

# Comparative Efficacy of Different Herbal Plant's Leaf Extract on Haematology, Intestinal Histomorphology and Nutrient Digestibility in Broilers

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**Abstract** The study was planned to determine the comparative efficacy of leaf extract of *Azadirachta indica*, *Cichorium intybus* and *Moringa oleifera*, on haematology, intestinal histomorphology and nutrient digestibility in broilers. Day old broiler chicks (n=180) purchased from a commercial hatchery were reared in a group for one week (adaptation period). At day 8, these birds were individually weighed and 120 birds of middle weight range were randomly selected and distributed into 12 replicates (10 chicks/replicate). These replicates were further allotted to four treatment groups designated as A, B, C and D. Group A was offered water without any supplementation and served as a control. Whereas, group B, C and D were offered water supplemented with leaf extract of *Azadirachta indica* (4%), *Cichorium intybus* (2%) and *Moringa oleifera* (6%), @ 50 ml/l, @ 10 ml/l and @ 30 ml/l, respectively. Results of the study revealed that supplementation of *Azadirachta indica* leaf extract showed better nutrient digestibility of crude protein and ether extract as compared to that of control. However, digestibility of crude fiber due to the treatments remained unaffected. Stabilization of blood metabolites resulted in improved intestinal histo-morphology. The birds using *Azadirachta indica* fetched the highest profit as compare to the other treatment groups. Therefore, use of *Azadirachta indica* leaf extracts in broiler is recommended as inexpensive and efficient growth promoting agent without residual effects like antibiotic growth promoter.

**Keywords** *Azadirachta Indica*, *Cichorium Intybus*, *Moringa Oleifera*, Haematology, Intestinal Histomorphology, Nutrient Digestibility

## 1. Introduction

Poultry meat is one of the most important sources of animal protein in the world and therefore, contributing significantly in maintaining the health status of the people,

especially in developing countries like Pakistan. Its share in total meat production in Pakistan is 26.8% [19]. However, rapid increase in human population of the country is demanding more efforts to increase meat production for food security. Besides the threat of ever increasing population, spread of diseases, high feed cost and non-availability of quality ingredients for balanced feed formulation are some of the factors, which limit the production performance of broilers. Therefore, farmers are encouraged to use growth promoters and different feed additives to overcome nutrient deficiencies to maintain optimum growth rate in poultry.

Poultry rations usually contain antibiotic growth promoters to enhance performance of birds. In the past, estimated cost of antibiotic growth promoters in poultry rations in Pakistan ranged 2-3 rupees/kg of feed [9]. As Poultry feed industry produced 4.9 million tons of feed during 2010-11; thus estimated cost of antibiotic used as growth promoters summed up to about 1 billion rupees during the year. Moreover, there is a great concern among scientific community on use of antibiotics in diets to prevent bacterial resistance in poultry birds. However, European Union has already imposed ban on the use of antibiotics as growth promoters, since 2006, to discourage indiscriminate use of antibiotics in poultry rations [3].

As an alternative to antibiotic growth promoters, medicinal plants are the most popular options [15]. Medicinal plants like neem, garlic, kasni, ginger, kalongi, turmeric savory, sea-buckthorn, moringa and mint have been studied intensively [1] as alternatives of antibiotic growth promoters. In these studies, different parts of plants and their extracts, oil, leaves, bark, seed, roots and other vegetative parts have been investigated in poultry diets. Growth promotion, antibacterial, anticoccidial, antiparasitic, antifungal, antitumor, anticancer, pesticide, immune booster and immunogenic properties of these candidate species have been investigated [37].

Neem (*Azadirachta indica*), one of the strongest candidates as herbal growth promoter, is known for its antifungal, antifertility, anti-inflammatory, antiulcerogenic,

antihyperglycaemic, antihypertensive, antihypercholestermic, hepatoprotective, immunostimulant, antioxidant, antigenotoxic and antibacterial. Neem leaves and its bark, flowers, seeds and oil has been studied for its medicinal properties. Numerous phytochemicals like isoazadirolide, nimbaflavone, nimbadiol, nimbinene, nimbolide, quercetin, quercitrin, rutin and vilasanin have been isolated from this plant and evaluated to have medicinal properties [37].

