

Full Length Research Paper

Performance, immunology and biochemical parameters of *Moringa oleifera* and/or *Cichorium intybus* addition to broiler chicken ration

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This study was aimed to evaluate the influence of *Moringa Oleifera* and/or *Cichorium Intybus* powder supplementation on performance, biochemical parameters, immunology and carcass quality of broiler chicks. Two hundred one-day-old chicks (Ross, 308 hybrid) were randomly allotted into four groups. Each group contained 50 chicks with five replicates. Feed was offered *ad libitum* to all groups. Group C were fed basal control diet. Chicks in the group M were fed basal diet supplemented with 1.5% *M. oleifera* and chicks in group CI were fed basal diet supplemented with 1.5% *C. Intybus*, while the chicks of group MC were fed basal diet supplemented with 0.75% *M. oleifera* plus 0.75% *C. Intybus* during experiment time. Body weight and feed amount were recorded every 15 days. Carcass yields were evaluated at the end of the experiment. The results revealed that supplements improved significantly bird weights, whereas the group C has the least mean value among the treatments. Group MC had better weight (239 3±80 g) than other groups (2180±48, 2020.5±97 1893±54 g, respectively for groups CI, M and C). Feed conversion ratio (FCR) was estimated 1.45, 1.48, 1.54 and 1.58 for MC, CI, M and C groups, respectively. Supplements group have lower total cholesterol than control. Finally, the use of a combination of *C. Intybus* and *M. oleifera* was recommended as good feed additives to improve productivity and enhance immunity.

Key words: Broiler, performance, *Moringa Oleifera*, *Cichorium Intybus*, biochemical parameters, immunology, carcass yields.

INTRODUCTION

Poultry health is affected by the surrounding environment. Infectious pathogens such as bacteria, viruses, parasites and fungi can easily infect poultry when its immune system is suppressed, which lead to different complicated

infections (Paliwal et al., 2011a; Sandhu et al., 2009). In European Union, from January 2006, antibiotics use is prohibited to avoid antimicrobial- resistance in bacterial strains and antibiotics residues in human food (Catala-

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Gregori et al., 2008); nowadays the herbal substitutes to enhance health status and performance is urgently needed (Panagasa et al., 2007; Singla and Gupta 2012). The immunity is challenged by environment and feed habits, with the concept that feed with natural antioxidants and micronutrients can boost the immune response (Paliwal et al., 2011a, b).

Herbs or extracted oils are safe to be fed to livestock with less risk than antibiotics which has harmful side effects and consider the most effective choice (Barrow, 1992), that is why, many types of plants are widely used in alternative medicine (Endo et al., 1999). The benefits of herbs raised the hope of using them instead of antibiotics (Panagasa et al., 2007). Herbs were recommended to enhance metabolic processes and the health condition of livestock (Panagasa et al., 2012). Some herbs can support the digestive enzymes action, improve feed intake, feed conversion ratio (FCR), carcass yields (Pietrzak et al., 2005), whereas, Halle et al. (2004) recorded no positive impact on broilers.

M. oleifera has beneficial anti-inflammatory and antioxidants properties (Yang et al., 2006). Dahot (1988) reported that *Moringa* contains vitamins (A, E, B2, B5, B6, folic acid) and minerals (Ca, Fe). *Moringa* has strong fungicidal and antimicrobial activity (Das et al., 1957). It also has an anti-blood cholesterol effect (Ghasi et al., 2000). Yang et al. (2006) mentioned that *M. oleifera* significantly enhanced immunity and decreased *Escherichia coli* and improved *Lactobacillus* counts in gastrointestinal tract (GIT) of broilers. So *Moringa* improves FCR and enhances immune response of birds. Also, its leaves has natural antioxidant compounds and soluble proteins (Sreelatha and Padma, 2009; Kakengi et al., 2007).

