

## Research Article

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# Comparative effect of methionine and cysteine supplementation on growth performance and blood profile of Desi chicks

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### Citation

Mehtab Haseena, Razia Iqbal, Muhammad Faheem Malik, Syed Usman Haider, Abid Hussain, Tahir Aziz and Naveed Iftikhar. Comparative effect of methionine and cysteine supplementation on growth performance and blood profile of Desi chicks. Pure and Applied Biology. Vol. 8, Issue 4, pp2362-2372.

<http://dx.doi.org/10.19045/bspab.2019.80182>

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Received: 24/05/2019

Revised: 25/07/2019

Accepted: 05/08/2019

Online First: 22/08/2019

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### Abstract

Methionine and cysteine are sulfur containing amino acids and have important role in protein synthesis and increases feed efficiency. This study was conducted to evaluate the comparative effect of methionine and cysteine on 22 day old Rhode Island Red (RIR) chicks. The effect of methionine and cysteine was assessed on blood profile and Feed Conversion Ratio (FCR) of Rhode Island Red chicks. Chicks were divided into 7 groups, A,B,C groups were given methionine, having concentrations 0.4 gram per kg (g/kg) body weight (BW), 0.6g/kg BW and 0.7g/kg BW respectively, while groups D,E,F were given the cysteine, having concentrations 0.4g/kg BW, 0.6g/kg BW and 0.7g/kg BW respectively and G was control group that was given the normal basal diet. FCR of the chicks was decreased significantly which indicates better growth performance at all concentrations of methionine and cysteine. Hematological parameters including Hemoglobin (Hb), Hematocrit (PCV), Red Blood Cells (RBCs), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) and Mean Corpuscular Volume (MCV) were increased in all treatment groups. It is concluded that sulfur containing amino acid are growth enhancer. These amino acid supplements should be added in animal's diet to improve growth and blood parameters. The study asserts further research on amino acid supplement to examine its effectiveness in other animals.

**Keywords:** Amino acid supplements; FCR; Hematological parameters; Rhode Island Red

### Introduction

Poultry production is increasing day by day. Chicks are taking protein rich diet and are showing better growth. During different growing phases, varying diets are given to the poultry [1]. At the age of four months, desi chicks provide the 0.79kg of meat and lay 30 eggs per year [2].

Two sulfur containing amino acids, methionine and cysteine are essential for life. These amino acids stabilize protein tertiary structure due to presence of disulfide bond. Major source of cysteine is structural protein such as collagen or keratin which is found in feathers, hair, skin and nails. Highest ratio of methionine is found in egg

albumin which belongs to protein class globulins. Due to this reason, methionine has become essential element for poultry [3].

Methionine is considered as a first essential amino acid while cysteine is semi essential amino acid in poultry nutrition. Supplements of methionine are required for protein synthesis and increases feed efficiency [4]. Methionine is not produced by chickens so they get methionine through their diets [5]. *Dexter laevus* (DL)-methionine and DL-2-hydroxy-4-methyl butanoic acid (HMBA) are considered as a source of methionine. Liquid DL-HMBA has 88% purity while powdered DLM has 98% purity. These two sources have biochemical and physical differences [6].

Methionine serves as a methyl group donor which is involved in non-proteingenic functions. Methyl group is added in the DNA and involved in cell development and differentiation during DNA methylation process [7]. In skeletal muscles, methylation process is affected by methionine present in diet [8]. Methionine can reduce the symptoms for atherosclerosis [9]. Methionine in basal diet increases feed efficiency and egg production. It is also involved in prevention from increased deposition of fats [10]. Oxidative status is related with feed efficiency and lower feed efficiency shows high oxidative status in liver, intestine and breast muscle [11, 12].