Moringa is a non-conventional vegetable protein source and can be used in poultry rations replacing canola meal [24]. It contains high quality protein and significant amount of essential amino acids for poultry [17]. Moringa has also been reported as hypocholesterolaemic, hypertensive [18], antiulcerative [31], diuretic and anti-inflammatory agent [38]. All these activities help in efficient functioning of liver in the body of broilers.

Chicory (*Cichorium intybus*) locally known as kasni, is another herbal medicinal plant commonly found in Pakistan having active ingredients as mucilage and resins [21]. All parts of chicory especially its leaves have medicinal properties and are known to have anti-bacterial, anti-inflammatory, anti-hypercholestermic, hepatoprotective, anti-oxidant, anti-genotoxic, anti-fungal, digestive, diuretic, immuno-stimulant, anti-cancer, anti-fertility, gastroprotective, laxative and cholagogic properties without any side effects [27].

It is, therefore, hypothesized that *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* leaf extracts having the medicinal/immunomodulator properties free from un-identified growth suppressing effects, can be good candidates for replacing antibiotic growth promoters. A project, therefore, was planned to study comparative effect of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* leaf extracts on hematology, intestinal histomorphology and digestibility of broilers.

## 2. Materials and Methods

### Performance trial

The research project was conducted at Animal Nutrition Research Center, IANFT, University of Agriculture, Faisalabad. Total duration of the project was 35 days. The detail of the materials and methods used in this project was as under:

*Azadirachta indica*, *Cichorium intybus* and *Moringa oleifera* leaves were collected, dried under shade and sliced without washing for making leaf powder. Thereafter, these leaf powders were added @ 4 g (*Azadirachta indica*), 2 g (*Cichorium intybus*) and 6 g (*Moringa oleifera*), each into 100 ml of distilled water and extracted at 80 °C for 3 hours at pH 7 [2]. The extracts thus prepared were filtered and then cooled to room temperature for 48 hours.

One hundred eighty, day old broiler chicks purchased from a local hatchery were reared in a group, on commercial broiler starter ration for one week (adaptation period). At day

8, these chicks were individually weighed and 120 chicks of middle weight range were used as experimental birds. These chicks were randomly divided in to twelve replicates (10 chicks/ replicate). These replicates were further allotted to four treatments groups (A, B, C and D) in such a way that each treatment received three replicates.

Two experimental rations (starter and finisher) were prepared and offered *ad libitum* to the chicks (Table 1). Starter ration was fed from 0-3 and finisher from 4-5 weeks of age.

**Table 1.** Proportion and chemical composition of ingredients used in experimental rations

Ingredients	Starter Ration (%)	Finisher Ration (%)
Maize	36	35
Wheat	10	10
Rice polish	5	5
Rice broken	5	8
Wheat bran	3	6
Guar meal	3	2
Sunflower meal	6	5
Corn gluten 60%	6	5
Soybean meal	10	10
Fish meal	8	6
Soya oil	3	3
Molasses	3	3
Lime stone	1.16	1.16
Mono & di-calcium phosphate	0.167	0.167
Pre-mix	0.5	0.5
Salt	0.173	0.173
Total	100	100
Chemical composition		
Crude protein %	22	20
Metabolizable energy Kcal/Kg	3100	3000
Crude fiber %	4.18	4.55

The birds in various groups were offered water, according to the following plan.

