance compared with the birds fed control diet during the starter period. Also, there were no significant differences among the performance parameters of group T1 and control group during the grower period; while group T2 recorded significantly higher body weight and feed intake compared to T1 and control groups. During the finisher period and the total experimental period; the effect of dietary inclusion of QSE was more pronounced with significant differences ($p<0.05$). Group T2 had significantly ($p<0.05$) higher body weight, weight gain and feed intake compared to T1 and control groups. It was also noted that T1 showed significantly higher ($p<0.05$) body weight, weight gain and feed intake compared to the control group.

The results in Table 3 indicated that supplementation of QSE to broiler diets improved significantly ($p<0.05$) feed conversion ratios of T1 and T2 at 25-36 days of age as compared to control group. Overall feed conversion ratios at the whole period (1-36 days of age) indicated no significant differences among all experimental groups.

The inclusion of plants or herbal extracts in broilers' diet were previously reported to have positive effect on broilers' growth by enhancing feed intake, secretion of gastrointestinal fluids and improvement of nutrients' digestion and absorption (Marzoni *et al.,* 2014). Our results are in agreement with Wang *et al.,* (2008) who reported that dietary inclusion of antioxidant improves broilers' performance due to the antioxidant positive effect on health and nutrient digestibility.

Table (3): Effect of dietary inclusion of Quinoa seeds extract on broilers' performance

Treatment / Parameter	Control group	T1	T2
Starter period(1-14 day)			
Body weight (g)	$355.33^{a}\pm29.01$	$359.00^{a}\pm28$	$370.66^{a}\pm17.56$
Body weight gain (g)	$311.33^{a}\pm29.01$	$315.00^{a}\pm28$	$326.66^{a}\pm17.56$
Feed intake (g)	$448.33^{a}\pm21.36$	$456.33^{a}\pm13.87$	$455.66^{a}\pm14.01$
Feed conversion ratio (g:g)	$1.44^{a}\pm0.07$	$1.45^{a}\pm0.09$	$1.40^{a}\pm0.07$
Grower period (15-28day)			
Body weight (g)	$1212.00^{b}\pm15.72$	$1221.33^{b}\pm16.20$	$1260.33^{a}\pm11.59$
Body weight gain (g)	$856.66^{a}\pm19.35$	$862.00^{a}\pm19.92$	$889.66^{a}\pm9.45$
Feed intake (g)	$1639.00^{b}\pm7.00$	$1649.66^{ab}\pm6.66$	$1701.66^{a}\pm50.08$
Feed conversion ratio (g:g)	$1.91^{a}\pm0.05$	$1.91^{a}\pm0.05$	$1.91^{a}\pm0.06$
Finisher period (29-36 day)			
Body weight (g)	$1706^{c}\pm20.42$	$1792.33^{b}\pm30.07$	$1855^{a}\pm9.54$
Body weight gain (g)	$494^{b}\pm17.088$	$571.66^{a}\pm30.55$	$594.67^{a}\pm11.72$
Feed intake (g)	$1066.33^{c}\pm16.50$	$1177.00^{b}\pm56.72$	$1247.66^{a}\pm12.50$
Feed conversion ratio (g:g)	$2.15^{a}\pm0.04$	$2.06^{b}\pm0.01$	$2.10^{b}\pm0.02$
Whole experimental period (1-36 day)			
Body weight (g)	$1706.00^{c}\pm20.42$	$1792.33^{b}\pm30.07$	$1855.00^{a}\pm9.54$
Body weight gain (g)	$1662.00^{c}\pm22.11$	$1749.00^{b}\pm30.07$	$1811.00^{a}\pm22.27$
Feed intake (g)	$3153.66^{c}\pm42.57$	$3283.00^{b}\pm66.55$	$3405.00^{a}\pm30.42$
Feed conversion ratio (g:g)	$1.90^{a}\pm0.01$	$1.88^{a}\pm0.01$	$1.88^{a}\pm0.02$

± Standard deviation (SD)

a,b,…: Means in the same row with different superscripts are significantly different ($p<0.05$)

Chickens' meat quality

The proximate analysis and total phenols content of breast and thigh meat as affected by the dietary addition of quinoa seeds extract is given in Table (4). The moisture and ash content of breast and thigh meat showed a statistically significant differences ($p<0.05$) among the different groups. The results also showed that breast and thigh meat of the chickens in treatment T2 recorded significantly ($p<0.05$) higher protein content as compared to the control and T1 groups. On the other hand, the breast and thigh meat of T2 had the significantly lowest fat content compared to the control and T1 groups. These results are in a good agreement with the fact that the protein and fat contents are negatively correlated (Puvaca *et al.,* 2015).