Cichorium intybus (cichory) is considered a good source of fiber that can be utilized by simple stomach livestock; also it is palatable for ruminants (Li and Kemp, 2005). Both inulin and oligofructose are the main constituents of cichory. It was documented that oligofructose improved broilers carcass and breast weights, and decrease abdominal fat percent (Ammermal et al., 1989); these findings is supported by those of Yusrizal and Chen (2003) results in which birds' abdominal fat content decreased. Chicory has essential mineral (Foster, 1988) and uronic acids (15%, DM), considered the main constituent of pectin (Voragen et al., 2001). High growth and improved digestibility of non-starch polysaccharide were observed in swine, besides little adverse influence on organic matter and digestibility with high level (16%) of *C. intybus* (Ivarsson et al., 2011). Prebiotic action of inulin was reported by Castellini et al. (2007), in livestock; also Gibson et al. (2004), observed the selective stimulation of lactobacilli and bifidobacteria, in the large intestine in rodents.

Therefore, the purpose of the study was to declare the benefits of *M. oleifera* and/or *C. intybus* as feed additive on broiler chickens in terms of feed intake (FI), growth

performance, immunology, biochemical parameters, and carcass yields.

MATERIALS AND METHODS

Experimental chicks, housing and management

This study was carried out in accordance with the regulations of the Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Sohag University, Egypt. Two-hundred (Ross 308 hybrid) chicks (n = 200) raised with traditional litter system with chopped straw were used as bedding material. Room humidity and temperature were controlled and 24 h of lightening was observed throughout the experimental period. Chicks were fed *ad libitum*, and health status was observed daily. All birds were vaccinated for infectious bronchitis at 7 days old followed by Newcastle (Zoetis, Fort Dodge) and infectious bursal disease (Zoetis, Fort Dodge) at 20 days old.

Experimental design and feeding

Broilers chicks were divided randomly into four groups (50 chicks per each). Each group contained 50 chicks with 5 replicates of 10 birds per pen. The trial lasted 42 days. Chicks in control group (C) were fed *ad libitum* on the basal control diets (starter for first three weeks of age, and grower-finisher for next three weeks); birds of group M received basal diet enriched with *M. oleifera* (1.5%); chicks of group CI were fed basal diet enriched with *C. intybus* (1.5%); birds of group MC were fed basal diet enriched with *M. oleifera* and *C. intybus* (0.75%:0.75%) during experimental period (Table 1). A standard basal diet was formulated to meet the nutrient requirements of broiler (NRC, 1994) as shown in Table 2.

Tested parameters

Performance measurements

Chicks were weighed at the start of the experiment and records were taken every 15 days until the end of the experiment. The feed intake was daily recorded for each of the different experiment groups. The average amount of feed intake of each bird was estimated by dividing the consumed amount by the respective number of birds in each group. Mortality was recorded.

Body weight gain (BWG), feed conversion ratio (FCR) and production efficiency factor (PEF) also known as European Production Efficiency Factor (EPEF) were estimated thus: BWG = average final live body weight (LBW) - average initial LBW at a certain period; FCR = total feed intake / total BW gain, and EPEF = ((Livability × LBW in kg)*100)/age in days × FCR (Mousa et al., 2016).

Carcass yields

At the end of the trial and before slaughter, chicks were given a feed withdrawal period of 12 h. From each group, ten birds were randomly chosen, weighed and slaughtered. Feathers were removed, carcass was eviscerated and carcass yield was calculated. Selected chicks were deboned and breast, thigh, and abdominal fat were weighed.

Blood biochemical parameters

Vein blood samples from ten chicks of each group were collected

Table 1. Herbal plants plan.

