Research & Reviews: Journal of Food and Dairy Technology

e-ISSN:2321-6204
p-ISSN:2347-2359

Effects of *Boswellia Carterii And Boswellia Serrata* in Drinking Water on the Growth Performance, Hematology Traits and Immune Response of Broiler Chicken

Al-Yasiry RMA[1,2], Jawad SAH[3,4]*, Menati KJ[5], Naji SA[5] and Lokman IH[3]

[1]Institute of Animal Nutrition and Bromatology, Faculty of Biology and Animal Breeding, University of Life Sciences, Lublin, Poland

[2]Department of Animal Resources, Faculty of Agriculture, University of Wasit, Iraq

[3]Department of Veterinary Preclinical Sciences, Faculty of Veterinary Medicine, University Putra Malaysia, Malaysia

[4]Department of Animal Production, Faculty of Agriculture, Baghdad University, Iraq

[5]Department of Animal Resources, Faculty of Agriculture, University of Al-Muthna, Iraq

Research Article

Received Date: 14/10/2016
Accepted Date: 21/11/2016
Published Date: 27/11/2016

***For Correspondence**

Jawad SAH, Department of Animal Production, Faculty of Agriculture, Baghdad University, Iraq, Tel: 00964-7735210728

E-mail: dr.hassan198366@yahoo.com

Keywords: *Boswellia. carterii*, *Boswellia. serrata*, Growth performance, Blood profile, Immune responses, Drinking water, Serum

ABSTRACT

A total of 300 Ross 308 broiler chickens, 7 days old, comprised the subjects in this study. They were randomly distributed into 5 treatments of 3 replicates each (15 bird/rpt). *Boswellia* was ground and mixed in drinking water of chickens during the whole period of the experiment, which lasted for 35 days, at levels of 0g (T1: Control), 2 g *Boswellia carterii*/l liter water (T2), 3 g *Boswellia. carterii*/l liter water (T3), 2 g *Boswellia. serrata*/l liter water (T4), and 3 g *Boswellia.serrata* / l liter water (T5). Growth performance parameters which included body weight, weight gain, feed intake, feed conversion ratio, mortality and EBI were reported every week during the experiment. Moreover, three birds per replicate, 35 days old, were slaughtered to assay the hematological characteristics and immune response parameters. The results tevealed that the fifth treatment (3gBs/l water) showed considertable improvement ($P<0.05$) in productivity traits (body weight, weight gain), hematological traits (RBC count, Hb concentration, PCV volume, total protein, globuline), and immune responses (Antibody titers against avian influenza virus, DTH test and bursa ratio) and decreased ($p>0.05$) feed intake, feed conversion ratio, albumin, glucose and cholesterol, followed by T4, T3, T2 respectively in comparison with control (T1). It was concluded that broilers that received Boswellia (BC, BS) especially T5 could have positively affected growth performance and well being of the broiler chickens.

INTRODUCTION

Medicinal plants and herbs have been used for centuries as traditional medicine for the healing of human ailments ad as health promoters. It is therefore no surprising that in recent years the use of medicinal plants and herbs has grown in popularity due to their low side effects and the presence of a wide range of beneficial compounds, as has been recommended by the World Health Organization (WHO) [1].

The acceptance and use of alternative medicine is on the rise, especially in developing countries following the directives from the WHO, resulting in the publication of numerous pre-clinical and clinical studies that have given scientific credence to the efficacy of numerous plants and herbs used in traditional folk medicine to treat infections [2]. In this context therefore, vegetables, herbs, spices and edible plants have been suggested as non-traditional feed additive or growth promoters in broiler diets to enhance the growth feed conversion efficiency and also, minimize feed cost [3,4]. Furthermore, the application of herbal plants in broiler diets to promote growth has been observed to significantly improve broilers' body weight gain, reduce the mortality rate and significantly improve feed conversion [5]. Earlier research has shown that the supplementation of herbs in broiler diets has had

e-ISSN:2321-6204
p-ISSN:2347-2359

significant positive effect on production performance and carcass quality [6-8]. Besides, several countries have limited or prohibited the use of chemicals due to their negative side effects on both the animals and on humans. This is another steps towards the encouraging the use of natural supplements as growth promotors [9].

Boswellia, also known as frankincense or olibanum is an aromatic material that has been used through the ages aas incense in Mesopotamia, Egypt, Greek and Rome. It comes from the resin of trees of the genus *Boswellia* (Burseraceae family), and mainly produced by four species, including *Boswellia serrata* in india, Boswellia carterii in East Africa and China, *Boswellia frereana* in Somalia and *Boswellia sacra* in Northern Africa and Arabia. Each of these produces a resin that is different due to variations in soil and climate. *Boswellia serrata* is an important component in Ayurvedic medicine as an antiarthritic, astringent, stimulant, expectorant, and antiseptic agent [10] while *Boswellia carterii* is primarily used in traditional Chinese medicine to ease pain and treat inflammation and for cancer [11]. The last 20 years have seen boswellia gaining the attention of scientists and the pharmaceutical industry to better define its medical effects and establish the constituents responsible for these effects. As a result, there have been numerous researches that have reported on the anticancer, anti-inflammatory, immunomodulatory, antimicrobial and antiviral activities of various *Boswellia* species [12-19]. Boswellia resin is a mixture containing more than 200 different substances [20] for instance: resin, sugar, essential oils, proteins, and inorganic compounds [21]. *Boswellia carterii and Boswellia serrata* possess the active pentacyclic triterpene acids α- and β- boswellic acid, 11-keto-β-boswellic acid, acetyl-11-keto-β-boswellic acid, acetyl-11-dien- β-boswellic acid, acetyl-α-boswellic acid and acetyl-β-boswellic acid. Acetyl-11-keto-β-boswellic acid (AKBA) is known to be the main constituent in boswellia [22,23]. The primary difference between resin B. carterii and B. serrata is the higher content of proteins (22%) for *B. serrata* than (6%) for B. carterii [24]. On the other hand, to our best knowledge, there have been no studies on the effects of Boswellia on broilers, and this current study was undertaken to determine the effect of supplementation of *Boswellia carterii and Boswellia serrata* on growth performance, Blood profile and immune responses in broiler chickens when used as supplements in drinking water.