Group A (Control)	Fresh clean water, without supplementation
Group B	Fresh clean water + Neem leaf extract @ 50 ml/liter
Group C	Fresh clean water + Chicory leaf extract @ 10 ml/liter
Group D	Fresh clean water + Moringa leaf extract @ 30 ml/liter

Experimental room was thoroughly cleaned, white washed, disinfected and fumigated before arrival of chicks. The birds in each replicate were reared in separate pens measuring 4×3 sq.ft. These birds were reared under the same management conditions like temperature, relative humidity, ventilation,

floor space and light, throughout the experiment. All the birds were vaccinated against Newcastle disease and Infectious Bursal disease according to a recommended schedule.

At the end of trial, blood samples (5 ml each) from 4 birds/replicate were collected in sterilized disposable syringes. The serum was collected from two blood samples/replicate in sterilized serum cups and frozen (-20° C) till analyzed for the determination of blood glucose and cholesterol by using standard kit (Biomega) method in biochemistry analyzer (Techno-786). The rest two blood samples of each replicate were taken in EDTA tubes for PCV and Hb analysis. Hemoglobin concentration (Hb) and packed cell volume (PCV) was determined by Hematology analyzer (Sysmax KX-21). Differential leukocyte count of the blood samples were obtained using compound microscope.

At the end of trial, two birds from each replicate were randomly picked up, individually weighed and slaughtered for intestinal histomorphology analysis. Samples from distal portion of duodenum, jejunum and ileum of small intestine (without material) were collected from slaughtered birds and fixed in 10 % buffered formalin saline. These intestinal segments were dehydrated by immersing through a series of alcohols of increasing concentrations (from 70% to absolute), infiltrated with xylene and embedded in paraffin wax. A micrometer was used to make cuts of 5µm which were mounted on glass slides and stained with hematoxylin-eosin. Three slides per intestinal segment were prepared for microscopy and three values per tissue (i.e. villus height, crypt depth and villus surface area) per intestinal segment were measured to take an average value. The values were measured using a light microscope [7]. Application of Image was run for biometry.

#### Digestibility trial

A separate digestibility trial was conducted on twenty chicks (5 chicks/treatment) obtained from the same batch as

was used for performance trial. These chicks were maintained separately in individual metabolic cages and were fed as described in the plan of work. However, from day 21, these birds were fed same amount of experimental rations for next seven days. Thereafter, the collection trays were put under each cage and droppings were collected for 48 hours (28<sup>th</sup>-29<sup>th</sup> day of age) to determine nutrient digestibility as described by Leeson and Summers [23]. The droppings thus collected were homogenized separately for each treatment and then were stored in airtight plastic bags. These samples were frozen till analyzed for crude protein, crude fiber and ether extract as described by A.O.A.C. [1].

#### Statistical analysis

Data collected was analyzed using Analysis of Variance Technique under Completely Randomized Design. Treatment means were compared by Least Significance Difference [36].

### 3. Results and Discussion

Statistical analysis of hematology data showed that supplementation of different herbal leaf extracts exhibited a significant ( $P < 0.05$ ) effect on blood glucose, cholesterol and red blood cells. The results revealed a significant ( $P < 0.05$ ) decrease in blood glucose and cholesterol in the birds of treatment group B and C which were offered drinking water supplemented with extract of *Azadirachta indica* @ 4% and *Moringa oleifera* @ 6 %, respectively. However, Red blood cell count significantly ( $P < 0.05$ ) increased in the birds of treatment group B, offered drinking water supplemented with extract of *Azadirachta indica* @ 4%. Whereas, hemoglobin, white blood cell and packed cell volume remained unaffected due to the addition of these herbal plants leaf extracts. (Table 2).