For best economic results, synthetic methionine is added into the diet. 0.5% methionine is essential for optimum growth but higher concentrations are required to modulate the immune response of host [13]. In chicks, during the first phase of growth, glutathione peroxidase activity and glutathione redox system is increased by giving higher concentration of methionine [14]. Deficiency in methionine results in reduction of feed efficiency and weight gain [15]. Methionine deficient diet can weaken

immune function in broilers by pathological changes in thymus. In the first feeding month of broiler, diet without methionine content results in damaging feed conversion [16]. An increase in apoptotic cells lead to reduction in thymus (T) cell proliferation and decreased T cell populations [17].

Methionine indirectly acts as precursor of sulphur source and it can be converted irreversibly to cysteine. Naturally, cysteine is derived from duck feathers or human hair. Cysteine has a thiol group and it is involved in formation of disulfide bonds as it undergoes substitution and addition reactions. Cysteine plays vital role in manufacturing antioxidant glutathione, as it involves in electron transfer reaction [18]. Supplementation of cysteine in diet reduces the plasma homocysteine concentration [19]. These two amino acids are part of proteins and involved in regulation of body's homeostasis and performance [20, 21]. These amino acids affect blood concentrations of heterophile, lymphocytes and stimulate defense function of gastrointestinal tract in chicks [16, 22]. Methionine and cysteine supplements can alleviate oxidative stress in tissues of chicken [23]. Cysteine synthesizes reduced glutathione which plays role in maintaining counteracts oxidative stress and redox balance in cells [24]. Catalase activity is affected by methionine and it is important in protection of tissues from toxic affect of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) [25]. Methionine and cysteine are important for maximum growth of commercial broilers [1].

High methionine and cysteine concentration is damaging to growth and immune response of chicks because they contain highly toxic substances including homocysteine and sulfuric acid [26, 27]. No significant relationship has found between cysteine and methionine [19]. Chicks cannot fulfill the requirements of amino acid by the imbalances of amino acid and positive result

comes from the balances of amino acid in feed [28].

Protein rich diet has less effect on growth performance in growing age of chicks. Cost of desi chicks rearing can be reduced by giving low energy diets in growing age [29]. Lethal dose (LD<sub>50</sub>) of sulphur containing amino acid is above 2.5 for chicks and half of the chicks showed mortality [30].

Poultry nutritionists considered National Research Council (NRC) as a special guideline for requirement of amino acid for poultry. NRC recommendation considered as a safe estimate for chicks [31]. Levels for methionine and cysteine should be more than the NRC recommended levels [32].

## **Materials and methods**

### **Research animals**

This study was carried out on 22 day old 105 desi chicks Rhode Island Red. These chicks were maintained at Govt. poultry farm Sook Kalan Jalal pur jattan road, Gujrat. The 7 groups were made according to different dose concentrations. The groups were A, B, C, D, E, F and G. Replicates such as A1, A2 and A3 were made in each group. Each replicate was carrying 5 birds.

### **Care and maintenance**

Birds were placed in iron cages. Cages were divided into many parts by partitions. Each part contained three partitions for one group. Optimum temperature was provided to the birds and sheds were made to minimize the heat stress. Regular feed was given to the birds and vaccinated after every week.

### **Dosage design (Oral)**

Amino acids were obtained from Merck Company. Powdered amino acids mixed in the feed were given to chicks with different time intervals. Group A, B and C were given methionine with concentrations (0.4g/kg BW, 0.6g/kg BW and 0.7g/kg BW) respectively. Group D, E and F were given cysteine having different concentrations (0.4g/kg BW, 0.6g/kg BW and 0.7g/kg BW)

respectively while group G was considered as a control group.

### **Treatment duration**

All treatments including methionine and cysteine had been given from the age of 22 day old chicks and continued for the period of 4 weeks. Three samples were made within the interval of 10 days.

### **Growth performance**

At the start of experiment, weights of chicks were recorded at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> days. Before recording the weight, feed was not given to the chicks for 12 hours. Weight of each group was measured separately. Feed conversion ratio was measured as feed intake divided by weight gain [15, 33].