It can be also noticed from Table (4) that the total phenols content of breast and thigh meat from chickens fed the diets supplemented with quinoa seeds extract (T1 and T2) showed significantly higher ($p<0.05$) total phenols content compared to the breast and thigh meat of control group. Also, the total phenols content varied proportionally with the supplementation level of QSE. The addition of quinoa seeds extract in broilers diet resulted in an enhancement of the antioxidative properties of chicken meat. These results are in agreement with the results of Jang *et al.,*, (2008) who found that the addition of medicinal herb extract into broilers' diet increased the total phenols content of breast meat indicating that the antioxidative activity in the breast meat of broiler chickens can be increased by the dietary addition of herbal extract.

Table (4): Effect of dietary inclusion of quinoa seeds extract on proximate analysis and total phenols of breast and thigh meat

	Breast					Thigh				
	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Total phenols (ppm)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Total phenol (ppm)
Control	74.04^{a} ± 0.05	23.31^{c} ±0.03	1.637^{a} ±0.02	1.013^{c} ±0.01	47.54^{c} ±0.39	71.29^{a} ±0.07	18.95^{c} ±0.02	8.82^{a} ±0.03	0.94^{c} ±0.02	50.57^{c} ±0.51
T1	73.76^{b} ± 0.05	23.56^{b} ±0.02	1.44^{b} ±0.02	1.233^{b} ±0.01	65.86^{b} ±0.21	71.12^{b} ±0.01	19.11^{b} ±0.01	8.12^{b} ±0.02	1.65^{b} ±0.01	72.90^{b} ±0.79
T2	73.22^{c}± 0.02	23.80^{a} 0.01	1.25^{c} ±0.03	1.736^{a} ±0.01	86.46^{a} ±0.44	70.73^{c} ±0.03	19.42^{a} ±0.03	7.82^{c} ±0.02	2.03^{a} ±0.01	89.46^{a} ±1.00

± Standard deviation (SD)

a,b,…: Means in the same row with different superscripts are significantly different (p<0.05)

Storage stability of chickens' meat

Chicken meat is usually subjected to oxidative deterioration because it contains high amount of polyunsaturated fatty acids (Zhang *et al.,* 2015). In the present work, the effect of dietary addition of QSE on the storage stability of chickens' meat was evaluated by determining the DPPH (1,1-Diphenyl-2-picrylhydrazyl) radical scavenging activity and the thiobarbituric acid reactant substances (TBARS) of breast and thigh meat under refrigerated storage conditions.

Table (5) shows the TBARS values of breast and thigh meat samples of the control and treated groups. The results indicated that during the first day of storage (D1) the TBARS values of breast and thigh meat of T1 and T2 were significantly lower (p<0.05) than those of control group although there were no significant differences (p>0.05) between T1 and T2. Upon increasing the storage period (at D4 and D7), the addition of QSE resulted in significantly lower (p<0.05) TBARS values for breast and thigh meat of T2 and T1 compared to control. It was also noticed that increasing the dietary level of QSE led to a significant (p<0.05) decrease in TBARS values of T2 as compared to T1. On the other hand, the TBARS values of breast and thigh meat of control group were significantly (p<0.05) increased at storage days 4 and 7 compared to day 1. In contrary, the TBARS values did not increase significantly (p>0.05) during storage for the breast and thigh meat of treated groups. Thus, it is clear that the dietary addition of QSE into broilers' diet succeeded in delaying the lipid oxidation of broilers' meat up to seven days of refrigerated storage.