Group	Treatment
Control group (C)	Allotted to basal diets without any supplementation
<i>Moringa oleifera</i> group (M)	Allotted to basal diets supplemented with 1.5% <i>M. oleifera</i> powder
<i>Cichorium intybus</i> group (CI)	Allotted to basal diets supplemented with 1.5% <i>C. intybus</i> powder
<i>M. oleifera</i> plus <i>C. intybus</i> group (MC)	Allotted to basal diets supplemented with 0.75% <i>M. oleifera</i> plus 0.75% <i>C. intybus</i> powder

from the wing. Samples were left to stand for 1 h and centrifuged at 4000 rpm for 15 min. The clear serum was kept in sterilized tubes and stored at -20°C for biochemical analysis. Levels of total proteins, albumin, triglycerides and cholesterol were measured in these samples according to the manufacturer's instruction (Chema Diagnostica, Italy).

Measurement of antibodies (Abs) titers against newcastle disease (ND) and infectious bursal disease (IBD) vaccines

In the collected sera, Abs titer against ND vaccine was measured by haemagglutination inhibition (HI) test according to OIE (2012) and Abs titer against IBD vaccine was measured by enzyme-linked immunosorbent assay (ELISA) test via IBDV ELISA kits (Synbiotics Laboratories, USA) according to the manufacturer's instruction.

Statistical analysis

This data obtain were analyzed with the standard procedures of analysis of variance (ANOVA), using SPSS Statistics 17.0 (Released 23 August 2008). Differences among means were separated using Duncan's multiple range test (Duncan, 1955). Significant difference was identified at a level of $P < 0.05$.

RESULTS AND DISCUSSION

Production performance

The growth data variables are shown in Table 3. The combination of *M. oleifera* (0.75%) and *C. intybus* (0.75%) improved significantly ($P \leq 0.05$) body weight gain along the experimental period, the best body weight gain was obtained by MC group (257 ± 25 g/bird) in comparison with CI group (246 ± 27 g/bird), C group (235 ± 53 g/bird) and M group (216 ± 16 g/bird). When the experiment was ended (after 42 days), the best cumulative LBW and FCR were recorded in the birds in MC group (2393 ± 30 g/bird and 1.45, respectively) followed by broilers in CI group (2180 ± 48 g/bird and 1.48, respectively) and the birds of C group (2020 ± 97 g/bird and 1.54, respectively), but the M group had the lowest values (1893 ± 54 g/bird and 1.58, respectively). Feed intake had the same order of LBW (MC>CI>C>M groups) of 3458, 3216, 3113 and 2996 g/bird, respectively.

European performance efficiency factor index

The EPEF indexes were significantly different between all

the treatments of study, whereas, MC group had better value (385), followed by CI group (344) and C group (293) then M group (279.5). When the EPEF index value is higher, the productive performance is better (Table 3). Health was observed and mortality was recorded throughout the experimental period (Table 3).

The result obtain for chicory as feed additive are in line with that of Yusrizal and Chen (2003) who found that the addition of it significantly improve feed intake, body weight and FCR. These results are supported by those of Ammerman et al. (1989) result, whereas, Waldroup et al. (1995) found no effect. Also, Castellini et al. (2007) found that, green *Cichorium* feeding decreased amount of feed and rabbit weight gain during suckling period. Result shows improvement along the experiment period in contrast with the report of Aghazadeh et al. (2011) who reported no effects during finishing period and explained this with the fact that fructans effects are age dependent, so stimulate microbial population and as a result enhancing performance during starter period.

Indeed, chicory (inulin) feeding to poultry have a good impact on both health status and production (Roberfroid et al., 2010); also absorption was improved via positive changes of the GIT mucosal membrane (Rehman et al., 2007); besides beneficial microflora growth was enhanced while, pathogenic bacteria growth decreased (Sevane et al., 2014). Also, the fat deposition decreased and fat profile improved (Velasco et al., 2010).

Yusrizal and Chen (2003) observed that chicory addition increase length of broilers GIT. When GIT is longer, the digestion and metabolism will be better, and so improve performance. Yeung et al. (2005) suggested that inclusion of chicory improve GIT absorption of Ca, Mg and Fe. Izadi et al. (2013) reported improved productive performance via increase surface of absorption through increase villi length, villi length/crypt depth, and villi number; also the performance improvement of broiler allotted on chicory could be related to insoluble non-starch polysaccharides content, which improve rate of digesta removal, and so enhance feed intake (Kalmendal et al., 2011). Chicory has galacturonic acids, which is the main constituent of pectin, the source of uronic acids that has high digestible values (Voragen et al., 2001).

