Performance, Immune Response and Carcass Quality of Broilers Fed Low Protein Diets contained either *Moringa Oleifera* Leaves meal or its Extract

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Abstract: The present study aimed to investigate the effect of adding graded levels of *Moringa olifera* leaves meal (MLM) or its extract (MLEx) on the productive performance, mortality, antioxidative potentials, the physico - chemical characteristics of meat and plasma biochemical parameters of broilers fed low protein diets. A total number of 270 day old averaging (41.00 ± 1.00 g) chicks were wing banded individually, weighed and randomly distributed into 6 treatments each in three replicates of 15 birds per replicate. Dietary treatments were T_1 – positive control fed commercial diet with CP recommended requirements. (23; 21 and 19% CP); T_2 negative control fed diets contained lower CP (21, 19 and 17% CP); T_3: fed negative control + 5% MLM powder; T_4: fed negative control + 10% MLM powder; T_5: fed negative control + 50 ml MLEx *extract* / liter drinking water and T_6: fed negative control + 100 ml MLEx / liter drinking water. Results showed that Moringa leaves contained appreciable amounts of crude protein 29.62%); carbohydrate (39.49%); crude fiber (10.23%), ash (14.25%), crude fat (8.40%) and metabolizable energy (2034.82 kcal/kg)**;** Calcium, (2.65%) and Phosphorus, (0.48%). Birds of T_6 (fed negative control +100 ml MLEx) recorded significantly ($P < 0.05$) the best values of body weight gain (2.63kg); feed conversion ratio (1.26); growth rate (1.94); performance index (226.66%) and European efficiency ratio (529.68) followed by birds of T_5 (fed negative control +50 ml MLEx) (2.35kg; 1.17; 1.93; 208.99% and 488.39, respectively). *Moringa oleifera* leaves Extract groups (T_5 and T_6) were significantly ($P > 0.05$) higher in antioxidant capacity (0.86 mmol/l) meanwhile, the positive control group (T_1) was the worst one. Also, *Moringa oleifera* extract groups (T_5 and T_6) achieved significantly ($P > 0.05$) the best values of total lipids (442.2 and 410.99 mg/dl); total cholesterol (167.95 and 159.87 mg/dl); HDL cholesterol (111.9 and 125.58 mg/dl) and LDL cholesterol (86.13 and 73.4 mg/dl) compared with control or powder groups. The extent of lipid oxidation (TBA number) in thigh meat after 7 d of refrigerated storage did not differ among all treatments. However, malonaldehyde concentration was different after 90 d of freez storage of birds fed diets supplemented with (50 and 100ml/l) of moringa extract significantly ($p<0.05$). The lowest TBA number of freez storage obtained at 42 and 90 days, while birds fed control group showed the highest TBA number. *Moringa oleifera* leaves extract groups (T_5 and T_6) appeared a good feed additive for color, odour, taste and overall acceptance (Table 9). Generally, the best values of overall acceptance being (8.49) had been significantly ($P\leq0.05$) recorded by birds fed (negative control+100 ml MLEx) (T_6). The best values of net revenue, economical efficiency and relative economical efficiency values due to feeding broiler low protein diet and supplemented 50 ml MLEx / liter drinking water (T_5) compared with control and other experimental groups, Meanwhile, the lowest value of economic efficiency was obtained by broilers fed 5% MLM (T_3). *It can be concluded that, Moringa oleifera* aqueous leaf extract given via drinking water (T_5 and T_6) appeared to be a good feed additive in order to obtain the best growth and feed utilization as well as the overall better health of broiler.
[M.S.M AbouSekken. **Performance, Immune Response and Carcass Quality of Broilers Fed Low Protein Diets contained either *Moringa Oleifera* Leaves meal or its Extract.** *J Am Sci* 2015;11(6):153-164]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 18

Key words: low-protein diets, *Moringa oleifera* extract, Meat quality, broiler performance, economical efficiency

1- Introduction.

Feed cost accounts for 60 to 70% of the total cost of poultry production. The high cost of conventional feed ingredients in poultry diets has necessitated the investigation into unconventional readily available feedstuffs. The impact of indigenous chickens in improving the nutritional status, income, food security and livelihood of small holders is significant owing to their low cost of production **(FAO, 1997).** Indigenous chickens contribute to the overall well-being of the households through employment creation and income generating **(Moreki *et al.*, 2010).** Any attempt to improve commercial poultry production and increase its efficiency therefore needs to focus on searching alternative and better utilization of feed resources **(Udedibie and Asoluka, 2008)**.

Moringa products have a wide range of applications in agricultural, industrial and pharmaceutical processes. Moringa leaves have a relatively high crude protein content which varies from 25% to 32%**.** A high proportion of this protein is potentially available for digestion due to a high

proportion of pepsin soluble nitrogen (82-91 %) and low proportion (1-2%) of acid detergent insoluble protein **(Makkar and Becker, 1997).** There has been an increased interest in the utilization of the *M. oleifera*, in improving of ruminants farming **(Gadzirayi *et al*., 2012)** and poultry performances **(Banjo, 2012; Portugaliza and Fernandez, 2012; Abbas and Ahmed 2012);** as a protein source for livestock **(Makkar and Becker, 1997; Sarwatt *et al.,* 2002);** industrial and medicinal uses **(Morton, 1991).** *Moringa oleifera* leaves are widely used traditionally for its antimicrobial abilities **(Suarez *et al*., 2005)** and its pharmacological properties **(Mehta *et al*., 2003).** However, trials were conducted to study the effect of these leaves meal on the growth performance of chicks **(Melesse *et al*., 2011)**, on the productive performance of laying hens **(Abou-Elezz *et al*., 2011),** on broilers' performance **(Olugbemi *et al*., 2010 and Zanu *et al.* 2012),** and on the growth, carcass, and blood indices of weaned rabbits **(Nuhu, 2010).** The effect of moringa leaves and seeds were also examined by researchers for increasing immunity responses and improving physiological and productive performance **(Abbas and Ahmed, 2012; Tesfaye *et al.*, 2012 and Ibrahim *et al.,* 2014)**).Also, Moringa (*Moringa oleifera*) leaves had been used as a natural antioxidant for its antioxidant activity/contain a higher amount of polyphenols **(Sreelatha and Padma, 2009);** high pepsin and total soluble protein which is suitable to monogastric animals such as poultry. **(Kakengi *et al.* (2007)** and has a positive effect on meat quality **(Waskar *et al*., 2009)** especially lipid peroxidation which is a major cause of meat quality deterioration, affecting colour, flavour, texture and nutritional value **(Giannenas *et al*., 2010).**