MATERIALS AND METHODS

Animals and Dietary Treatments

A total of 300 day-old broiler chickens of mixed sex (Ross-308) were weighted and randomly allocated to five treatment groups, each with 3 replicates of 20 chicks. Boswellia was ground into powder and mixed with drinking water 12 hours before (to ensure solubility) and supplemented to the drinking water of chicks during the whole period of the experiment, which lasted 35 days, at levels of 0 g (T1; Control), 2 g Bc/ l liter water (T2), 3 g Bc / l liter water (T3), 2 g Bs/ l liter water (T4), and 3 g Bs / l liter water (T5). Boswellia (Bc, Bs) was added to drinking water from the age of 7 days and until the end of the experiment. The basal diet **(Table 1)** was formulated according to nutrient requirements of broilers recommended by National Research Council (NRC) [25]. From day 1 to day 14 the birds were fed a starter diet, and from day 15 to day 35. All the dietary treatments were added to the basal diets in place of corn. Chicks were raised on floor pens (120 cm x 120 cm x 80 cm) for 5 weeks and throughout the whole experimental period, there was free access to feed and water. The lighting regime was 23 h light followed by 1 h of darkness while ambient temperature in experimental house was a constant 32°C for the first week and gradually lowered by 3°C in weeks 2 and 3 before being fixed at 22°C until the end of the experiment.

Table 1. Composition of basal diet.

Item,%	Starter%	Grower%
	1 to 21 d	22-35 d
Yellow corn, ground	56.0	64.80
Soybean meal (44%CP)	29.0	23.65
Corn gluten meal (60%CP)	8.20	5.80
Vegetable oil	3.40	2.40
Di – calcium phosphate	1.80	1.30
Calcium carbonate	0.90	1.30
Sodium chloride	0.30	0.30
Vit. and Min. premix *	0.30	0.30
DL – Methionine	0.10	0.05
L-Lysine	0.00	0.10
Total	100	100
Calculated analysis (%)**		
CP Crude protein	22.51	19.53
EE Ether extract	2.620	2.840
CF Crude fibre,	2.470	2.420
Ca	0.869	0.906
Available P	0.444	0.346
Methionine	0.515	0.411
Methionine +Cystine	0.944	0.781

e-ISSN:2321-6204
p-ISSN:2347-2359

Lysine	1.088	1.010
ME, K cal/Kg	3109	3150

Each 3.0 kg of the Vit. and Min. premix contains : Vit. A, 12000000 IU; Vit. D3 2500000. IU; Vit. E, 10 g; Vit. K, 2.5 g; Vit. B1, 1.5 g; Vit. B2, 5 g; Vit. B6, 1.5 g; Vit. B12, 10 mg; Choline chloride, 1050 g; Biotin, 50 mg; Folic acid, 1 g; Nicotinic acid, 30 g; Ca pantothenate, 10 g; Zn, 55 g; Cu, 10 g; Fe, 35 g; Co, 250 mg; Se, 150 mg; I, 1 g; Mn, 60 g and anti-oxidant, 10 g.

**According to NRC [25].

Performance

Body weights of broilers were recorded at 14, 21, 28, and 35 days of age. Feed intake and weight gain were documented in different periods, and FCR was computed. Mortality was accordingly documented as it occurred and adjustments made on the basis of the total number of birds to determine the total feed intake per bird and FCR.

Blood Parameters

The prepared emulsions were fish/algal oil with antioxidants in combinations transformed into microencapsulated powder using the table top spray drier equipped with an anti-blocking device operated under the influence of compressed air (to avoid the blockage during spray drying) (M/s. Basic Technologies Pvt. Ltd., Kolkata) under standard conditions. The emulsion was sprayed into the chamber at a pressure of 2 kg/cm^2 (30 psi) through a one way nozzle (0.8 mm). The inlet and outlet temperature was maintained at 160°C and 70°C respectively. The microencapsulated powder (5g) each was filled in brown plastic containers and stored in refrigerator for 7 days.

Immune Responses

Humeral immunity, newcastle disease antibody titer: The commercially available oil-adjuvant injectable emulsion against Newcastle disease virus (NDV) was used to vaccinate broiler chicks. Injection was administered subcutaneously with 0.2 mL per chick at 9 day of age. Antibody titers against NDV, and relative weight of lymphoid organs (spleen, bursa of fabricius) were recorded as immune responses. At 35 days of age, three male broilers from each pen were randomly selected, and blood samples collected by puncturing the brachial vein and centrifuging the blood at 2000×g for 10 min. Then, the serum was collected and kept at -20°C until needed for analysis of antibody titers against NDV. Serum antibody titers against NDV were recorded using the hemagglutination inhibition test [26]. Hemagglutination inhibitions were then converted to log. Spleen and bursa were collected, weighed and computed as a percentage of live body weight after slaughtering three birds per replicate.

Delayed Type hypersensitivity (DTH) test: On day 35, 10 chickens from each group were injected with 100 µg/0.1 mL PHA antigen (Phytohemagglutinin PHA-P, Sigma) in PBS (Phosphate-Buffered Saline) Buffered Saline in the right wattle. The extent of swelling at the injection site was recorded after 24 h with a micrometer [27].

Statistically Analysis

The approach adopted was a completely randomized experimental design with the data statistically analyzed employing the General Linear Models (GLM) procedure of SAS software [28] for analysis of variance [29]. Multiple range test was used to establish the variances among treatment means, which were considered different at $p<0.05$ and $p<0.01$.

RESULTS

Performance

Body weight (BW)

The average live body weight at the periods of 14, 21, 28 and 35 d are shown in **Table 2**. Chickens that received two different levels of BC, BS in their drinking water showed no significant differences in BW at 14 days of age. However, the chicks that received 3 g Bs/l water showed significant differences ($p<0.05$) in BW at 14, 21,28 and 35 days of age in comparison with other treatments except T4, which did not differ from T5 at 21d. There were no significant differences of BW observed between T3, T4 at 28 and 35 d also between T1, T2, T3 at 21 d., but T1 was significant differences with T2 at 28, 35 d.

Table 2. Performance parameters of the broiler drinking water different levels of *Boswellia* (Bc, Bs) (Mean and SE).