Cichorium has fructo-oligosaccharides and inulin, which could manipulate intestinal microflora and enhance mucosal integrity (Flickinger et al., 2003); it also contains sucrose, cellulose, protein, esculin, coumarins, flavonoids,

Table 2. Ingredients (kg) and chemical composition of basal and experimental diets for broiler chicks.

Ingredient	Basal diets		Diets supplemented with <i>Moringa</i>		Diets supplemented with <i>chicory</i>		Diets supplemented with <i>Moringa + chicory</i>	
	Starters	Grower-finisher	Starter	Grower-finisher	Starter	Grower-finisher	Starter	Grower-finisher
Corn grain	54.5	62.45	54.5	62.45	54.5	62.45	54.5	62.45
Soy bean meal	28	21	28	21	28	21	28	21
Conc. mixture	10	10	10	10	10	10	10	10
Sunflower oil	2.2	1.6	2.2	1.6	2.2	1.6	2.2	1.6
Di-calcium phosphate	2	1.8	2	1.8	2	1.8	2	1.8
Calcium carbonate	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Common salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium bicarbonate	0.25	0.1	0.25	0.1	0.25	0.1	0.25	0.1
Minerals-vitamins premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lysine	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Additives tested	1.5 distiller grains	1.5 distiller grains	1.5 <i>Moringa</i>	1.5 <i>Moringa</i>	1.5 <i>chicory</i>	1.5 <i>chicory</i>	1.5 <i>Moringa + chicory</i>	1.5 <i>Moringa + chicory</i>
Sum (kg)	100	100	100	100	100	100	100	100
Estimated analysis								
ME(kcal/kg)	2990	3130	2980	3120	2980	3120	2980	3120
T. P (%)	21.81	19.43	21.8	19.42	21.78	19.41	21.79	19.41
Calcium (%)	1	0.90	1	0.90	1	0.90	1	0.90
phosphorus	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.8
Lysine (%)	1.4	1.2	1.4	1.2	1.4	1.2	1.4	1.2
Methionine (%)	0.58	0.57	0.58	0.57	0.58	0.57	0.58	0.57

Premix provided the recommended amount of both vitamins and mineral according to NRC (1994).

and vitamins (Meehye and Shin, 1996; Van Loo, 2007). Inulin improves lipid-to-glucose metabolism with potential effects on weight gain, fat deposition and appetite (Urias-Silvas et al., 2007). A beneficial action of chicory (inulin and oligofructose) feeding is decreasing the pH, which could explain thickening of the small intestine wall (Remesy et al., 1992).

Sevane et al. (2014) identified 33 genes

associated with protein regulation activity, vital cellular processes, localization and peptidase activity, and so influence productive improvement; 43 genes were also identified that regulate cell division and growth, DNA and RNA synthesis, finally resulting in increasing cellular activity.

Besides, chicory stimulates PPARA, which is a member of peroxisome proliferator-activated receptors, related to energy metabolism regulation,

cell growth, dividing and maturation, and in inflammation and immune status (Gervois and Mansouri, 2012).

The result of *Moringa* is supported by observation of Akhouri et al. (2013), who recorded improved body weight and enhanced FCR of broilers with *M. oleifera*; it is also in line with the results of Banjo (2012) finding, who reported that supplementation of *M. oleifera* to diet of broiler

Table 3. Impact of *M. oleifera* and/or *C. intybus* addition to broiler chicken ration on weight gain, feed intake, FCR and EPEF.