Antioxidants have been discovered to be efficient in diminishing lipid oxidation of meat. However, the use of natural antioxidants to stabilize meat has gained much attention from consumers because they are considered to be safer than synthetic antioxidants such as butylated hydroxytoluene (BHT) and tertiary butyl hydroquinone (TBHQ) and have greater application potential for consumer's acceptability, palatability, stability and shelf-life of meat products **(Waskar *et al*., 2009).** Natural antioxidants also have the ability to increase the antioxidant capacity of the plasma and reduce diseases **(Chanda and Dave, 2010).**

The importance of *Moringa oleifera* in ethanobotany as health remedy the antimicrobial property of crude extracts and anti-nutritional factors, particularly saponins can be removed through solvent and aqueous extractions of the petals of *Moringa oleifera* that has been studied as part of the exploration for new and novel bio-active compounds (**Makkar and Becker,1997** and **Richter *et al.*,2003).**

Recently, **Akhouri *et al*. (2013)** reported that aqueous extract and dried powder of *Moringa oleifera,* respectively each at 250 mg/kg body weight detected significant ($P<0.05$) increase in body weight gain and feed conversion efficiency in the birds. Few studies have showed the substitution of *Moringa oleifera* leaves or its extract in broilers low protein diets on antimicrobial abilities; immune system; meat quality; antioxidative properties and physiological and productive performance of farm animals and poultry. ***Therefore,*** the aim of this study was designed to investigate the effect of feeding different levels of *Moringa oleifera* leaves meal (MLM) or its extract (MLEx) on feed intake, growth performance, mortality, antioxidative potentials, immune response and the physico -chemical characteristics of meat from broilers.

2. Materials and Methods.

The present study was carried out at Poultry Research Station belonging to Environmental Studies and Research Institute (ESRI), University of Sadat City, Minufiya Province, Egypt. A total number of 270 day old male *Hubbard* broiler chicks were used in this study. Chicks were given a starter control diet (Table 1) for 4 days of age and then chicks were wing banded, individually weighed and randomly distributed into 6 treatments, each contained three replicates of 15 birds per replicate in floor brooders.

Preparation of Moringa leaf Extract (MLEx).

The leaves of *Moringa oleifera* were collected and dried under shade and ground into powder. About 5 kg of M. *olefera* leaf powder were placed in plastic container with 25 liter of aqueous ethanol, soaking to 24 hours and then filtered using a filter paper (Whatmann size no.1) and the filtrate evaporated to dryness in water bath at 60ºC as described by **Portugaliza and Fernandez (2012).** Ethanol extraction was evaporated using rotatory evaporator followed by evaporation to dryness in a water bath at 40°C. A brownish residue was obtained and kept in air tight bottle and stored in a refrigerator at 4◦C until used. The concentrated extract was diluted using distilled water (volume/volume) into 50ml/1000ml and 100ml/1000ml H2O.The extract was stored in a refrigerator for 1 week until being used.

The experimental diets were supplied with required nutrients to satisfy the recommended requirements of the breed and were made iso-nitrogenous and iso-energetic according to **NRC(1996).** Chicks were allocated on the following dietary treatments:

1- (T_1): (positive control)**:**fed commercial diet which contain the recommended crude protein requirement of *Hubbard* broilers during starter,

grower and finisher periods. (23; 21 and 19%CP).

2- (T_2): (negative control): fed tested diets which contain a lower requirement of crude protein during starter, grower and finisher periods (21, 19 and 17% CP) without moringa powder or extract.
3- (T_3): fed negative control diet with dietary 5% MLM powder
4- (T_4): fed negative control diet with dietary 10% MLM powder
5- (T_5): fed negative control diet with 50 ml MLEx / liter drinking water
6- (T_6): fed negative control diet with 100 ml MLEx / liter drinking water.

Table 1. Composition and calculated analysis of positive and negative control diets.

Item	Starter (4 –10 days)		Grower (11 – 24 days)		Finisher (25 – 42 days)	
	Positive control	Negative control	Positive control	Negative control	Positive control	Negative control
Yellow Corn, ground	56.60	60.44	60.44	63.00	63.00	69.19
Soybean meal (44% CP)	27.00	23.50	23.50	24.00	24.00	19.00
Corn gluten meal (62% CP)	10.00	9.00	9.00	5.51	5.51	4.5
Di-calcium phosphate(Di-Ca-P)	2.00	1.50	1.50	1.34	1.34	1.80
Limestone	1.60	1.60	1.60	1.48	1.48	1.10
Common salt	0.30	0.30	0.30	0.30	0.30	0.3
Vegetable oil	1.50	2.81	2.81	3.70	3.70	3.13
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.10	0.15	0.15	0.15	0.15	0.18
L-Lysine	0.60	0.40	0.40	0.22	0.22	0.50
Total	100.00	100.00	100.00	100.00	100.00	100
Price(L.E. /kg diet)**	3.37	3.32	3.32	3.15	3.15	3.03
Calculated values***						
ME, kcal/kg	3027	3153	3153	3195	3195	3209
CP %	23.06	**21.00**	21.00	**19.12**	19.12	**17.00**
CF %	3.47	3.28	3.28	3.30	3.30	3.00
EE %	2.80	2.84	2.84	2.87	2.87	3.00
Ca %	1.00	0.92	0.92	0.85	0.85	0.88
Avail. P %	0.57	0.45	0.45	0.42	0.42	0.46
Lys. %	1.42	1.17	1.17	1.04	1.04	1.10
Meth. %	0.55	0.57	0.57	0.52	0.52	0.51
Meth. + Cyst. %	0.94	0.92	0.92	0.84	0.84	0.799
Determined values						
CP %	**22.90**	**20.88**	**20.47**	**19.17**	**19.00**	**16.78**
CF %	3.50	3.11	3.50	2.98	3.50	3.46
EE %	3.00	2.96	2.90	2.58	2.90	2.88
Ash %	9.99	8.87	8.90	8.98	10.15	8.86
Ca %	1.52	1.63	1.53	1.48	1.46	1.76
P%	0.44	0.46	0.53	0.41	0.49	0.52

*The premix (Vit. & Min.) was added at a rate of 3 kg per ton of diet and supplied the following per kg of diet (as mg or I.U. per kg of diet): Vit. A 12000 I.U., Vit. D3 2000 I.U., Vit. E 40 mg, Vit. K3 4 mg, Vit. B1 3 mg, Vit. B2 6 mg, Vit. B6 4 mg, Vit. B12 0.03 mg, Niacin 30 mg, Biotin 0.08 mg, Pantothenic acid 12 mg, Folic acid 1.5 mg, chloride 700 mg, Mn 80 mg, Cu 10 mg, Se. 0.2 mg, I 0.4 mg, Fe 40 mg, Zn 70 mg and Co 0.25mg.