Parameters	Day	Treatments				
		T1	T2	T3	T4	T5
BW (g)	14d	328.83 ± 1.67	333.14 ± 2.09	332.97 ± 1.87	329.91 ± 1.90	330.77 ± 2.01
	21d	725.73 ± 7.01 ^{c}	728.35 ± 6.13 ^{c}	734.64 ± 6.24 ^{bc}	735.92 ± 5.99 ^{a}	746.33 ± 6.86 ^{a}
	28d	1169.90 ± 10.02 ^{d}	1191.22 ± 9.66 ^{c}	1204.76 ± 11.23 ^{b}	1207.14 ± 10.56 ^{b}	1223.06 ± 10.78 ^{a}
	35d	1700.30 ± 13.57 ^{d}	1766.43 ± 13.70 ^{c}	1785.11 ± 13.88 ^{b}	1791.23 ± 14.46 ^{b}	1832.68 ± 14.17 ^{a}

e-ISSN:2321-6204
p-ISSN:2347-2359

BWG(g)	14d	212.83 ± 2.29	213.08 ± 1.72	211.61 ± 2.06	214.25 ± 1.15	211.28 ± 1.20
	21d	396.95 ± 2.29^{c}	395.21 ± 1.72 ^{c}	401.67 ± 2.06 ^{bc}	406.01 ± 1.15 ^{b}	415.56 ± 1.20 a
	28d	444.17 ± 3.26 ^{c}	462.87 ± 3.17 ^{b}	470.12 ± 2.84 ^{a}	471.22 ± 2.97 ^{a}	476.73 ± 2.83 ^{a}
	35d	530.40 ± 5.01 ^{d}	570.21 ± 5.13 ^{c}	580.35 ± 4.89 ^{b}	584.09 ± 4.74 ^{b}	609.62 ± 4.30 ^{a}
	1-35	1371.52 ± 11.03 ^{e}	1433.29 ± 12.15 ^{c}	1452.14 ± 12.44 ^{b}	1461.32 ± 12.68 ^{b}	1501.91 ± 11.77 ^{a}
FI (g)	14d	333.53 ± 29.17	332.39 ± 30.55	333.50 ± 30.71	335.43 ± 27.88	334.09 ± 29.72
	21d	653.87 ± 61.12	654.74 ± 60.31	657.23 ± 59.98	660.02 ± 61.18	665.34 ± 61.36
	28d	773.60 ± 70.19^{b}	780.280 ± 70.31 ^{ab}	785.640 ± 71.56 ^{a}	786.11 ± 71.34 ^{a}	788.52 ± 71.46 ^{a}
	35d	991.85 ± 90.55 ^{c}	1006.38 ± 94.18 ^{b}	1007.13 ± 92.48 ^{b}	1012.59 ± 90.25 ^{b}	1017.40 ± 92.30 ^{a}
	1-35d	2752.67c ± 112.07	2773.79b ± 145.08	2783.50b ± 109.45	2794.15 ab ± 127.59	2805.44a ± 150.43
FCR	14d	1.57 ± 0.01	1.56 ± 0.02	1.58 ± 0.02	1.57 ± 0.01	1.58 ± 0.02
	21d	1.65 ± 0.02	1.65 ± 0.01	1.64 ± 0.03	1.63 ± 0.03	1.60 ± 0.02
	28d	1.74 ± 0.02 ^{a}	1.69 ± 0.03 ^{ab}	1.67 ± 0.03 ^{b}	1.67 ± 0.04 ^{b}	1.65 ± 0.02 ^{b}
	35d	1.87 ± 0.03 ^{a}	1.76 ± 0.02 ^{b}	1.74 ± 0.03 ^{b}	1.73 ± 0.02 ^{b}	1.67 ± 0.01 ^{c}
	1-35d	1.71 ± 0.05 ^{a}	1.67 ± 0.03 ^{ab}	1.66 ± 0.04 ^{b}	1.65 ± 0.03 ^{b}	1.63 ± 0.03 ^{b}
Mortality (%)1-35d		1.67 ± 0.72 ^{a}	5.00 ± 0.39 ^{a}	3.33 ± 0.26 ^{b}	3.33 ± 0.21 ^{b}	1.67 ± 0.13 ^{b}
EBI		265.14 ± 24.11 ^{d}	287.10 ± 20.18 ^{c}	297.02 ± 25.22 ^{b}	299.85 ± 24.58 ^{b}	315.88 ± 21.79 ^{a}

Mean values with ($^{a-d}$) superscript in row differ significantly at ($p<0.05$).

T1 served as control while T2, T3, T4 and T5 were kept on drinking water containing T2: 2 g (Bc), T3: 3 g (Bc), T4: 2 g (Bs), T5: 3 g (Bs).

Values (Mean ±SD) of each experimental day in each row followed by different letters differ significantly ($p<0.05$, $p<0.01$).

Body weight gain (BWG)

Table 2 shows that different levels of Bc, Bs added to drinking water made no significant differences in BWG at 14 days of age. Chicks that received 3 g Bs/l water) showed higher BWG ($p<0.05$) than other treatments during the period 21 to 35 days of age. However, there were no significant effects of BWG between T5 and T3, T4 at 28 d. but the highest value ($p<0.01$) of BWG was recorded in T5 (1501.91 g) at the total period of 1 to 35d.

Feed Intake (FI)

Data presented in **Table 2** shows no significant effects on FI for the period from 14 to 21 days of age. Birds receiving 3 g Bs/l in drinking water had higher FI ($p<0.05$) during the period of 28 to 35 days of age (788.52, 1017.40, respectively). However, the lowest FI was in control treatment (773.6, 991.85, respectively) during the period from 28 to 35 days of age. Whereas, no significant differences in FI among chicks that received 2,3 g Bc /l, 2 g Bs /l in drinking water from 28 to 35 days of age.

Feed Conversion ratio (FCR)

Table 2 shows no significant effects on FCR during the period from 14 to 21 days of age. Control treatment had higher FCR ($p<0.05$) during the period 28 to 35 days of age (1.74, 1.87, respectively). Nevertheless, the lowest FCR was in birds that received 3 g Bs/l in drinking water (1.65, 1.67, respectively) for the period from 28 to 35 days of age. Whereas, no significant differences in FCR for birds that received 2,3 g/l 3 g/l BC, 2 g/l BS in drinking water from 28 to 35 days of age.

Mortality percentage

Cumulative mortality percentage was calculated during the starting and finishing periods and presented in **Table 2**. Obtained results suggest that the percentage of mortality in T1, T2 was higher than in treatments T3, T4, T5 and statistically significant ($p<0.05$).