**Table 2.** Blood hematological mean values of Glucose, Cholesterol, Hb, PCV, RBCs and WBCs of broiler offered drinking water with herbal plants leaf extract

Variables	Treatments				S.E
	Control	B	C	D	
Blood Glucose(mg/dl)	209.00 <sup>a</sup>	190.00 <sup>c</sup>	204.83 <sup>ab</sup>	195.66 <sup>bc</sup>	2.722
Cholesterol (mg/dl)	136.00 <sup>a</sup>	125.667 <sup>b</sup>	124.00 <sup>b</sup>	125.00 <sup>b</sup>	1.830
Hemoglobin (g/dl)	9.36	10.11	9.66	10.35	0.306
Packed cell volume %	27.86	30.71	28.66	31.00	1.509
Red blood cell %	2.10 <sup>b</sup>	2.28 <sup>a</sup>	2.13 <sup>a</sup>	2.21 <sup>a</sup>	0.153
White blood cell %	203.51	238.00	207.00	225.00	8.380

Values within the same row which have different superscripts are significantly different ( $P < 0.05$ )

The results of the present are compatible with those observed by Velasco *et al.* [39] and Rezaei *et al.* [32] who observed reduction in blood glucose level in broilers. This may be due to the suppressive effect of herbals plants leaf extracts on glucagon, which otherwise increases blood glucose in chickens, thereby maintaining blood glucose homeostasis. Similar results have also been observed by Miao *et al.* [25] and Chen *et al.* [11] in broilers who observed that addition of different herbal plants leaf extracts as antibiotic replacer significantly decreased the total blood cholesterol level of the experimental birds. The present results are in line with the findings of Olugbemi *et al.* [30], who studied the supplementation of herbal plants leaf extracts in broilers and its influence on blood hematology. It was reported that hemoglobin was not affected significantly due to the supplementation of these extracts. These results are compatible with those observed by Olugbemi *et al.* [30] who reported that packed cell volume did not affect due to the supplementation of *Azadirachta indica* leaf extract. It was reported that white blood cells was not affected significantly due to the supplementation of neem leaf extracts.

Data regarding nutrient digestibility when subjected to statistical analysis revealed that addition of *Azadirachta indica*, *Cichorium intybus* and *Moringa oleifera* leaf extracts exhibited a significant ( $P < 0.05$ ) effect on crude protein digestibility of broilers in all treatment groups when compared to those of control groups. The results revealed significantly ( $P < 0.05$ ) higher digestibility of crude protein and crude fat in the birds of treatment group B which were offered drinking water supplemented with extract of *Azadirachta indica* @ 4%, as compared to those of other treatment groups. Whereas the lowest digestion of crude protein and crude fat was observed in the birds of control groups (A), offered drinking water without any supplementation. However, digestibility of CF remained unaffected due to the addition of different herbal plants leaf extracts, in all the treated groups (Table 3).

The results of the present study are in line with the findings of Nabizadeh [26] who reported that supplementation of herbal plants leaf extracts significantly ( $P < 0.05$ ) improved crude protein digestibility of the rations. Improved crude protein digestibility may probably be due to

increased amino acid digestibility in broilers. Similar results due to supplementation of herbal plants extracts to broiler were reported by Awad *et al.* [5] and found improve mucosal growth, villus height, width, crypt depth and villus height to crypt depth ratio, these factors may stabilize nutrients and increase the crude protein digestion and absorption. Similarly the results of the present study are in agreement with the finding of Awad *et al.* [5] who observed increase in the digestibility of crude fat in birds fed diet supplemented with different herbal plants (mint and garlic) leafs extracts. The result of present study are also in agreement with the finding of Durrani, [15] who observed higher digestibility of crude fiber and dry matter in the birds fed diet supplemented with Neem leafs infusion. Similarly, supplementation of ginger and kalongi [10] improved the crude fiber digestibility in broiler fed supplemented diets.