**According to market prices of the year 2014.

***According to **Feed Composition Tables for animal & poultry feedstuffs used in Egypt (2001).**

Live performance measurements, were measured and/or calculated in terms of live body weight (LBW), body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR), growth rate (GR) by using the following formula: $GR=(W_2-W_1)\ /0.5(W_1+W_2)\times100$. Where: W_1 =Initial LBW of a certain period, W_2 = Final LBW at the end of the same period; performance index (PI) according the equation reported by **North (1981)** as follows: PI =LBW(kg)/FCR× 100; Mortality rate (MR) and European efficiency factor (EEF) which calculated according to the methods described by **Lemme et al.(2006)**. as follows: EEF = (Final LBW, kg × Livability, %)/(Age, days × FCR) × 100.

At the end of the experimental period (45 days), three birds were taken randomly from each treatment and slaughtered to obtain the carcass and edible organs included heart, empty gizzard and liver. Carcass, edible organs and abdominal fat percentage

were calculated on the basis of live body weight. Individual blood samples were taken from birds within each treatment and collected into dry clean centrifuge tubes containing drops of heparin and centrifuged for 20 minutes (3000 rpm) to obtain plasma. The antioxidant capacity in plasma was determined using commercial kits produced by Biodiagnostic Company. Plasma constituents were determined colorimetrically and suitable commercial diagnostic kits (Stambio, San Antonio, Texas, USA) as described by manufactures in terms of total lipids (TL, mg/dl), cholesterol (Cho, mg/dl), HDL cholesterol, LDL cholesterol, glucose (mg/dl), aspartate aminotransferase (AST, U/L), alanine aminotransferase (ALT) and alkaline phosphatase (ALP, U/L).

Table 2. Composition and calculated analysis of the basal diets used in the 2nd feeding trial.

Item / Moringa level %	Starter (0 –10 days)		Grower (11 – 24 days)		Finisher (25 – 42 days)	
	5	10	5	10	5	10
Moringa leaves Powder	5.00	10.00	5.00	10.00	5.00	10.00
Yellow Corn, ground	57.75	54.00	61.00	68.00	66.50	61.00
Soybean meal (44% CP)	20.00	19.00	20.00	18.00	14.75	15.90
Corn gluten meal (62% CP)	10.00	8.25	6.00	5.55	6.00	3.00
Di-calcium phosphate	1.50	1.50	1.50	1.50	1.50	1.80
Limestone	1.60	1.60	1.6	1.6	1.6	1.65
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable oil	3.00	4.50	3.75	4.20	3.50	5.36
Premix*	0.30	0.30	0.30	0.30	0.3	0.3
DL-Methionine	0.15	0.15	0.15	0.15	0.15	0.18
L-Lysine	0.40	0.40	0.40	0.40	0.40	0.51
Total	100.00	100.00	100.00	100.00	100	100
Price (L.E. /kg diet)**	3.70	4.11	3.89	4.07	3.36	3.81
Calculated values***						
ME, kcal/kg	3041	3165	3170	3195	3214	3219
CP %	21.25	21.22	19.14	19.20	17.20	17.07
CF %	3.46	3.80	3.49	3.4	3.23	3.64
EE %	3.12	3.35	3.17	3.70	3.30	3.46
Ca %	1.04	1.1	1.4	1.6	1.26	1.22
Avail. P %	0.44	0.43	0.44	0.6	0.43	0.49
Lys. %	1.14	1.18	1.30	1.14	1.00	1.15
Meth. %	0.58	0.56	0.52	0.5	0.5	0.499
Meth. + Cyst. %	0.94	0.92	0.84	0.84	0.79	0.798
Determined values						
CP %	21.65	21.53	19.55	19.83	16.94	17.43
CF %	3.84	4.32	3.58	3.77	3.98	4.04
EE %	2.89	4.25	3.47	4.70	3.58	4.86
Ash %	11.33	10.45	9.89	10.46	10.72	10.43
Ca %	1.04	1.1	1.4	1.6	1.26	1.22
P%	0.45	0.55	0.42	0.48	0.46	0.44

* The premix (Vit. & Min.) was added at a rate of 3 kg per ton of diet and supplied the following per kg of diet (as mg or I.U. per kg of diet): Vit. A 12000 I.U., Vit. D3 2000 I.U., Vit. E 40 mg, Vit. K3 4 mg, Vit. B1 3 mg, Vit. B2 6 mg, Vit. B6 4 mg, Vit. B12 0.03 mg, Niacin 30 mg, Biotin 0.08 mg, Pantothenic acid 12 mg, Folic acid 1.5 mg, chloride 700 mg, Mn 80 mg, Cu 10 mg, Se. 0.2 mg, I 0.4 mg, Fe 40 mg, Zn 70 mg and Co 0.25mg.

** According to market prices of the year 2014.

*** According to **Feed Composition Tables for animal & poultry feedstuffs used in Egypt (2001).**

Chemical analysis:

Proximate analysis of moringa leaves meal and the experimental diets were analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extracts (EE) and Ash content as described by **A.O.A.C (2005)**. All chemical analysis for feedstuffs and excreta samples were carried out at Animal and Poultry Nutrition Laboratory (APNL), Department of environmental Sustainable Development and its projects Management, Environmental Studies and Research Institute (ESRI), University of Sadat City and Agricultural Research Centre, Ministry of Agriculture. Nitrogen free extract (NFE) was calculated by difference (NFE = 100 - (Moist % + CP% + EE% + Ash% + CF %); Tannin was determined using the method of **Trease and Evans (2001),** Saponin by **Birk *et al.* (1963)** as modified by **Hudson and El-Dufrawn (1979),** alkaloids level

using the methods of **Harbone, (1980).** Moreover, Determination of polysaccharides was done as described by **Teteh *et al.* (2013).** The quantities of these different components are expressed in % of dry matter (Table 3).

Table 3: Levels of chemical groups contained in hydro-alcoholic extract of *Moringa* leaves (% of DM).

Chemical groups	Quantity(% of DM)
Total phenols	3.65
Total flavonoids	0.63
Tannins	1.98
Polysaccharides	21.84

Lipid oxidation test (TBARS).