Table (5): Effect of dietary inclusion of quinoa seeds extract on TBARS (mg of malondialdehyde/kg of meat) of chickens' meat at storage days (1, 4 and 7)

	Breast meat			Thigh meat		
	D1	D4	D7	D1	D4	D7
Control	0.70^{a}±0.02	0.82^{a}±0.01	0.94^{a}±0.01	0.75^{a}±0.01	0.88^{a}±0.01	1.08^{a}±0.01
T1	0.48^{b}±0.02	0.50^{b}±0.01	0.53^{b}±0.01	0.52^{b}±0.01	0.53^{b}±0.01	0.55^{b}±0.01
T2	0.40^{b}±0.01	0.40^{c}±0.01	0.42^{c}±0.01	0.50^{b}±0.01	0.47^{c}±0.01	0.49^{c}±0.01

± Standard deviation (SD)

a,b,…: Means in the same row with different superscripts are significantly different (p<0.05)

The changes in DPPH scavenging activity of chickens' meat of the control and QSE treated groups at different days of refrigerated storage are given in table (6). The DPPH scavenging activities of breast and thigh meat from broilers in groups T1 and T2 were significantly increased (p<0.05) at all investigated storage days (1, 4 and 7). The DPPH-scavenging activities of groups T1 and T2 were significantly higher (p < 0.05) than those of the control group. The breast and thigh meat of chickens fed the T2 diet showed significantly greater DPPH scavenging activity than that of chickens fed T1 at all storage days. It has also to be noted that by increasing the storage time from d1 to d7 the DPPH scavenging activity of chicken meat fed the control group significantly decreased. However, the chicken meat of groups T1 and T2 showed no significant (p>0.05) reduction in their DPPH scavenging activities at d7.

Table (6): Effect of dietary inclusion of quinoa seeds extract on DPPH scavenging activity (%) of chickens' meat at storage days (1, 4 and 7)

	Breast meat			Thigh meat		
	D1	D4	D7	D1	D4	D7
Control	22.66^{c}±0.57	19.56^{c}±0.35	18.66^{c}± 0.57	25.33^{c}± 0.57	23.00^{c}±1.00	20.33^{c}±0.57
T1	29.66^{b}± 0.57	29.53^{b}± 0.05	28.66^{b}±0.57	38.00^{b}± 1.00	35.00^{b}±1.00	31.66^{b}±0.57
T2	35.00^{a}±1.00	34.60^{a}± 0.1	33.23^{a}±0.057	42.00^{a}± 1.00	40.00^{a}±0.57	36.66^{a}±0.57

± Standard deviation (SD)

a,b,…: Means in the same row with different superscripts are significantly different (p<0.05)

The addition of quinoa seeds extract into broilers diets resulted in a significant improvement in the antioxidative properties and increased storage stability of chickens' meat as shown from the results of Tables 5 and 6. The dietary addition of plant extracts with antioxidant properties helps in extending the shelf life and improving the quality of meat products by reacting with the lipids and hydroxyl radicals and converting them into stable compounds (Jang *et al.,* 2008).

Economics of production

The effect of dietary addition of quinoa extract on the economic efficiency of broilers' production is presented in Table 7. The results showed that the price per Kg feed for broilers in groups T1 and T2 were 3.83 and 3.89 L.E being slightly higher than that of control group which was 3.8 L.E. On the other hand, the total and net revenue values of experimental groups (T1and T2) were somewhat higher than that of control group due to the higher final live body weight of T1 and T2. Finally, the results in table 7 revealed that the addition of quinoa extract in broilers' diet resulted in approximately similar values of relative economic efficiency of both T1 and T2 as compared to the control group.