Economic Efficiency index (EBI)

Table 2 shows that EEI value at 35 days of age had a higher value (315.88) in birds that received 3 g Bs/l in drinking water in comparison with control, which had the lowest value (265.14), whereas, the other treatments T2, T3, T4 showed higher value (287.10, 297.02, 299.85, respectively) than control but lower than T5.

Blood Profile

The overall mean packed cell volume (PCV), Hemoglobin (Hb), total erythrocytes count (RBC) are given in **Table 3**. As can be seen from the table, mean PCV, Hb, RBC values were reduced significantly ($p<0.05$) in T1, T2, T3 and T4. However, PCV, Hb and RBC were significantly ($p<0.05$) increased in the birds which were offered drinking water supplemented with 3g Bs (T5) compared

e-ISSN:2321-6204
p-ISSN:2347-2359

to control treatment and other treatments, except T4, which did not show any significant differences with T5 in PCV.

Table 3. Haematological parameters of the broiler drinking water different levels of Boswellia (Bc, Bs) (Mean and SE).

Parameters	Treatments				
	T1	T2	T3	T4	T5
PCV (%)	3.110^{c} ± 29.53	2.560^{bc} ± 29.89	3.390^{ab} ± 30.18	3.220^{a} ± 30.29	2.160 ^{a} ± 30.87
Hb (g/dl)	5.914 ± 0.5780^{d}	6.228 ± 0.6600 ^{c}	6.513 ± 0.7870 ^{b}	6.580 ± 0.6130 ^{b}	6.893 ± 0.5440 ^{a}
RBC (x10^{3}/ mm^{3})	2.853 ± 0.3430^{d}	2.967 ± 0.4220 ^{cd}	3.22 ± 0.2470^{bc}	3.243 ± 0.3210 ^{b}	3.466 ± 0.1780^{a}

Mean values with ($^{a-d}$) superscript in row differ significantly at ($p<0.05$).T1 served as control while T2, T3, T4 and T5 were kept on drinking water containing T2: 2 g (Bc), T3: 3 g (Bc), T4: 2 g (Bs), T5: 3 g (Bs).

Values (Mean ± SD) of each experimental day in each row followed by different letters differ significantly ($p<0.05$). PCV: Packed cell volume, Hb: Haemoglobin, RBC: Red Blood Cell.

Blood Serum Constituents

Different biochemical parameters (total serum cholesterol, protein, albumin, globulin, glucose) are given in **Table 4**. The total serum cholesterol, albumin and glucose values decreased significantly throughout the experimental period in birds which were offered drinking water supplemented with BC, BS in comparison with control, which had high values in three qualities. However, the lowest values of cholesterol, albumin and glucose was recorded in T5 (3 g Bs/l water), whereas, total protein and globulin significantly ($P<0.05$) increased in the birds which were offered drinking water supplemented with 3 g Bs/l water compared to other treatments and control during the total period. However, the lowest value was recorded in control.

Table 4. Blood serum parameters of the broiler drinking water different levels of Boswellia (Bc, Bs) (Mean and SE).

Parameters	Treatments				
	T1	T2	T3	T4	T5
Cholesterol, mmol/L	105.18 ± 9.330^{a}	97.56 ± 10.020^{b}	94.7 ± 8.450^{c}	93.89 ± 9.340^{c}	87.47 ± 10.560^{d}
Total protein, g/L	5.875 ± 0.700 ^{d}	6.246 ± 0.660^{c}	6.518 ± 0.590 ^{b}	6.543 ± 0.740^{b}	6.988 ± 0.630^{a}
Albumin g/L	1.656 ± 0.020^{a}	1.593 b ± 0.030	1.544 ± 0.020 ^{c}	1.521 ± 0.030 ^{c}	1.437 ± 0.010 ^{d}
globuline g/L	3.91 ± 0.530 ^{d}	4.73 ± 0.460 ^{c}	5.08 ± 0.400 ^{b}	5.29 ± 0.520 ^{b}	5.74 ± 0.330 ^{a}
Glocuse (mg/dl)	340.37 ± 14.420 ^{a}	298.55 ± 12.890 ^{b}	226.65 ± 13.530 ^{c}	207.22 ± 15.300 ^{c}	193.17 ± 12.240 ^{d}

Mean values with ($^{a-d}$) superscript in row differ significantly at ($p<0.05$).T1 served as control while T2, T3, T4 and T5 were kept on drinking water containing T2: 2 g (Bc), T3: 3 g (Bc), T4: 2 g (Bs), T5: 3 g (Bs).

Values (Mean ± SD) of each experimental day in each row followed by different letters differ significantly ($p<0.05$).

Immune Responses

Table 5 shows the effects of treatments on immune response-related parameters. Antibody titer against NDV showed a significant ($p<0.05$) increase in birds, which were given drinking water supplemented with 3 g Bs/l water compared to other treatments and control. Control treatment showed a significant ($p<0.05$) decrease in Newcastle disease antibody titer in comparison with other treatments. DTH test indicated increased ($p<0.05$) values when broilers were given drinking water supplemented with 3 BS/l water compared with other treatments. Control treatment and T2 (2 g BC/l water) had lower ($p<0.05$) values in DTH test in comparison other treatments. Furthermore, the lymphoid organs which are related to immune response are shown in **Table 6**. According to **Table 6** the wright of the spleen did not differ significantly as a result of the dietary treatments, although bursa weights (%) were observed to be significantly ($p<0.05$) higher in chickens supplemented with T5 (3 g Bs/l water) compared to other treatments.

Table 5. Effect of *Boswellia* (Bc, Bs) in drink water on immune response of broilers at 35d (Mean and SE).

Parameters	Treatments				
	T1	T2	T3	T4	T5
Necastle disease antibody titer(Log2)	3.49 ± 270.80 d	3.53 ± 282.50 c	3.56 ± 313.30 b	3.56 ± 307 b	3.57 ± 242.1 a
DTH1test(mm)	0.389 ± 0.0230 d	0.446 ± 0.0260 c	0.494 ± 0.0240 b	0.502 ± 0.0310 b	0.541 ± 0.0220 a

Mean values with ($^{a-d}$) superscript in row differ significantly at ($p<0.05$).T1 served as control while T2, T3, T4 and T5 were kept on drinking water containing T2: 2 g (Bc), T3: 3 g (Bc), T4: 2 g (Bs), T5: 3 g (Bs).