The extent of lipid oxidation was determined by measuring the Thiobarbituric Acid-Reactive Substances (TBARS) at 7 days for meat stored under refrigeration and at 30 days for meat stored under frozen conditions and expressed as g of malonaldehyde per kg of thigh meat using the procedure described by **Strange *et al.*, (1977)** and **Abou Sekken *et al.*(2013a)** as following**:** A 20 g of meat sample was blended with 50 ml of cold 20% trichloroacetic acid (TCA) for 2 minutes. The blended contents were raised with 50 ml of water, mixed together, and filtered through Whatman No. 4 filter paper. This filtrate is termed TCA extract. A 5 ml of the TCA extract was mixed with 5 ml of 0.02 M of TBA. This solution kept for 14 hrs at room temperature. Colorimetric absorbance was measured using UV scanning spectrophotometer at 532 nm. Readings were converted to g of malonaldehyde per kg of meat and reported as TBARS values.

Organoleptic evaluation of chicken cooked meat.

Sensory evaluation of chicken cooked meat was carried out to evaluate the color, odour, taste, texture and overall acceptability. Ten experienced panelists were asked to rank the samples on numerical hedonic scale of 1(very poor), 2-3 (poor), 4-5 (fair), 6-7 (good), 8 (very good) and 9 (excellent) according to (**Malnder, 1960 and Ranadheera *et al.*, 2010**).

Economical efficiency (EEf):

To determine the EEf of the diets for meat production, the management factors in all dietary treatments are stabilized. The price of the experimental diets was calculated according to the price of the used ingredients of the local market at the time of the study. So, the cost of feed consumed of each treatment was easy to be calculated as well as the price of live weight of broilers,so, the economical efficiency could be easily calculated according to **Bayoumi (1980)**.

Statistical analysis:

Data were analyzed using the General Linear Models (GLM) procedure of SAS (Statistical Analysis System, Version 9.1, 2003). (One way analysis) **(SAS®, Institute 2003).** Significant differences among treatment means were distinguished by using Duncan's Multiple Range Test **(Duncan, 1955).** All statements of significance were based on $P \leq 0.05$. The statistical model one – way analysis used in the experiment was: $Y_{ij} = \mu + T_i + E_{ij}$ where:

Y_{ij} = the individual observation.

μ = the overall mean.

T_i = The effect of dietary treatment (I =1, 2,,.,.,.,.,4.,).

E_{ij} = the experimental random error.

4. Results And Discussion

4.1. Chemical composition of *Moringa oleifera* leaves ant its extract.

The results of proximate analysis of *Moringa oleifera powder* on dry matter (DM) basis are presented in Table 4a. The results revealed that Moringa leaves contained appreciable amounts of crude protein (29.62%); carbohydrate (37.50%); crude fiber (10.23%), ash (14.25%), ether extract (8.40%), Metabolizable energy (ME) (2034.82 kcal/kg)**;** Calcium (Ca), (2.65%) and Phosphorus (p), (0.48%).The fiber fractions of *Moringa oleifera* leaves meal (MLM) was higher in NDF(13.78 g/kg) and Cellulose (6.51 g/kg). **Mabruk *et al.* (2010)** reported that Nutrient composition (DM, Ash, CP, EE, CF) and digestibility of *Moringa oleifera* leaves,(g/kg) were 930.0; 138.9; 267.9; 64.0; 210.0 and 790.5, respectively.

Recently, **Aye and Adegun (2013)** found lower percentages of DM of *Moringa oleifera* leaves meal(MOLM) to be 93.63±0.01, ash (7.96±0.03), CP (22.23±0.25), CF (6.77±0.01), EE (6.41±0.01), NFE (40.28+0.25) while gross energy was (14.790) (MJ/kg). These results indicate that nutrient composition of MOLM differs according to location and possibly stage of harvesting of Moringa leaves. The CP value obtained from *Moringa oleifera* leaves (MOL) was comparable to those reported by **Makkar and Becker (1996)** and **Sarwatt *et al.* (2002).** This depicts the nutritional importance and socioeconomic use of leaves apart from edible fruits, more in rural and under-nourished part of the world. Meanwhile, when treated *M. oleifera* leaves with ethanol, yielded 9.75% of extract on weight basis (**Misra *et al.*, 2014).** Qualitative estimation of phytochemicals in ethanol extract of leaves as summarized in Table 4b shows the presence of carbohydrate, protein, steroid, flavonoids, tannin, alkaloid and glycosides.

Table 4a. Composition of *Moringa oleifera* leaf meal, % of DM

Nutrients	(On DM basis)
Dry matter (DM), %	93.45
Crude protein (CP), %	29.62
Crude fiber (CF), %	10.23
Ether extract(EE), %	8.40
Ash, %	14.25
Nitrogen free extract(NFE), %	39.49
DE, kcal/kg	4435.63
ME, kcal/kg	2034.82
Calcium (Ca), %	2.65
Phosphorus (p), %	0.48
NDF(g/kg)	13.78
ADF(g/kg)	7.76
ADL(g/kg)	1.25
Cellulose(g/kg)	6.53
Hemicellulose(g/kg)	3.22

Table 4b. Preliminary phytochemical screening of *Moringa* leaves extract. (MLEX)

Chemical tests	Moringa leaf ethanol extract (MLEX)
1) Carbohydrate	++
2) Protein	++
3) Steroid	+
4) Flavonoids	+
5) Tannin	+
6)Alkaloids	+
7) Glycosides:	
a)Coumarin	-
b)Saponin	+
c)Cardiac	-
d)Anthraquinone	+
e)Cynogenetic	+

+: Present; -: Absent

4.2. Growth performance of broilers:

The data of growth performance of broilers fed graded levels of MLM and its extract are shown in Table 5. Results showed that birds fed T_6 (negative control diet +100 ml MLEx / liter drinking water) recorded significantly ($P < 0.05$) the best body weight gain (2.63kg); feed conversion ratio (FCR) (1.26); growth rate (GR) (1.94); performance index (PI) (226.66%) and European efficiency ratio (EER) (529.68) followed by those fed T_5 (negative control diet +50 ml MLEx / liter drinking water) being 2.35kg; 1.17; 1.93; 208.99% and 488.39, respectively compared to birds fed the control and other experimental groups.