**Table 3.** Digestibility of crude protein, crude fiber and ether extract in broilers supplemented with different herbal plants leaf extract

Variables	Treatments				S.E
	A Control	B <i>Azadirachta indica</i>	C <i>Moringa oleifera</i>	D <i>Cichorium intybus</i>	
Crude protein	72.38 <sup>b</sup>	75.08 <sup>a</sup>	73.49 <sup>ab</sup>	74.48 <sup>a</sup>	2.168
Crude fiber	13.00	17.80	14.76	15.20	0.981
Ether extract	85.20 <sup>b</sup>	87.56 <sup>a</sup>	86.90 <sup>a</sup>	87.34 <sup>a</sup>	1.453

Values within the same row which have different superscripts are significantly different ( $P < 0.05$ )

Statistical analysis of intestinal histomorphology showed that addition of different herbals leaf extracts exhibited a significant effect on small intestinal histomorphology. Supplementation of these extracts in drinking water of the birds increased their villus height (0.96 to 5.2%), crypt depth (7.32 to 12.78%) and villus surface area (12 to 21.78%) in duodenal segment of their small intestine. Similarly jejunum segment of small intestine also revealed a significant increase in villus height (0.61 to 5.46%), crypt depth (6.22 to 13.16%) and villus surface area (17.56 to 24.63%) due the supplementation of the leaf extracts. Although ileum villus surface area increased significantly from 4 to 9.4 % but villus height and crypt depth remained unaffected due to the treatments (Table 4).

**Table 4.** Effect of different herbals plants leaf extracts on intestinal histomorphology of broiler

Variables		Treatment				SEM
		A	B	C	D	
Duodenum	Villus height ( $\mu\text{m}$ )	1331 <sup>b</sup>	1403 <sup>a</sup>	1345 <sup>b</sup>	1404 <sup>a</sup>	10.088
	Crypt depth ( $\mu\text{m}$ )	232 <sup>c</sup>	266 <sup>a</sup>	249 <sup>b</sup>	265 <sup>a</sup>	4.209
	Villus surface area ( $\text{mm}^2$ )	0.250 <sup>d</sup>	0.320 <sup>a</sup>	0.280 <sup>c</sup>	0.300 <sup>b</sup>	1.235
Jejunum	Villus height ( $\mu\text{m}$ )	1142 <sup>c</sup>	1208 <sup>a</sup>	1149 <sup>c</sup>	1186 <sup>b</sup>	8.422
	Crypt depth ( $\mu\text{m}$ )	209 <sup>c</sup>	242 <sup>a</sup>	224 <sup>b</sup>	243 <sup>a</sup>	4.332
	Villus surface area ( $\text{mm}^2$ )	0.205 <sup>d</sup>	0.272 <sup>a</sup>	0.241 <sup>c</sup>	0.251 <sup>b</sup>	0.957
Ileum	Villus height ( $\mu\text{m}$ )	751	814	783	821	8.787
	Crypt depth ( $\mu\text{m}$ )	159	181	171	174	3.509
	Villus surface area ( $\text{mm}^2$ )	0.125 <sup>d</sup>	0.138 <sup>a</sup>	0.130 <sup>c</sup>	0.135 <sup>b</sup>	1.763

Values within the same row which have different superscripts are significantly different ( $P < 0.05$ )

The results of the present study are in agreement with the findings of Debnath *et al.* [13] who observed that supplementation of herbal growth promoter (AV/AGP/10) @ 250 g/ton of feed significantly increased the duodenum villus length, crypt depth and increased villus surface area in broilers. Similarly, supplementation of *Azadirachta indica* @ 10 g/kg [35] and Fructo-oligosaccharide @ 0.4% significantly increased jejunum villus's height, crypt depth and increased villus surface area of broilers.

Reduction of *E. coli* in intestine has been shown to result in higher villus length, crypt depth and increased villus surface area. *Azadirachta indica*, *Chicory intybus* and *Moringa oleifera*, having antimicrobial activity against a wide range of microorganisms [14] are known to suppress *E. coli* count in small intestine and cecum of broilers. Therefore, antimicrobial activity of the herbal plant extracts used in this study, might be the cause of increased villus height, crypt depth and villus surface area, resulting in better intestinal health of the experimental birds. Another probable cause of increased gut health (villus height, crypt depth and villus surface area) may be the presence of Cu in *Moringa oleifera* (1.1mg/100 g) and *chicory intybus* (1.5mg/100 g), as has been observed by Ayssiwede *et al.* [6]. Because supplementation of Cu into broiler diet has shown to reduce intestinal bacteria, exhibiting an improvement in intestinal histomorphology. They also observed that the birds fed diet supplemented with Cu-MMT showed higher villus height and crypt depth because Cu-MMT had surplus positive charge and the antimicrobial effect of Cu<sup>+</sup> ion on bacteria can reduce bacterial activity in intestine, thus leading to improved intestinal morphology. Therefore, it is quite possible that improvement in histomorphology of the broilers in this study may be due to the effect of copper present in these herbals plant extracts.