Values (Mean ± SD) of each experimental day in each row followed by different letters differ significantly ($p<0.05$). [1]DTH: delayed type hypersensitivity test.

e-ISSN:2321-6204
p-ISSN:2347-2359

Table 6. Effect of *Boswellia* (Bc, Bs) in drink water on lymphoid organs on day 35(Mean and SE).

Parameters	Treatments				
	T1	T2	T3	T4	T5
Spleen*	0.13 ± 0.01	0.12 ± 0.01	0.11 ± 0.02	0.12 ± 0.01	0.11 ± 0.01
Bursa*	0.069 ± 0.001 c	0.075 ± 0.003 c	0.088 ± 0.002 b	0.090 ± 0.001 b	0.102 ± 0.002 a

Mean values with ($^{a-c}$) superscript in row differ significantly at ($p<0.05$).T1 served as control while T2, T3, T4 and T5 were kept on drinking water containing T2: 2 g (Bc), T3: 3 g (Bc), T4: 2 g (Bs), T5: 3 g (Bs).

Values (Mean ± SD) of each experimental day in each row followed by different letters differ significantly ($p<0.05$). * Percentage of live body weight.

DISCUSSION

Effect of Boswellia (BC, BS) on Broiler Performance

Boswellia carterii and Boswellia serrata positively affected body weight, weight gain, feed intake and E.B.I, especially among broilers that received 3 g Bs/l in drinking water through the experimental period. These findings may be attributed to the presence of boswellic acid which contains phenolic acid and is known to improve enhance protein and energy by decreasing microbial competition in the host for nutrients of subclinical infections and secretion of immune mediators and also by a decrease in the production of ammonia, as revealed in studies by Chevrier et al. [22] and Dibner and Buttin [30]. In this context [31] indicated that presence Boswellia in a digestible system is considered as a stimulant, gas repellent, an catalyst for appetite, and it increases the flow the digestive juices and thus leads to improvement process of digestion and absorption because it stimulates the secretion of pancreatic enzymes. These results are in harmony with [32] who reported that rats diabetic treated with BC for 30 days led to significant increase in body weight, liver glycogen ($P>0.01$). Contrary results by Pooja et al. [33] found that rats treated with a high dose (1000 mg BS/kg B. wt. /day) had a considerable reduction in body weight gain. In the current study, FCR had an important ($p<0.05$) effect on control in comparison with the other treatments. These results are inconsistent with Tabatabaei et al. [34] who reported that FCR in birds treated with 0.5% BS was higher than broilers fed in control during the grower period, but the best FCR was in birds treated with 0.15 BS for the total period whereas, the differences were not statistically significant. Boswellia effect on broilers' performance observed in this study is in line with previous findings that reported dietary supplementation with extracts of some plants enhanced growth performance and feed efficiency in broilers [35-37]. In addition, Khalaji et al. [38] suggested that plant extracts could enhance nutrient absorption due to greater villi length and crypt depth.

Effect of Boswella (BC, BS) on Serum Biochemical Profiles

Serum biochemical and heamatological profiles could be beneficial measures for the assessment of the safety or monitoring of harmful effects of boswellia on broilers health. Determining the impact of these boswellia (BC, BS) on the concentration of total protein, globuline, albumin, cholesterol and glucose can be achieved by evaluating the blood of the test subjects [39]. The effect of inclusion of 2, 3% BC and 2, 3% BS in drinking water for 6 weeks on broiler chickens was a significant rise in the serum total protein concentration in T5 in comparison with control **(Table 4)**, while the rest of the treated groups also showed significant increase in comparison with the control. These outcomes are opposed to those of Pooja et al. [33] who indicated that rats treated with *Boswellia serrata* at three different doses 100, 500 and 1000 mg/kg B.wt./day exhibited no changes in total protein in comparison with the control group animals. Also, Sakuntala et al. [40] indicated that using 100, 500 and 1000 mg/kg respectively of alcoholic extract of *Boswellia ovalifoliolata* orally for 28 days did not result in any significant difference in total protein between the treated and control groups. However, the results in the present study, similar to those of Zhang [41] who discovered that the concentration of total protein in serum of ginger-supplemented 5 g/kg of broiler diet was higher at 21 days and 42 days of age in comparison with that of control broilers. Thus, it can be suggested that elevated total serum protein level could be attributed to high level of protein and other nutrients in boswellia. This could be in line with the findings of Hoffman [42], who indicated that serum protein levels can be affected by nutritional influences. Notably the apparent higher total protein in serum blood for chickens treated with boswellia, may also have been responsible for an improved rate of BW and BWG [43].

The level of serum globulin showed significant ($p<0.05$) increase in groups that received 3 g Bs/l in drinking water compared to control, whereas, the other treatments with boswellia had also shown increasing significance compared with the control. The level of globulin was increased by adding experimental additives, which may indicate enhanced immunity for the birds. These results agree with those of AL-Homidan [44], who stated that the chicks fed *Zingiber officinale* at 2% for 7 weeks of the diet, were observed to have a higher value in the serum globulin concentration in comparison with the control broilers. The researcher attributed this increase of the serum globulin to the immunostimulant effect of *Zingiber officinale*. However, further studies on immunological parameters in boswellia for broilers are needed [45].

As presented in **Table 4**, the level of albumin indicates a significant ($p<0.05$) increase in the control group compared to the other treatments which showed significant decrease. These results may be indication of normal liver function from supplementation

e-ISSN:2321-6204
p-ISSN:2347-2359

of boswellia compare to the control group. The findings of this study are in agreement with those of Ademola et al. [46] who reported that broilers that received different levels of garlic and ginger (5, 10,15 g/kg 10,15 g/kg diet) showed a decrease in albumin concentration in treated groups compared to chicks used as control. Similar results were produced by. Mehdi et al. [47], who noticed that birds fed 4 g/kg cinnamon were not affect3e by the dietary treatments in their serum albumin. Likewise, Ali et al. [48], discovered that a diet of 0.2% *Cuminum cyminum* had no effect om chicks' plasma albumin concentration.

The level of total cholesterol showed a considerable increase in the control group while in comparison the lowest value was in the group that received 3 g Bs/l in drinking water. The other treated groups showed significant decrease in comparison with control. Our results were in agreement with those of Pandey et al. [49] who reported that the supplementation of *Boswellia serrata* gum resins extract 15 mg/100 g body wt for 90 days led to a reduction in serum cholesterol and increased HDL in rats. Similar results were obtained by Hazim et al. [50] who observed that birds treated with *Boswellia carterii* at levels of 0.5, 0.75 and 1 g/l in drinking water had significant ($p<0.05$) decrease in cholesterol, triglycerides and LDL. This suggests the possibility that *Boswellia serrata* supplementation restores β-cells function for insulin secretion, and that insulin helps to reduce serum lipid profiles [51]. Furthermore, Altman, et al. [14] mentioned that *Boswellia carterii* may have direct protective effect on β cells through its antioxidant action.