The improve in weight gain of birds fed MLEx diets could be attributed to higher protein content and lower content of tannins, alkaloids and glycosides in the diets which were efficiently metabolized for growth. The reduced weight gain of birds fed T_2 and T_3 diets compared to birds fed T_5 and T_6 diets could be partly ascribed to the availability of the amino acids contents of T_5 and T_6 diets which may have impaired nutrient digestion and absorption **(Onu and Aniebo,2011).** The lower weight gain of birds fed T_4 diet despite its higher crude protein content might also be due to the negative effect of the antinutritional factors present in MLM on the birds. *Moringa oleifera* contain 1-23g of tannin per 1 kilogram of leaves **(Kakengi *et al.*, 2007).** Tannins has been reported to interfere with the biological utilization of protein and to a lesser extent with available carbohydrate and lipids.

In contrast to these findings, **Olugbemi *et al.* (2010)** found that an addition of 5% *Moringa oleifera* leaf meal to cassava-based broilers' diet (20% and 30%) had no significant ($P > 0.05$) effect on weight gain, feed conversion ratio, final body weight, and feed cost per kilogram of weight gain when compared to control diet. However, levels above 5% of *Moringa oleifera* leaf meal decreased broilers' performance. **Gadzirayi *et al.* (2012)** investigated the effects of supplementing soya bean meals with MOLM as a protein source in poultry and found no significant differences in feed intake of broilers, Also, **Tesfaye *et al* (2012)** concluded that substitution of MLM to soybean meal appeared not to have a positive effect on broiler performance with the exception of feed efficiency. This is exhibited through its protein content, relatively low fiber and higher mineral contents. Also, **Portugaliza and Fernandez (2012)** supplemented Cobb broiler diets with varying concentrations of *M. oleifera* aqueous leaf extract (MoALE) through drinking water and found that at 90 ml MoALE, feed intake of broilers was consistently lower than that of control group (commercial diet). The live weight of broilers given 30 ml, 60 ml and 90 ml MoALE were significantly higher than the control group. The MoALE treated broilers were more efficient converters of feeds into meat than the control group. Recently, **Akhouri *et al.* (2013)** showed that *M. oleifera* significantly ($P<0.05$) increased average body weight gain and improved feed conversion efficiency of broilers.

The crude extract of *Moringa oleifera* like other herbal drugs may contain digestion enhancing properties and stimulates favorable growth of good bacteria while, decreasing bad microorganisms and influence the growth performance and so gut microflora of poultry.

Table 5. The effect of feeding different levels of *Moringa oleifera* leaves meal (MLM) or its extract on broilers Performance at the total period (4 - 42 days). (Means ± SE)

T**	In. Wt.(kg)	LBW(Kg)	LBWG (Kg)	Feed Intake(g)	FCR (g feed/g gain)	GR	PI %	EER	Mortality rate %
T_1	0.041±0.0001	2.067^{cd} ±0.045	2.03 ±0.045^{cd}	2900.32±45.77^{c}	1.455^{b} ±0.034	1.92^{cd} ±0.001	146.77^{bc} ±8.03	343.00^{bc} ±18.77	4.44
T_2	0.041±0.0001	1.96^{d} ±0.044	1.91^{d} ±0.044	2940.88^{c} ±45.24	1.46^{b} ±0.034	1.91^{d} ±0.001	127.43^{cd} ±7.94	297.79^{cd} ±18.56	2.22
T_3	0.041±0.0001	2.01^{d} ±0.044	1.97^{d} ±0.044	3624.17^{a} ±44.74	1.88^{a} ±0.034	1.92^{d} ±0.001	112.83^{d} ±7.85	263.68^{d} ±18.35	0
T_4	0.041±0.0001	2.19^{c} ±0.044	2.15^{c} ±0.044	3088.08^{b} ±45.25	1.47^{b} ±0.034	1.92^{c} ±0.001	156.52^{b} ±7.94	365.779^{b} ±18.56	2.22
T_5	0.041±0.0001	2.39^{b} ±0.044	2.35^{b} ±0.044	2729.13^{d} ±44.74	1.17^{c} ±0.034	1.93^{b} ±0.001	208.99^{a} ±7.85	488.39^{a} ±18.35	0
T_6	0.041±0.0001	2.63^{a} ±0.044	2.60^{a} ±0.044	3202.04^{b} ±45.24	1.26^{c} ±0.034	1.94^{a} ±0.001	226.66^{a} ±7.94	529.68^{a} ±18.56	2.22
Sig.	NS	*	*	*	*	*	*	*	

In. Wt.:Initial weight; LBW(Kg): Live body weight; LBWG(Kg): Live body weight gain; FCR: Feed conversion ratio; GR: Growth Rate; PI %:Performance Index; EER: European Efficiency Ratio.

*A, b, c and d means in each column, within each item, bearing the same superscripts are not significantly different (P<0.05). (NS). Not significant

** T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

Table 6. The effects of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on blood Plasma biochemical Parameters (Means ± SE**).**

Item	T_1	T_2	T_3	T_4	T_5	T_6	Sig.
Antioxidant capacity (mmol/l)	0.48±0.01	0.72^{b} ±0.01	0.74±0.010^{b}	0.73^{b}±0.01	0.86^{a}±0.01	0.86^{a}±0.01	*
Total lipids (mg/dl)	600.47 ±40.27	576.78^{a} ±40.27	479.40^{ab} ±40.27	546.82^{ab} ±40.27	442.20^{c} ±40.27	410.99^{c} ±40.27	*
Total Cholesterol (mg/dl)	205.55^{a} ±3.66^{a}	192.21^{b} ±3.66	189.81^{b}±3.66	190.60^{b} ±3.66	167.95 ±3.66	159.87^{c} ±3.66	*
HDL cholesterol (mg/dl)	87.83^{c} ±3.37	106.00^{b} ±3.37	95.38^{c}±3.37	89.22 ±3.37	111.9^{b}±3.37	125.58^{a} ±3.37	*
LDL cholesterol (mg/dl)	103.63^{a} ±5.95	102.07^{a} ±5.95	88.74^{ab}±5.95	98.22^{a}±5.95	86.13^{ab}±5.95	73.40^{b} ±5.95	*
ALK. P (mg/dl)	161.19^{ab} ±1.29	155.36^{d} ±1.29	160.02^{bc} ±1.29	156.30^{cd} ±1.29	162.68^{ab} ±1.29	164.62^{a} ±1.29	*
Glucose (mg/dl)	285.56^{ab} ±9.14	258.05^{bc} ±9.14	177.69^{d}±9.14	254.91^{c} ±9.14	281.75^{bc} ±9.14	312.93^{a} ±9.14	*
AST (µ/l)	90.67^{ab} ±8.75	70.67^{ab}± 8.75	81.00^{ab}±8.75	83.67^{ab} ±8.75	67.00^{b} ±8.75	97.67^{a} ±8.75	*
ALT (µ/l)	25.0±1.87	25.00±1.87	19.00±1.87	24.67±1.87	22.67±1.87	19.00±1.87	NS