Variable		Control group (C)	<i>Moringa oleifera</i> group (M)	<i>Chicory intybus</i> group (CI)	<i>M. oleifera</i> plus <i>C. intybus</i> group (MC)
Number of birds		50	50	50	50
Initial body weight		45.3	45.2	45.1	45.2
Body weight (g/bird)	15 days old	216±53 ^d	235±16 ^c	246±27 ^b	257±25 ^a
	30 days old	1218±145 ^d	1339±95 ^c	1397±135 ^b	1482±62 ^a
	42 days old	1893±97 ^d	2020±54 ^c	2180±48 ^b	2393±80 ^a
Feed intake (g/bird)	15 days old	250.2±23 ^d	266.3±33 ^c	280.5±24 ^b	295.5±43 ^a
	30 days old	1503.7±46 ^d	1537.5±27 ^c	1588.5±52 ^b	1670.6±76 ^a
	42 days old	1242.3±65 ^d	1310.1±39 ^c	1347.4±61 ^b	1492.3±33 ^a
Cumulative		2996.2±107 ^d	3113.9±47 ^c	3216.4±57 ^b	3458.4±74 ^a
FCR		1.58	1.54	1.48	1.45
EPEF		279.5	293.5	344	385
Mortality		3	1	1	1

^{a,b,c,d}Means on the same row with different superscripts are significantly different (P<0.05).

Table 4. Antibody titer of broilers chicks against ND and IBD vaccines allotted on *M. oleifera* and/or *C. intybus* supplemented ration at 30 days old.

Group	HI of NDV (log2)	Elisa of IBD
Control group (C)	254.84±70 ^d	1241±23 ^d
Group (M)	584.54±59 ^b	2130±70 ^b
Group (CI)	296.89±67 ^c	1802±42 ^c
Group (MC)	612.23±42 ^a	2209±34 ^a

^{a,b,c,d}Means on the same column with different superscripts are significantly different (P<0.05).

chicken enhanced weight gain. Nuhu (2010) reported in young rabbits that received diet with *M. oleifera*, improvement in protein digestibility and weight gain, while feed intake, FCR, and carcass yields were not affected. Grubben and Denton (2004) reported higher growth of rabbit as a result of vitamin A and essential elements of *M. oleifera*, that promote health. *M. oleifera* also has antimicrobial ability (Caceres et al., 1990). *M. oleifera* leaves contain 0.1 to 0.23% of tannin (Kakengi et al., 2003, 2007), that decrease protein digestion and absorption while lipids and carbohydrate utilization are less affected (Esonu et al., 2001).

Immunological parameters

An elevation of antibodies titers of both ND and IBD vaccine was found in groups MC, CI, M than group C (Table 4). The titer of IBD and NDV vaccine improved due to the presence of flavonoides, inulin and polyphenolic compound. Result obtained pointed an effect of chicory and *M. oleifera* addition on the improvement of immunity by improving the activity of

genes and fastening pathways related to body defense processes, where the addition of chicory (inulin) stimulated various immune pathways. Sevane et al. (2014) identified 20 genes implicated in immune response pathways, antibodies and immune action. Also, chicory has anti-apoptotic activity, via antioxidant activation, which boosts T-helper activity (Wammes et al., 2013) besides activating enzymes which enhance formation of acyl-CoA, ATP and CoA, and so promote mitochondria action (Wammes et al., 2013). Chicory also regulates glutathione metabolism that also enhances antioxidant defense and regulation of cellular metabolism, where its deficiency leads to oxidative stress (Wu et al., 2004).

Oligofructose suppresses challenged infections of broilers (Van Leeuwen et al., 2005). In quails, inclusion of inulin prevents the pathogenic bacteria growth and enhances the activities of microflora, which have a protective role (Catala et al., 1999). Nodular lymphoid tonsils improvement and infiltration of lymphoid cells were recorded with chicory feeding (Spaeth et al., 1990), besides Kelly-Quagliana et al. (2003) described that both inulin and oligofructose triggers immune defense

Table 5. Some blood parameters of broilers chicks received ration supplemented with *M. oleifera* and/or *C. intybus* at 42-days old.