The blood-glucose levels showed significant ($p<0.05$) increase in the control group whereas the lowest value was in the group that received 3 g Bs/l water in drinking water in comparison with the control. However, the remaining treated groups showed significant decrease in comparison with control. Similarly, Hazim et al. [50], reported that drinking water of broiler chickens supplemented with different levels of *Boswellia carterii* powder caused significant decrease in blood plasma concentrations of glucose, at levels 0.5, 0.75 and 1 g/l. However, 0.75, 1 g/l water supplementation led to lower values of blood plasma concentrations of glucose. Ahangarpour et al. [52] also reported that 6 weeks supplementation of *Boswellia serrata* to type 2 diabetic patients, produced a very significant decrease in fasting blood glucose and an increase in insulin level. Similarly, aqueous extract of *Boswellia glabra* (*B. glabra Roxb*. (Also known as *B. serrata*) increased the synthesis of secretory granules in the beta-cell, and led to an increase in pancreatic enzyme resulting in reduced blood-sugar level [53].

Effect of Boswellia (BC, BS) on Hematological Parameters

From the results of hematological parameters, the indication is that red blood cells, packed cells volume and Hb have higher value ($p<0.05$) in T5 (3 g Bs/l water) than T4 and T3 compared with the control group (T1). These indicate that with the administration of *Boswellia serrata*, animals showed an improvement in major haematological parameters. It may be concluded that the *Boswellia serrata* has a positive effect on the health of animals. The results of this study concur with those of Sturikie et al. [54] who reported that improvements in digestion and absorption are accompanied by an increase of red blood cells because they are responsible for transporting food to the various cells of the body. However, our results are contrary to those of Pooja et al. [33] who observed that rats treated with *Boswellia serrata* with three different doses of 100, 500 and 1000 mg/kg/day orally did not show any changes in hematological parameters like WBC count, RBC count, hematocrit, and platelet count when compared with the control group with the exception of hemoglobin, which showed slightly higher values in the high-dose group. Likewise, Sakuntala et al. [40] found that rats treated with doses of 100, 500 and 1000 mg/kg respectively in alcoholic extract of *Boswellia ovalifoliolata* orally for 28 days showed no significant difference compared to the treated groups and control group in terms of the hematological parameters [54].

Effect of Boswella (BC, BS) on Immune Response

In immune response, boswellia affected the antibody titer against NDV, delayed type hypersensitivity (DTH), and relative weight of lymphoid organs (bursa) compared with control. It is unfortunate that to our best there have been no other available reports regarding the effects of boswellia (BC, BS) on birds' immunity. However, Sharma et al. [55] reported that rats treated with BAs at 25-100 mg/kg/day for 21 days showed increased body weight, total leukocyte counts, and primary and secondary antibody titers. Treatment with doses beyond 50 mg/kg/day, caused reduction of polymorphonuclear (PMN) and an increase in lymphocyte population. However, Chevrier et al. [22] found that *Boswellia carterii* dissolved in sesame oil in concentrations of 10 µg/ml to 50 µg/ml is immunomodulatory rather than immunosuppressive, as these concentrations simultaneously inhibit TH1 cytokine production and promote TH2 cytokine production. In the present study antibody titer against NDV and DTH tests was of higher value ($p<0.05$) in treatment T5 (3 g Bs/l water) and followed, in effectiveness by the other treated groups when broilers were offered drinking water supplemented with boswellia compared to control. Bursa weights were observed to be of higher value ($p<0.05$) for chickens which were offered drinking water supplemented with 3 gBs/l water and followed in effect (2 g Bs/l water) (3 g BC/l water) compared to control. As boswellia has been reported to have antifungal [56], antimicrobial [57], Antioxidant Activities [58], Anti-Inflammatory [59] and immunomodulatory [22], broilers have more resistance against diseases with larger bursa of fabricius [60]. Broilers have higher synthesis of immunoglobulins with larger bursa of fabricius [61] and higher antibody titers with birds having larger bursas [62]. Our results concur with those of Saeed et al. [63] who used different levels of chicory leaf extracts in drinking water and exhibited significant effect ($P<0.05$) on Newcastle disease (ND) titers. Similarly, birds treated with different levels of chicory extract were observed to have higher antibody titers. Aqueous extract of ginger rhizome mixed in water gives better performance as an immune stimulant against ND [64]. In the humoral defense system, a mixture of BAs at lower doses enhanced secondary antibody titers and in the cellular defense boswellic acids increase lymphocyte proliferation [65]. In contrast, *Boswellia serrata*

e-ISSN:2321-6204
p-ISSN:2347-2359

extract (BES) and constituents of BES reduce the cellular activity of the immune system by inhibiting the activation, proliferation and differentiation of B- and T- lymphocytes (IL-1, IL-2, IL-4, IL-6), tissue destruction (IL-1), action of NK-cells (IL-12), fever (IL-1, IL-6) and antibody production (IL-6) [66].

The delayed type hypersensitivity (DTH) test is a way to evaluate cell-mediated immunity *in vivo*. The study observed that DTH test was improved by boswellia (BS, BC) treatments, especially T5 (3g BS/l). Our finding is similar to that of Gayathri et al. [67] who indicated reported that *Boswellia serrata* extract exhibited anti-inflammatory in human peripheral-blood mononuclear cells (PBMCs) and mouse macrophages by inhibiting tumor necrosis factor-alpha (TNF-alpha), interleukin-1beta (IL-1beta) Banno et al. [68] also reported that boswellic acid extracts from *Boswellia carterii* have been shown to inhibit the production of inflammatory mediators, reduce the production of leukotrienes through its inhibitory action on lipoxygenase.

CONCLUSION

In conclusion, drinking water supplementation with different levels of boswellia (Bc,Bs) resulted in significant improvement to most of the rearing efficiency included within this study. Therefore, T5 (3 g Bs/l water) followed by other treatments with boswellia can be used as an efficient feed additive for the enhancement of general productivity traits and health status of birds.