*A,b,c and d means in each row, within each item, bearing the same superscripts are not significantly different (P<0.05). (NS). Not significant

** T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

4.3. Blood plasma biochemical parameters:

Effect of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on blood plasma biochemical parameters are presented in Table 6. Data showed that *Moringa oleifera* extract groups (T_5 and T_6) were significantly ($p < 0.05$) higher in antioxidant capacity (0.86 mmol/l) meanwhile, birds of positive control (T_1) was the worst one. Also, *Moringa oleifera* extract groups (T_5 and T_6) achieved significantly ($P > 0.05$) the best values of total lipids (442.2 and 410.99 mg/dl); total cholesterol (167.95 and 159.87 mg/dl); HDL cholesterol (111.9 and 125.58 mg/dl) and LDL cholesterol (86.13 and 73.4 mg/dl) compared with control or powder groups (T_1;T_2;T_3;T_4) (Table 6). Similarly, T_6 birds group achieved significantly ($p < 0.05$) the best values of alkaline phosphatase (164.62 mg/dl) and blood plasma glucose (312.93 mg/dl) compared with control or powder groups (T_1; T_2; T_3 and T_4) (Table 6). In this connection, **Johnson (2004)** detected that exogenous antioxidants from natural sources can improve the function of the endogenous antioxidant system which is responsible for preventing free radicals in the body. Also, **Charoensin and Wongpoomchai (2012)** reported that the aqueous extract of *M. oleifera* leaves contained polyphenols. Furthermore, there are some reports which claim that *M. oleifera* leaves are rich in polyphenols and flavonoids and have antioxidant activity **(Luqman *et al.*, 2012; Santos *et al.*, 2012)**. Recently **Charoensin (2014)** reported that *M. oleifera* leaves extracted with methanol and dichloromethane also showed antioxidant activity. **Olugbemi *et al.* (2010)** investigated the potential of MLM as a hypocholesterolemic agent that facilitate reductions of egg cholesterol content.

4.4. Relative lymphoid organs weight and immune response.

Data in Table 7 illustrate relative lymphoid organs weight and immunity response as affected by feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract. Results indicate that the highest spleen relative weight and the minimum size and relative weight of bursa have been detected with T_6 (0.12 and 0.06%) followed by T_5 (0.11and0.10%), However, the highest thymus relative weight was recorded significantly ($P < 0.05$) with T_5 birds group (0.36%).Also, data of total protein; globulin and Albumin/globulin ratio were significantly ($P < 0.05$) improved with extracted groups (T_5 and T_6) compared to control or powder groups(T_1;T_2;$T_3$and T_4).These

results indicated that feed supplemented with 50 and 100 ml/l of *M. oleifera* leaves ethanolic extract in drinking water may improve the immune response and significantly better disease resistance**.** Since the extract contains a range of compounds such as protein, flavonoids, tannin etc., the observed activity may be due to single chemical moiety and/or group of therapeutically active components like protein, flavonoids, tannin etc. which may cause immunity response**.** In this concern, **Katanbaf *et al.*, 1989)** reported that the increase in the relative organ weight is considered as an indication of the immunological advances. The primary organs of immune system are bursa of Fabricus and thymus, reached their maximum size in chicks about four weeks after hatching and then undergo gradual involution **(Tizard, 1995).**

Table 7. The effects of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on Relative lymphoid organs weight and Immunity response (Means ± SE).

Item	T_{1***}	T_2	T_3	T_4	T_5	T_6	Sign.
Spleen % **	0.11±0.02	0.10±0.02	0.10±0.02	0.09±0.02	0.11±0.02	0.12±0.02	NS
Thymus % **	0.17^{bc} ±0.03	0.25^{b} ±0.03	0.25^{b} ±0.03	0.22^{bc} ±0.03	0.36^{a} ±0.03	0.14^{c} ±0.03	*
Bursa % **	0.08^{cd} ±0.02	0.13^{ab} ±0.02	0.16^{a} ±0.02	0.12^{abc} ±0.02	0.10^{bcd} ±0.02	0.06^{d} ±0.02	*
Total protein (g/dl)	4.05^{bc} ±0.28	3.53^{c} ±0.28	4.09^{bc} ±0.28	4.08^{ab} ±0.28	5.16^{a} ±0.28	5.27^{a} ±0.28	*
Albumin (g/dl)	2.22±0.15	2.32±0.15	2.47±0.15	2.27±0.15	2.11±0.15	2.10±0.15	NS
Globulin (g/dl)	1.83^{b} ±0.38	1.20^{b} ±0.38	1.62^{b} ±0.38	2.21^{ab} ±0.38	3.05^{a} ±0.38	3.17^{a} ±0.38	*
A/G Ratio	1.25^{ab} ±0.34	1.97^{a} ±0.34	1.82^{a} ±0.34	1.31^{ab} ±0.34	0.70^{b} ±0.34	0.68^{b} ±0.34	*

*a,b,c and d means in each row, within each item, bearing the same superscripts are not significantly different (p<0.05). (NS). Not significant. ** As % of live body weight.

***T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

4.5. Carcass characteristics.

The effects of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on carcass characteristics are presented in Table 8. Results indicated that groups fed dietary moringa extract (T_5 and T_6) did not differ significantly ($P > 0.05$) from control and dietary moringa powder groups (T_1; T_2;T_3 and T_4). The carcass weight (%) of head and leg analysis in all the groups did not show appreciable variations while, carcass weight (%) of neck significantly ($P < 0.05$) with groups fed both moringa powder and extract groups. The organ weight (%) of gizzard, liver and heart showed that birds groups fed 50 ml/l MLEx (T_5) achieved significantly ($P < 0.05$) the best values (1.6; 2.84 and 0.62 %). These results may be due to presence of phytochemicals in ethanol extract of moringa leaves which improve the physical and chemical proprieties of meat. These results are in agreement with those obtained by **Abousekken *et al.* (2013b).** In this concern, **Qiao (2008)** reported that treatments of different level of sinipic acid in diets did not affect relative weight of gizzard, liver and heart. Significant differences on abdominal fat % between the different experimental treatments were observed. Group fed dietary 100 ml/l MLEx extract (T_6) appeared to have significantly ($P < 0.05$) the lowest abdominal fat (AF %) value (0.44%) followed by those group fed dietary 50 ml/l MLEx (T_5) (0.70%). Meanwhile, birds of positive control (T_1) were the worst one (1.30%).