Group	Protein (g/100 ml)	Albumin (g/100 ml)	Globulin (g/100 ml)	Cholesterol (mg/100 ml)	Triglycerides (mg/100 ml)
C	3.84±0.3 ^d	1.57±0.13 ^d	2.27±0.3 ^c	149.8±8 ^a	53.73±2.1 ^a
M	5.67±0.15 ^b	1.68±0.06 ^c	3.99±0.2 ^b	122.2±9 ^b	37.62±1.3 ^c
CI	4.25±0.34 ^c	1.96±0.08 ^a	2.29±0.1 ^c	117.6±7 ^c	42.71±1.4 ^b
MC	5.82±0.52 ^a	1.76±0.15 ^b	4.06±0.2 ^a	106.4±4 ^d	41.30±2.3 ^b

^{a,b,c,d}Means on the same column with different superscripts are significantly different (P<0.05).

mechanism. Without doubt, *M. oleifera* is medicinally used as antioxidants and antifungal (Mohammed and Barhate, 2012; Paliwal et al., 2011a, b), so high-fat foods could be preserved for long time due to potent antioxidants presence such as flavonoids and total phenolic compounds (Doughari et al., 2008; Jain et al., 2010). The leaves are also free of deleterious substances such as tannins and saponins (Celikel and Kavas, 2008).

Antimicrobial activity is the key for the wide use of *M. oleifera* (Suarez et al., 2005). It has immunomodulatory ability in the immune system (Paliwal et al., 2011a). This herb also serves as promoter to immune system and is used to overcome malnutrition (Paliwal et al., 2011b). It was chosen due to its phytochemical compound content, which include saponins, carotenoids, phenolic compounds and flavonoids. Saponin and flavonoid are considered natural immunomodulator because they enhance lymphocyte cells development (Anwar et al., 2007). Lipophilic constituents of *Moringa* explained the antimicrobial activity (Jabeen et al., 2008); *Moringa* also contain antibiotic metabolites and cell wall degrading enzymes (Rachmawati and Rifa'i, 2014).

According to Hefni (2013), aqueous extract of *M. oleifera* increases the number of hematopoietic stem cells, B lymphocytes, naive T cells expression and pro-inflammatory cytokines.

Biochemical parameters

Table 5 show that blood serum total cholesterol values were different ($P \leq 0.05$) among the groups, where lower value as well as triglycerides values was recorded in the chicory-*Moringa* (MC) group, followed by CI and M groups, where C group comes last, while there was a significant improvement in total protein and globulin values in both MC and M groups than CI and C groups. The result was similar to those of Yusrizal and Chen (2003) findings that revealed on addition of chicory to broilers diet a decrease in serum cholesterol level and abdominal fat deposition and an increase in cecum weight and GIT length. Also, result of Yusrizal and Chen (2003) showed that inulin decreased cholesterol content in serum. Jeusette et al. (2004) and Diez (1997) observed a decrease in cholesterol and triglyceride values in the

presence of inulin or oligofructose. Delzenne et al. (1995) observe an increase in calcium bioavailability which modifies the bone structure.

The result of the study is similar to the findings of Elson (1995), which recorded that enzyme of synthetic pathway of cholesterol was suppressed by isoprenoids. Moreover, Kim (2000) reported that chicory presence decreased 30% of cholesterol absorption, meanwhile Fremont et al. (2000) recorded that phenolic compounds decrease cholesterol concentration in blood and meat. Similarly, *M. oleifera* extract had hypo-cholesterolemic properties that were explained with low density lipoprotein (LDL) plasma levels due to the presence of B-sitosterol of *Moringa* (Ghasi et al., 2000, Kane and Malloy, 1982). Also, Luqman et al. (2012) confirmed the antioxidant activities as a result of polyphenols and flavonoids found in extract of *M. oleifera*.