Table 7. Economical evaluation of the experimental diets

Item	Control	T1	T2
Price of diet/ Kg[1] (L.E)	3.800	3.830	3.890
Average feed consumption (Kg)	3.153	3.283	3.405
Total feed cost (L.E)	11.980	12.57	13.25
Average weight gain (Kg)	1.662	1.749	1.811
Price/ Kg weight gain[2] (L.E)	16	16	16
Total revenue (L.E)	26.590	27.980	28.980
Net revenue (L.E)	14.610	15.410	15.730
Economic efficiency	122	123	119
Relative economic efficiency[3] (%)	100	101	98

[1]**Based on the local market price of different ingredients available in the market at the experimental period**
[2]**According to the local market price at the experimental time**
[3]**Assuming that the relative economical efficiency of the control diet equals 100**

CONCLUSION

From the present study, it can be concluded that the dietary inclusion of quinoa seeds extract in broilers' diet as a natural antioxidant has a positive effect on broilers performance, meat quality and also improved the chicken meat oxidative stability during refrigerated storage up to 7 days. The results of the economical study along with the results of meat quality and improvement of antioxidative properties are very important for both the producers and consumers.

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إستخدام مستخلص بذورالكينوا كمضاد طبيعي للأكسده في علائق دجاج التسمين و تأثيره على مقاييس النمو و جودة اللحم

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أجريت هذه التجربه لتقييم تأثير تدعيم علائق دجاج التسمين بمستخلص بذور الكينوا كمضاد أكسده طبيعي علي المظاهر الانتاجيه والكفاءه الإقتصاديه للدواجن وجودة اللحم والثبات ضد الأكسده للحوم الدواجن المحفوظه بالتبريد .تم تحضير المستخلص وإجراء التحاليل المختلفه عليه قبل إستخدامه في العلائق . وكذلك تم إجراء تجربة نمو إستخدم فيها ١٣٥ كتكوت من نوع الروص وُزعت عشوائيا علي ثلاث معاملات غذائيه ، كل معامله من ثلاث مكررات بكل مكرر ١٥ طائرا .تم تغذية مجموعة المقارنه علي العليقه الأساسيه دون أي إضافات بينما تم تدعيم المعامله ١ والمعامله ٢ بمستخلص بذور الكينوا بمعدل ١٠و٣٠ جرام /١٠٠كجم عليقه علي الترتيب. أظهرت النتائج أن مستخلص الكينوا يحتوي على العديد من المكونات الفيتوكيميائيه ذات النشاط المضاد للأكسده. و قد تم تأكيد هذه النتائج عن طريق إجراء الإختبارات الخاصه بتحديد النشاط الكلي المضاد للأكسده و الفينولات الكليه و قدرة المستخلص على تثبيط الشوارد الحره. و قد أدت اضافة المستخلص في علائق دجاج التسمين إلى زياده معنويه ($p<0.05$) في وزن الجسم و الوزن المكتسب و العلف المستهلك للمجموعه T2 مقارنة بالمجموعتين T1 و الكونترول. و قد أظهرت نتائج التحليل الكيميائي للحوم الدواجن أن لحم الصدر و الفخذ للمجموعه T2 يحتوي على نسبة بروتين أعلى معنوياً ($p<0.05$) من مجموعتي T1 و الكونترول. و بالنسبه للخواص المضاده للأكسده فقد أدى إضافة مستخلص الكينوا في علائق دجاج التسمين إلى تحسن معنوي ($p<0.05$) للخواص المضاده للأكسده في لحوم الدواجن و بالنسبه للثبات ضد الأكسده للحوم الدجاج عند ظروف التخزين بالتبريد فقد تم تقييمها عند فترات تخزين مختلفه (١ و ٤ و ٧ أيام). و قد إتضح أن إضافة المستخلص إلى العلائق نجح في تأخير عملية أكسدة الدهون بالنسبه للحوم الدواجن حتى ٧ ايام من التخزين بالتبريد. كما أن لحوم الطيور في المجموعتين T1 وT2 لم يحدث لهما إنخفاض في النشاط المضاد للأكسده حتى ٧ ايام من التخزين بالتبريد. من الدراسه الحاليه يمكن إستنتاج أن إضافه مستخلص الكينوا في علائق دجاج التسمين كمضاد أكسده طبيعي له تأثير ايجابي على مقاييس النمو و جودة اللحم كما أنه أدى الى تحسين الثبات ضد الأكسده للحوم الدواجن المحفوظه بالتبريد لفترة تصل إلى ٧ أيام.

الكلمات الداله: كينوا – مضادات أكسده – دجاج تسمين – جودة اللحم – أكسدة الدهون – التخزين بالتبريد