REFERENCE

1. Kumar S and Rashmi KD. Evaluation of antidiabetic activity of Euphorbia hirta Linn in streptozotocin induced induced diabetic mice. Indian Journal of Natural Products and Resources. 2010;1:200-203.
2. Dilhuydy JM and Patients O. Attraction to complementary and alternative medicine (CAM): A reality which physicians can neither ignore nor deny. Bulletin du cancer. 2003;90:623-628.
3. Al-Harthi MA. Performance and carcass characteristics of broiler chicks as affected by different dietary types and levels of herbs and spices as non-classical growth promoters. Egyption Poultry Science. 2002;22:325-343.
4. Hassan II, et al. Influence of some medicinal plants on performance; physiological and meat quality traits of broiler chicks. Egypt. Poultry Science Journal. 2004;24:247-266.
5. Sabra KL and Mehta RK. A comparative study on additive of livol (Herbal growth) promoters and chemical growth promoters in the diets of broiler chickens. Indian journal of animal production and management. 1990;6:115-118.
6. Schleicher A, et al. Zastosowanie wybranych zioł w mieszankach tre ciwych dla kurcz_t rze_nych (The use of some herbs in concentrates for broiler chickens). Roczniki Naukowe Zootechniki. 1998;25:213-244.
7. Tekeli A, et al. Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Proceedings of 12th European Poultry Conference, Verona, Italy. 2006;307-308.
8. Tekeli A, et al. The use of Propolis as an alternative to antibiotic growth promoters in broiler diets. Proceedings of 23rd World's Poultry Congress, Brisbane, Australia. 2008;482.
9. Richmond A and Mackley CK. Herbs and spices. 2nd edn. Lorenz Books Anness Publishing Inc., London, UK; 2000.
10. Gupta I, et al. Effects of gum resin of Boswellia serrata in patients with chronic colitis. Planta Medica. 2001;67:391-395.
11. Bhanu P, et al. Antifungal, antiaflatoxin and antioxidant potential of chemically characterized Boswellia carterii Birdw essential oil and it's in vivo practical applicability in preservation of Piper nigrum L. fruits. LWT-Food Science and Technology. 2014;56:240-247.
12. Buchele B, et al. Characterization of 3alpha-acetyl-11-keto-alpha-boswellic acid, a pentacyclic triterpenoid inducing apoptosis in vitro and in vivo. Planta Medica-Natural Products and Medicinal Plant Research. 2006;72:1285-1289.
13. Buchele B, et al. Analysis of pentacyclic triterpenic acids from frankincense gum resins and related phytopharmaceuticals by high-performance liquid chromatography. Identification of lupeolic acid, a novel pentacyclic triterpene. Journal of Chromatography B. 2003;791:21-30.
14. Altmann A, et al. Coupling of boswellic acid-induced Ca2+ mobilisation and MAPK activation to lipid metabolism and peroxide formation in human leucocytes. British Journal of Pharmacology. 2004;141:223-232.
15. Akihisa T, et al. Cancer chemopreventive effects and cytotoxic activities of the triterpene acids from the resin of Boswellia carterii. Biological and Pharmaceutical Bulletin. 2006;29:1976-1979.
16. Borrelli F, et al. Effect of Boswellia serrata on intestinal motility in rodents: inhibition of diarrhoea without constipation. British journal of pharmacology. 2006;148:553-560.
17. Bruno M, et al. Extraction of Santalum album and Boswellia carterii Birdw. Volatile oil by supercritical carbon dioxide:

e-ISSN:2321-6204
p-ISSN:2347-2359

influence of parameters. Flavour and Fragrance Journal. 2006;21:718-724.

18. Alsaba F, et al. Acetyl-11-keto-β-boswellic acid (AKBA); targeting oral cavity pathogens. BMC Research Notes. 2011;4:406.
19. Al-Saidi K, et al. Composition and antibacterial activity of the essential oils of four commercial grades of Omani Luban, the oleo-gum resin of Boswellia sacra. Chemistry and biodiversity. 2012;3:615-624.
20. Kreck C and Saller R. Herbal drugs of foreign cultures and medical systems exemplified by Indian incense. Considerations regarding social and insurance medicine expert assessment. Versicherungsmedizin. 1999;51:122-127.
21. Ammon HPT. Boswellic acids (components of frankincense) as the active principle in treatment of chronic inflammatory diseases. Wiener medizinische Wochenschrift. 2002;152:373-378.
22. Chevrier MR, et al. Boswellia carterii extract inhibits TH1 cytokines and promotes TH2 cytokines in vitro. Clinical and diagnostic laboratory immunology. 2005;12:575-580.
23. Thorne Review. Boswellia serrata. Monograph Altern Med Rev. 2008;13:165-167.
24. Herrmann A, et al. Proteoglycans from Boswellia serrata Roxb and B. carteri Birdw and identification of a proteolytic plant basic secretory protein. Glycobiology. 2012;22:1424-1439.
25. NRC. Nutrient Requirements of Poultry. 9th Rev. edn. National Academy Press, Washington, DC; 1994.
26. Mond GA. Development of specific ELISA antibody Monoclonal antibody. Poultry Science. 1997;76:302-310.
27. Kegley EB and Spears JW. Immune response, glucose metabolism and performance of stressed feeder calves fed inorganic or organic chromium. Journal of animal science. 1995;73:2721-2726.
28. SAS. SAS /STAT User‘s Guide: Statistics Cary. SAS Institute Inc., NC, USA; 1996.
29. Duncan DB. Multiple range test and multiple F tests. Biometrics. 1955;11:1-42.
30. Dibner and Buttin. Use of Organic Acids as a Model to Study the Impact of Gut Microflora on Nutrition and Metabolism Oxford Journals. Poultry Science. 2002;11:453-463.
31. Rao RM, et al. Toxicity studies in mice of Commiphora molmol oleo- gum-resin. Journal of ethnopharmacology. 2001;76:151-154.
32. Eman GEH, et al. Effect Of Boswellia Carterii Birdw On Carbohydrate Metabolism In Diabetic Male Albino Rats. Egyption Journal of Hospital Medicine. 2005;20:38-45.
33. Pooja S, et al. A-90 Day Gavage Safety Assessment of Boswellia serrata in Rats. Toxicology international. 2012;19:273-278.
34. Tabatabaei SN, et al. Effect of different levels of Boswellia serrata Triana & Planch on immune responses of broilers chicks. Journal of Herbal Drugs (An International Journal on Medicinal Herbs). 2012;3:49-54.
35. Bampidis VA, et al. Effect of dietary dried oregano leaves on growth performance, carcase characteristics and serum cholesterol of female early maturing turkeys. British Poultry Science. 2005;46:595-601.
36. Griggs JP and Jacob JP. Alternatives to Antibiotics for Organic Poultry Production. The Journal of Applied Poultry Research. 2005;14:750-756.
37. Hernandez F, et al. Influence of two plant extracts on broilers performance, digestibility, and digestive organ size. Poultry Science. 2004;83:169-174.
38. Khalaji S, et al. Black cumin seeds, Artemisia leaves (Artemisia sieberi), and Camellia L. plant extract as phytogenic products in broiler diets and their effects on performance, blood constituents, immunity, and cecal microbial population. Poultry Science. 2011;90:2500-2510.
39. Aravind KL, et al. Efficacy of esterified glucomannan to counteract mycotoxicosis in naturally contaminated feed on performance and serum biochemical and hematological parameters in broilers. Poultry Science. 2003;82:571-576.
40. Sakuntala DPR, et al. Safety Evaluation of Alcoholic Extract of Boswellia ovalifoliolata Stem-bark in Rats. Toxicology international. 2012;19:115-120.
41. Zhang GF, et al. Effects of ginger root (zingiber officinale) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. Poultry Science. 2009;88:2159-2166.
42. Hoffman WS. The biochemistry of clinical medicine. 4th ed. Year Book Medical Publishers, Chicago; 1966.
43. Badria FA, et al. Immuno modulatory Triterpenoids from the Oleogum Resin of Boswellia carterii Birdwood . Zeitschrift für Naturforschung C. 2003;58:505-516.