#### 4. Recommendations

Supplementation of *Azadirachta indica* leaf extracts @ 4% (group B) exhibited better nutrient digestibility of crude protein and ether extract of the rations fed to the birds in treated groups coupled with improved intestinal histomorphology and hematological parameters studied. Therefore, use of *Azadirachta indica* leaf extracts in broiler is recommended as inexpensive and efficient growth promoting agent without residual effects like antibiotic growth promoter.

#### REFERENCES

- [1] A.O.A.C. 2000. Association of Official Analytical Chemist. Official Methods of Analysis. 15<sup>th</sup> edition, Arlington, Virginia, Washington D.C.
- [2] Amer, H., W. A. Helmy and H. A. A. Taie. 2010. *In vitro* antitumor and antiviral activities of herbal plant seeds and leaves extracts. Int. J. Acad. Res. 2: 47-51.
- [3] Anonymous. 2011. Ban on antibiotic as growth promoters in animal feed enters into effect. (Accessed on 14.11.2011).
- [4] Ansari, J. Z., A. Haq, M. Yousaf, T. Ahmad and S. Khan. 2008. Evaluation of different medicinal plants as growth promoters for broiler chicks. Sarhad J. Agri., 24: 323-329.
- [5] Awad, W. A., K. Ghareeb and J. Bohm. 2011. Evaluation of the chicory inulin efficacy on ameliorating the intestinal morphology and modulating the intestinal electrophysiological properties in broiler chickens. J. Anim. Physiol. Anim. Nutr. 95: 65-72.
- [6] Ayssiwede, S. B., J. C. Zanmenou, Y. Issa, M. B. Hane, A. Dieng, C. A. A. M. Chrysostome, M. R. Houinato, J. L. Hornick and A. Missohou. 2011. Nutrient composition of some unconventional and local feed resources available in Senegal and recoverable in indigenous chickens or animal feeding. Pak. J. Nutr. 10: 707-717.
- [7] Bancroft, J. D. and A. Stevens. 1990. Theory and practice of histological techniques. Churchill Livingstone, Edinburgh, London, Melbourne and New York.
- [8] Behboud, J., R. Ali and H. Elmira. 2011. Comparative effect of Chicory (*Cichorium intybus L.*) and *Nigella sativa* extract with an antibiotic on different parameters of broiler chickens. J. Appl. Environ. Biol. Sci. 1: 525-528.
- [9] Bhatti, M. Y. 2011. Emerging prospects of poultry production in Pakistan at the dawn of 21<sup>st</sup> century. Veterinary News and Views (Special Edition), Vol. 06 Sept., 24-30.
- [10] Biu, A. A., S. D. Yusuf and J. S. Rabo. 2009. Studies on the effect of aqueous leaf extract of neem (*Azadirachta Indica A. Juss*) on hematological parameters in chicken. J. Afri. Sci., 10: 189-192.
- [11] Chen, Y. C., C. Nakthong and T. C. Chen. 2005. Effects of chicory fructans on egg cholesterol in commercial laying hen. Int. J. Poul. Sci. 4: 109-114.
- [12] Coles, E. H. 1991. Veterinary Clinical Pathology. 4<sup>th</sup> ed. W. B. Saunders Company, London. pp: 280-293.
- [13] Debnath, B. C., K. B. D. Choudhary, K. Ravikanth, A. Thakur and S. Maini. 2014. Comparative efficacy of natural growth promoter with antibiotic growth promoter on growth performance and intestinal morphometry in broiler birds. Int. J. Pharmacol. Sci. pp. 2249 -5738.
- [14] Devendra, B. N., N. Srinivas, V. S. S. L. Prasad, P. S. Talliuri and Latha. 2011. Antimicrobial activity of *Moringa olifera* leaf extract against selected bacterial and fungal strains. Int. J. Pharmacol. Bio. Sci. 2: 32-37.
- [15] Durrani, F. R., N. Chand, M. Jan, A. Sultan, Z. Durrani and S. Akhtar. 2008. Immunomodulatory and growth promoting effect of neem leaves infusion in broiler chicks. Sarhad J. Agri., 24: 655-659.
- [16] Esonu, B. O., M. N. Opara, I. C. Okoli, H. O. Obikaonu, C. Udedibie and O. O. M. Iheshiulor. 2006. Physiological response of laying birds to neem (*Azadirachta Indica*) leaf meal-based diets: body weight organ characteristics and haematology. Online J. Health Allied Sci. 2:4. (<http://www.ojhas.org/issue18/2006-2-4.htm>).
- [17] Foidl, N. and R. Paull. 2008. *Moringa oleifera*. In: Encyclopedia of Fruit and Nuts. CABI, Oxfordshire, UK. pp.