Table 8. The effect of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on carcass characteristics (Means ± SE).

Parameter		Group Mean weight and organs: body weight ratio (%)						Sig.
		T_1	T_2	T_3	T_4	T_5	T_6	
1.	Pre-Slaughter weight(Kg/bird)	3.21^{a} ±0.11	2.93^{ab} ±0.24	2.50^{b} ±0.20	2.58^{b} ±0.10	2.58^{b} ±0.23	2.73^{ab} ±0.11	*
2.	Dressed(Carcass) weight(Kg/bird	2.60^{a} ±0.20	2.38^{ab} ±0.20	1.55^{c} ±0.23	1.36^{c} ±0.15	1.67^{c}±0.31b	1.93^{abc} ±0.24	*
3.	Dressing (%)	80.79^{a} ±5.12	81.31^{a} ±0.92	61.35^{b} ±3.92	53.16^{b} ±7.53	63.85^{ab} ±6.28	70.1^{ab} ±6.24	*
4.	Carcass weight (%):							
4.1	Nek	5.89^{bc} ±0.45	5.69^{bc} ±0.33	6.87^{ab} ±0.63	7.38^{a} ±0.31	4.98^{c} ±0.34	6.47^{ab} ±0.22	*
4.2	Head	2.31±0.25	1.98±0.18	2.22±0.18	2.028±0.08	2.49±0.31	2.47±0.10	NS
4.3	Leg	4.33±0.31	3.77±0.62	4.12±0.09	4.09±0.29	3.82±0.15	3.49±0.02	NS
5.	Organ weight (%)							
5.1	Gizzard	1.10^{c} ±0.043	1.27^{bc} ±0.06	1.42^{ab} ±0.07	1.41^{ab} ±0.09	1.60^{a} ±0.16	1.17^{bc} ±0.02	*
5.2	Liver	1.685^{c} ±0.1	1.88^{bc} ±0.26	2.27^{abc} ±0.06	2.39^{ab} ±0.05	2.84^{a} ±0.36	2.18^{abc} ±0.13	*
5.3	Heart	0.43^{ab} ±0.06	0.38^{b} ±0.04	0.61^{a} ±0.10	$0.61\pm^{a}$ 0.03	0.62^{a} ±0.05	0.59^{a} ±0.02	*
6.	Abdominal fat (AF %)	1.30^{a} ±0.02	1.24^{a} ±0.17	0.91^{b} ±0.14	0.75^{bc} ±0.06	0.70^{c}±0.06b	0.44^{c} ±0.09	*

**Data are mean (±SD) of three results. a,b,c and d means in each row, within each item, bearing the same superscripts are not significantly different (P<0.05). (NS). Not significant.

*** T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.; T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

4.6. Lipid oxidation test TBARS.

TBA-Reactive Substances (TBARS) of thigh muscle (g kg-1 malonaldehyde) of broilers fed dietary treatments are presented in Table 9. Results indicated that the extent of lipid oxidation (TBA number) in thigh meat after 7 d of refrigerated storage was not differed between all treatments. However, malonaldehyde concentration was different after 90 d of freeze storage. Birds fed diets supplemented with (50 and 100ml/l) of moringa extract significantly ($p<0.05$) had the lowest TBA value for 42 and 90 days (0.391;0.373 and 0.466;0.433g/kg^{-1}, respectively), while birds fed control group showed the highest TBA value (0.628 and 0.776 g/kg^{-1}). These results may be attributed to presence of phenolic antioxidants in moringa powder and its ethanolic extract which improved the oxidative stability of poultry abdominal fat **(Bartov and Bornstein, 1981and AbouSekken *et al.* 2013b)**. These results are in agreement with **Mohdaly *et al*., (2010)** who reported that sugar beet pulp (ethanolic extract) is a potent source of natural antioxidants that explored to prevent oxidation of storage vegetable oils**.** Also, Phenolic antioxidant is less well known but improved stability of vegetable oils under storage **(Pinkowski *et al*., 1986; Hawrysh *et al.,* 1992).**

4.7. Organoleptic characters and evaluation.

Organoleptic evaluation values of cooked meat in terms of color, odour, taste, texture, flavor and overall acceptance are illustrated in Table 9. Results indicated that control negative and dietary moringa powder groups (T_2; T_3 and T_4) significantly ($P\leq0.05$) achieved lower values of color, taste, Oder, texture, flavor and overall acceptance. Meanwhile, *Moringa oleifera* leaves extract groups (T_5 and T_6) appeared significantly ($P\leq0.05$) a good feed additive for color, odour, taste and overall acceptance (Table 9). Generally, the best values of overall acceptance being (8.49) had been significantly ($P\leq0.05$) recorded by birds group fed diets supplemented with (100ml/l) *Moringa oleifera* leaves ethanolic extract (T_6) followed by T_5 (8.09) and control negative (T_1) (7.87). The worst value (6.89) was achieved by birds fed dietary 5% *Moringa oleifera* leaves meal (MLM). These results may be due to presence of Phenolic antioxidants in moringa extract which improve the physical and chemical proprieties of meat **(Ranadheera *et al.*, 2012)**. These results are in agreement with those obtained by **Abou Sekken *et al.* (2013b)** who found that the best value of overall acceptance being (8.17) had been recorded by birds fed diets supplemented with (1%) ethanolic extract. Meanwhile, the worst one (6.88) was achieved by birds fed diets with BHT supplementation. In contradict results, **Hayat *et al.* (2010)** reported that antioxidant supplementation (vitamin E or BHT) did not enhance the acceptability of eggs by trained panelists, color, odor, taste and overall acceptance were decreased.

Table 9. TBA-Reactive Substances (TBARS) of Thigh muscle (g kg^{-1} malonaldehyde) of broilers fed different levels of *Moringa oleifera* leaves meal (MLM) and its extract.

Item		Treatments						Sig.
		T_1	T_2	T_3	T_4	T_5	T_6	
Days after storage	7	0.446±0.06	0.404±0.06	0.515±0.06	0.511±0.06	0.346±0.06	0.313±0.06	NS
	42	0.628^{a} ±0.05	0.519^{ab} ±0.14	0.565^{ab} ±0.09	0.589^{ab} ±0.01	0.391^{bc} ±0.11	0.373^{c} ±0.08	*
	90	0.776^{a} ±0.05	0.624^{abc} ±0.05	0.602^{bc} ±0.05	0.648^{a} ±0.05	0.466^{cd} ±0.05	0.433^{d} ±0.05	*

*a,b,c and d means in each row, within each item, bearing the same superscripts are not significantly different ($P<0.05$).