e-ISSN:2321-6204
p-ISSN:2347-2359

44. AL-Homidan AA. Efficacy of Using Different Sources and Levels of Allium cepa, Allium Sativum and Zingiber officinale on Broiler Chicks Performance. Saudi Journal of Biological Science. 2005;2:96-102.

45. Struki PD. Avian physiology. 6th ed. Springer Vertag Inc, New York; 1976.

46. Ademola SG, et al. Growth, haematological and biochemical studies on garlic-and ginger-fed broiler chickens. Moor Journal of Agricultural Research. 2006;5:122-128.

47. Mehdi T, et al. Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical and haematological parameters in broiler chicks. Livestock science. 2011;138:167-173.

48. Ali Rania AM. The effect of the Cinnamomum verum (Elgerfa) on glucose tolerance a plasma parameters profile in alloxan induced diabetic rats. 2009;43-56.

49. Pandey S, et al. Extract of gum resins of Boswellia serrata L. inhibits lipopolysaccharide induced nitric oxide production in rat macrophages along with hypolipidernic property. Indian Journal of Experimental Biology. 2005;43:509-516.

50. Al-Daraji J, et al. Effect of supplementation of different levels frankincense to drinking water on certain hematological traits of broiler. Journal of Biological Chemistry and Environmental Sciences. 2013;8:589-601.

51. Tripathi YB, et al. Anti-inflammatory properties of BHUx, A polyherbal formulation to prevent atherosclerosis. Inflammation Pharmacology. 2004;12:131-152.

52. Ahangarpour A, et al. The effect of Boswellia serrata on blood glucose, insulin level and insulin resistance in type 2 diabetic patients. Daneshvar. 2013;103:1-10.

53. Kavitha JV, et al. Hypoglycemic and other related effects of Boswellia glabra in alloxan-induced diabetic rats. Indian journal of physiology and pharmacology. 2007;51:29-39.

54. Sturkei PD. Avian Physiology. 5th ed. Springer Verlag, New York; 2000.

55. Sharma ML, et al. Anti-arthritic activity of boswellic acids in bovine serum albumin (BSA) induced arthritis. International Journal of pharmacology. 1989;11:647-652.

56. Camarda L, et al. Chemical composition and antimicrobial activity of some oelegum resin essential oil from Boswellia spp. (Burseraceae). Annali di Chimica. 2007;97:837-844.

57. Rajendra CE, et al. Comparative evaluation of antimicrobial activities of methanolic extract of curcuma longa and Boswellia serrata. International journal of research in pharmacy and chemistry. 2013;3:2231-2781.

58. Frank A and Unger M. Analysis of frankincense from various Boswellia species with inhibitory activity on human drug metabolising cytochrome P450 enzymes using liquid chromatography mass spectrometry after automated on-line extraction. Journal of Chromatography A. 2006;1112:255-262.

59. Siddiqui MZ. Boswellia Serrata, a Potential Anti-inflammatory Agent. An Overview. Indian Journal of Pharmaceutical Sciences. 2011;73:255-261.

60. Jaffe WP and Jaap RG. A lack of effect of bursa size on disease resistance and antibody production. Poultry Science. 1966;45:157-159.

61. Yamamoto Y and Glick B. A comparison of the Immune Response between Two Lines of Chickens Selected for Differences in the Weight of the Bursa of Fabricius. Poultry Science. 1982;61:2129-2132.

62. Sadler CR and Glick B. The relation of the size of the bursa of Fabricius to antibody production. Poultry Science. 1962;41:508-510.

63. Saeed M, et al. Use of Cichorium Intybus Leaf Extract as Growth Promoter, Hepato protectant and Immune Modulent in Broilers. Journal of Animal Production Advances. 2015;5:585-591.

64. Nidaullah H, et al. APRN. Journal of Agricultural and Biological Science. 2010;5:53.

65. Ammon HP. Modulation of the immune system by Boswellia serrata extracts and boswellic acids. Phytomedicine. 2010;17:862-867.

66. Langmead L and Rampton DS. Review article: Complementary andalternative therapies for inflammatory bowel disease. Alimentary Pharmacology and Therapeutics Journal. 2006;23:341-349.

67. Gayathri B, et al. Pure compound from Boswellia serrata extract exhibits antiinflammatory property in human PBMCs and mouse macrophages through inhibition of TNF alpha, IL-1beta, NO and MAP kinases. International immunopharmacology. 2007;7:473-482.

e-ISSN:2321-6204
p-ISSN:2347-2359

68. Banno N, et al. Anti-inflammatory activities of the triterpene acids from the resin of Boswellia carterii. Journal of ethnopharmacology. 2006;107:249-253.