- 509-512.
- [18] Gilani, A. H., K. Aftab, A. Suria, S. Siddiqui, R. Saleem, B. S. Siddiqui and S. Faizi. 1994. Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from *Moringa oleifera*. *Phytotherapy Res.* 8: 87-91.
- [19] Government of Pakistan (GOP), 2012-2013. Pakistan Economic Survey. Ministry of Finance, Govt. of Pakistan, Islamabad. ([http://finance.gov.pk/survey\\_1213.html](http://finance.gov.pk/survey_1213.html)) accessed on 20-09-2103.
- [20] Izadi, H., J. Arshami., A. Golian and M. R. Raji. 2013. Effects of chicory root powder on growth performance and histomorphometry of jejunum in broiler chicks. *Vet. Res. Forum.* 4: 169-174.
- [21] Kalantari, H. and M. Rastmanesh. 2009. Protective property of *Cichorium intybus* CC14 induced liver damage in mice. *Arch. Iran. Med.* 3: 46-47.
- [22] Kucukersan, M. K., B. H. Koksall and K. Cakin. 2011. Effects of dietary L-carnitine and/or inulin supplementation on growth performance, carcass traits, visceral organs and some blood biochemical parameters in broilers. Department of Animal Nutrition and Nutrition Disease, Faculty of Veterinary Medicine. Ankara University. 11: 552-557.
- [23] Leeson, S. and J. D. Summers. 2001. Determination of digestibility. In: *Nutrition of the Chicken*. 4<sup>th</sup> ed. International Book Distributing Company (Publishing Division) Charbagh, Lucknow, India. pp. 533-534.
- [24] Liaqat, S. 2012. Effect of replacement of canola meal with *Moringa oleifera* leaf meal on blood hematology, immune response and performance of broilers. M.Sc. (Hons) thesis, Department of Poultry Science. University of Agriculture, Faisalabad.
- [25] Miao, X., H. U. Tianming, Z. Cunlin, W. Quanzhen, S. Changhui and S. Weize. 2008. Effect of water-soluble extract of Chicory on slaughter performance and lipid metabolism of broilers. *Academic J. Electronic Magazine*, Northwest A&F University, Yangling Shaanxi 712100, DFA. 31650.
- [26] Nabizadeh, A. 2012. The effect of inulin on broiler chicken intestinal microflora, gut morphology and performance. *J. Anim. Feed Sci.* 21: 725-734.
- [27] Nandagopal, S. and B. D. Rangita. 2007. Phytochemical and antibacterial studies of chicory (*Cichorium Intybus L.*) a multipurpose medicinal plant, *J. Adv. Biol. Res.* 2: 17-21.
- [28] Nidaullah, H., F. R. Durrani and S. Gul. 2010. Aqueous extract from different medicinal plants as anticoccidial, growth promotive and immunostimulant in broilers. *J. Agri. Bio. Sci.* 5: 53-59.
- [29] Ogbe, A. O. and J. P. Affiku. 2013. Effect of polyherbal aqueous extracts (*Moringa oleifera*, Gum arabic and wild *Ganoderma lucidum*) in comparison with antibiotic on growth performance and haematological parameters of broiler chickens. *Res. J. Recent Sci.* 1: 2277-2502.