The LDL of birds reduced with inclusion of *Moringa* explained by the presence of myriad phytochemicals in *M. Oleifera*. Some compounds present in *Moringa* were reported to have antibacterial and anticancer activity (Fahey, 2005; Mekonnen and Dräger, 2003), as well as antioxidant activity (Win and Jongen, 1996).

Carcass yield

As shown in Table 6 it could be observed that there was a significance difference ($P \leq 0.05$) among the groups in dressed carcass % of live body weight, where M (70.3) and MC (86.3) groups are better than CI groups (66.1) and C groups (65.3). Treatments had significant effect on breast, thigh and abdominal fat. Broilers which received diets with M had better carcass weight (%), but not the body weight (MC group). The examined groups had higher breast weight (%) than the control group C ($P < 0.05$).

The study result is in line with the finding of Brunsgaard and Eggum (1995), who reported improving carcass dressing and BW percentage.

The chicory inclusion to broilers improves carcass dressing and BW percentage that could be explained as fiber effect, which is obviously observed through the lower GIT length more than in the upper part (Brunsgaard and Eggum, 1995).

Table 6. Some carcass yield affected by addition of *M. oleifera* and/or *C. intybus* to broiler ration.

Carcass parameter	Control group (C)	Group (M)	Group (CI)	Group (MC)
Dressed carcass (%) of LBW	65.3±2 ^c	70.3±1 ^a	66.1±3 ^c	68.3±2 ^b
Breast (%) of carcass	37.3±2 ^c	39.8±3 ^a	36.5±6 ^d	38.9±1 ^b
Thigh (%) of carcass	37.1±6 ^b	35.3±4 ^c	39.1±3 ^a	37.3±4 ^b
Abdominal fat (%) of LBW	1.9	1.89	1.79	1.77

^{a,b,c,d}Means on the same row with different superscripts are significantly different (P<0.05).

These results were confirmed by Yusrizal and Chen (2003) findings, who reported that inclusion of chicory lower the blood cholesterol concentration in broilers chicks, besides increase cecum weight and GIT length, but lowered the abdominal fat. A suggested explanation is diminishing stress condition through the action on immune system.

In rats Jaiswal et al. (2009) recorded that glucose concentration lowered with *M. oleifera* extract addition, that confirm the insulin like action of *Moringa* on body tissues, that might be due to cellular glucose utilization or cease gluconeogenesis. *M. oleifera* has abilities to increase glucose utilization by body tissues (Luqman et al., 2012) via suppress hepatic gluconeogenesis or improve glucose utilization by the body tissues (Desta et al., 2011; Kamanyi et al., 1994). Consequently, this could explain the higher dressed carcass of *Moringa* than other treatments.

Generally, abdominal fat deposition is determined by the amount of fat intake and the amount of fat metabolized and excreted. So, if the fat intake and excreted is equal, decreased body fat accumulation could be due to lipolysis or decreased fatty acid production or to the both mechanisms. In contrary to this, the findings of Sizemore and Siegel (1993), who found no effects of dietary fat amount when the calorie protein ratio remained constant, in broiler diets supplemented with chicory. Similar to the result, Ologhobo et al. (2014) reported better values of carcass weights for birds received diets with *M. oleifera* more than birds received the basal one.

Preston and William (1973) result mentioned that birds with heavier weight have higher dressing percentage and eviscerated yield.

Safa and Tazi (2014) found that feeding *M. oleifera* had fair effect on quality of chicks carcass and increased breast weight of chicks, while Zanu et al. (2012) found that carcass characteristics parameters may not be affected by *Moringa* addition.

Finally, it can be concluded that the use of combination of both *M. oleifera* and *C. intybus* is better than each one alone, due to the beneficial synergistic effect on performance, biochemical parameters and immunology, besides improving carcass quality.

Hence, combination of *M. oleifera* and *C. intybus* was recommended as good feed additives with potential antioxidant ability for broiler chicks.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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