** T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

Table 10. The effects of feeding different levels of *Moringa oleifera* leaves meal (MLM) and its extract on organoleptic evaluation of cooked chicken meat (means ± SE).

Item	Treatments						Sig.
	T_1	T_2	T_3	T_4	T_5	T_6	
Color	8.22^{ab} ±0.34	8.11^{ab} ±0.67	7.78^{bc} ±0.34	6.89^{c} ±0.34	8.11±0.34^{ab}	8.89±0.34^{a}	*
taste	7.67^{abc} ±0.38	7.56± ^{c} 0.38	7.22^{c} ±0.38	7.22^{c} ±0.38	8.56^{ab} ±0.38	8.78±0.38^{a}	*
Oder	8.22^{bc} ±0.45	5.22^{c} ±0.45	6.67^{c} ±0.45	7.00^{bc} ±0.45	7.22^{ab} ±0.45	8.00±0.45^{a}	*
Texture	7.33^{bc} ±0.36	6.33^{c} ±0.36	6.33^{c} ±0.36	7.33^{bc} ±0.36	8.33^{ab} ±0.36	8.67±0.36^{a}	*
flavor	7.89^{ab} ±0.28	7.44^{abc} ±0.52	6.44^{c} ±0.20	7.11^{c} ±0.48	8.22^{a} ±0.29	8.11±0.17^{ab}	*
Allover acceptability	7.87^{a} ±0.21	6.93^{b} ±0.21	6.89^{b} ±0.21	7.11^{b} ±0.21	8.09^{a} ±0.21	8.49±0.21^{a}	*

*a,b,c and d means in each row, within each item, bearing the same superscripts are not significantly different ($P\leq0.05$).

** T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

4.8. Economical Efficiency

Results of economical analysis of including moringa leaf meal and its extract in broilers low protein diets are presented in Table 11. The economical efficiency values were calculated according to prevailing local market (selling) prices at the experimental time (2015). Results showed an improvement in the average values of net revenue, economical efficiency; relative economical efficiency (28.13; 2.97and 122.72%, respectively) due to feeding broiler low protein diet supplemented with 50 ml (MLEx) / liter drinking water (T_5) compared with control and other experimental groups. Meanwhile, the lowest value of economical efficiency was obtained by broilers fed 5% (MLM), being 1.39 (T_3).

Therefore, using dietary *Moringa oleifera* leaves meal (MLM) decreased the feed cost and also decreased the net revenue for broilers. These results are agreement with those by **Zanu *et al.* (2012)** who observed that partial replacement of fish meal with *Moringa oleifera* leaf meal decreased the feed cost and also decreased the net revenue for broilers. Also, The results indicated also that dietary *Moringa leaves extract* (MLEx), from economical point of view, tend to decrease the feed cost but increased the net revenue by supplementing 50 ml *Moringa leaves extract* (MLEx) / liter drinking water (T_5) (Table 11).

In this connection, **Ayssiwede *et al.* (2011)** noticed that incorporation of 24% *Moringa oleifera* leaf meal in diets of growing chickens produced the highest feed cost/kg carcass. However, the lowest feed cost/kg carcass was achieved when 8% and16% of *Moringa oleifera* leaf meal was introduced into the diets of the birds. **Adeniji and Lawal (2012)** examined the economical benefits of *Moringa oleifera* leaf meal in grower rabbit diets and found that increasing the levels of *Moringa oleifera* leaf meal up to 100% replacement significantly ($P < 0.05$) reduced feed cost. **Abbas and Ahmed (2012)** concluded that the levels of inclusion of *Moringa* leaf meal that can be expected to be cost-effective are 10% to replace fish meal in broilers.

Table 11. Economic analysis of inclusion of moringa leaf meal (MLM) and its extract in broilers low protein diets

Item	T_1	T_2	T_3	T_4	T_5	T_6
Average feed intake (kg/bird)=A	2.90	2.94	3.62	3.09	2.73	3.20
Price/Kg feed (LE)=B*	3.28	3.17	3.65	4.00	3.47	3.77
Total feed cost (LE)C=AXB	9.51	9.32	13.21	12.36	9.47	14.85
Average LBWG(kg/bird) =D	2.03	1.91	1.97	2.15	2.35	2.60
Price/Kg live weight (LE)** E	16	16	16	16	16	16
Total Revenue (LE) F=DXE	32.48	30.56	31.52	34.4	37.6	41.6
Net Revenue (LE) =F-C=G***	22.97	21.24	18.31	22.04	28.13	26.75
Economical Efficiency (G/C)	2.42	2.28	1.39	1.78	2.97	1.80
Relative Economical efficiency****	100	94.22	57.44	73.55	122.73	74.38

*According to the price of different ingredients available and market price at the experimental time (2014).
** LE:Egyptian Pound and 1 US$=7 LE
*** Net revenue per unit cost. **** Compared to the economical efficiency of the control group.
T_1: Positive control fed commercial diet; T_2: Negative control fed experimental diet contain lower crude protein without moringa powder or extract; T_3: Fed negative control diet + 5% Moringa leaves powder; T_4: Fed negative control diet + 10% Moringa leaves powder;T_5: Fed negative control diet + 50 ml *Moringa leaves extract* (MLEx) / liter drinking water.;T_6: Fed negative control diet + 100 ml *Moringa leaves extract* (MLEx) / liter drinking water.

Conclusion

It can be concluded that supplementation of 50 ml and 100 ml concentrations of *Moringa oleifera* aqueous leaf extract/l drinking water had improved growth performance, feed intake, feed conversion ratio of broilers, carcass quality and freeze storage of meat (shelf live) and is a good feed additive for color, odor, taste and overall acceptance. Also, the presence of phytochemicals in ethanol extract of moringa leaves such as carbohydrates, protein, steroid, flavonoids, tannins, alkaloids and glycosides tend to improve the immune response and cause better disease resistance and achieved the best values for broilers blood plasma biochemical. *From economical point of view*, the inclusion of 50 ml *Moringa leaves extract* (MLEx) / liter drinking water (T_5) for broilers low protein diets, improved values of net revenue, economical efficiency; relative economical efficiency. *However,* further research is needed to validate the potential promising outcome of *Moringa oleifera* aqueous leaf extracts for the broiler industry in terms of achieving optimum growth performance and better return of investment.

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