- [30] Olugbemi, T. S., S. K. Mutayoba and F. P. Lekule. 2010. Effect of *Moringa (Moringa oleifera)* inclusion in cassava based diets fed to broiler chickens. *Int. J. Poult. Sci.* 9: 363-367.
- [31] Pal, S. K., P. K. Mukherjee and B. P. Saha. 1995. Studies on the antimicrobial action of the leaf extract of *Moringa oleifera* Lam. *Ancient Sci. Life.* 14: 197-199.
- [32] Rezaei, M., A. Attar, A. Ghodrathnama and H. Kermanshahi. 2010. Study the effects of different levels of fat and chicory inulin on performance, carcass characteristics and serum composition of broiler chicks. *Int. J. Poul. Sci.* 2: 178-182.
- [33] Rehman, H., W. Vahjen, A. K. Parisini, A. Ijazi and J. Zentek. 2012. Influence of fermentable carbohydrates on the intestinal bacteria and enteropathogens in broilers. M. Sc. thesis, Department of Physiology and Biochemistry, Faculty of Biosciences, University of Veterinary and Animal Sciences, Lahore, Pakistan.
- [34] Rehman, Z., B. Aslam and T. Khaliq. 2010. *Manual of Physiology-1*. Department of Physiology and Pharmacology, University of Agriculture, Faisalabad.
- [35] Rehman, H., P. Hellweg, D. Taras and J. Zentek. 2008. Effects of dietary inulin on the intestinal short chain fatty acids and microbial ecology in broiler chickens as revealed by denaturing gradient gel electrophoresis. *J. Poult. Sci.* 87: 783-789.
- [36] Steel, R. G. D., J. H. Torrie and D. A. Dickey. 1997. *Principles and Procedures of Statistics. A biometric approach* (3<sup>rd</sup> Ed.). McGraw Hill Book Comp. Inc. New York, USA.
- [37] Subapriya, R. and S. Nagini. 2005. Medicinal properties of neem leaves: A Review of Current. *Medicine Chemistry – Anti-Cancer Agents.* 5: 149-156.
- [38] Udupa, S. L. and A. L. Udupl. 1994. Studies on the anti-inflammatory and wound healing properties of *Moringa oleifera* and *Aeglemarmelos*. *Fitoterapia* 65: 119-123.
- [39] Velasco, S. L. T. Ortiz, C. Alzueta, A. Rebole, J. Trevino and M. L. Rodriguez. 2010a. Study the effects of different levels of fat and chicory inulin on performance, carcass characteristics and serum composition of broiler chicks. *Int. J. Poult. Sci.* 89: 1651-1662.
- [40] Xia, M. S., C. H. HU and Z. R. XU. 2004. Effects of copper-bearing montmorillonite on growth performance, digestive enzyme activities and intestinal microflora and morphology of male broilers. *Poult. Sci.* 83: 1868-1875.
- [41] Zanu, H. K., P. Asiedu, M. Tampuori, M. Abada and I. Asante. 2011. Possibilities of using *Moringa oleifera* leaf meal as a partial substitute for fish meal in broiler chickens diets. *J. Anim. Feed. Res.* 1: 70-75.