FCR= Total feed intake/total weight gain

### **Collection of blood sample**

By using vein puncture technique, blood sample was collected. Vacuum sampling tubes having anticoagulant EDTA.K3 was used for blood collection. Wing was pulled and vein was clearly shown between the muscles of biceps and triceps. Bifurcates v was visible between the wing's vein. Feathers were plucked for the visibility of vein. 70% alcohol was used to disinfect the area near the bleeding site. Syringe was injected in to the tendon and blood was flowed in to the syringe. This blood was shifted into vacuum sampling tubes having anticoagulant EDTA and by well shaking of tubes, clotting was prevented. These tubes were kept at 37 °C for preservation [34].

### **Hematological studies**

After collection of blood, within 24 hours, Automated Haematology Analyzer (model HKTE0112 Guangzhoun Hekang) was used [35]. Coulter method was used for hematological analysis [36].

### **Statistical analysis**

The SPSS (Statistical Package for Social Science) version 21.0 was used for statistical analysis. The standard error means ( $\pm$ S.E.M) for CBC and FCR were calculated by using Excel. One-way ANOVA was used for data

analysis. To check variations within these groups, *post hoc* test was also applied.

## Results

### Growth performance

In (Figure 1 & 2) it is showing better growth performance as FCR has decreased in RIR chicks after treating them with different doses of methionine (0.4g/kg, 0.6g/kg and 0.7g/kg) and cysteine (0.4g/kg, 0.6g/kg and 0.7g/kg) respectively.

Moreover, the statistical data analysis for methionine also depicts that mean values for treated group T1 (3.32±0.008, 3.33±0.005, 3.20±0.005) T2 (3.23±0.005, 2.55±0.008, 2.42±0.005) and T3 (2.67±0.008, 1.77±0.005, 1.64±0.005) are comparatively lower than control group T0 (3.52±0.008, 3.47±0.008, 3.27±0.005). However, FCR is highly decreased in methionine (0.7g/kg) group at 30<sup>th</sup> day (Figure 1).

Mean values for cysteine for treated group T1 (3.27±0.008, 3.31±0.005, 3.20±0.005) T2 (2.85±0.005, 2.67±0.008, 2.44±0.005) and T3 (2.21±0.008, 2.16±0.005, 2.07±0.005) were significantly decreased with respect to control T0 (3.52±0.008, 3.47±0.008, 3.27±0.005 (Figure 2).

### Hematological parameters for methionine

In (Table 1) it is indicating the result for hematological parameters for methionine For WBC at day 10<sup>th</sup> T1 (8.68±0.09), T2 (8.11±0.48) and T3 (7.25±0.46) were significantly decreased with respect to control T0 (9.21±0.29). At 20<sup>th</sup> and 30<sup>th</sup> day T1 (8.25±0.01, 8.21±0.00) has no significant difference with respect to control T0 (9.33±0.29, 9.43±0.29) but T2 (6.78±0.06, 7.54±0.00) and T3 (6.22±0.01, 7.29±0.01) were significantly decreased. However, overall WBCs were decreased by giving methionine in diet.

The RBCs counts at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> have no significant difference with respect to control except T3. T1 (4.45±0.078, 4.46±0.01, 4.97±0.01) and T2 (4.97±0.01, 4.99±0.01, 4.99±0.01) showed no significant

difference with respect to control T0 (4.39±0.145, 4.42±0.145, 4.55±0.145) but T3 (5.01±0.264, 5.18±0.02, 5.01±0.01) were significantly increased. RBCs were increased by increasing concentration of methionine. For Hb at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (11.91±0.14, 11.95±0.02, 11.99±0.00) has no significant difference while others T2 (12.96±0.577, 12.99±0.01, 12.56±0.02) and T3 (12.37±0.360, 12.99±0.01, 13.01±0.00) were significantly increased with respect to control T0 (11.82±0.074, 11.86±0.074, 11.90±0.074). Hb levels were improved by giving higher concentration of methionine. HCT levels at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (37.02±0.296, 37.73±0.01, 37.11±0.01) showed no significant difference as compared to control T0 (36.21±0.577, 36.55±0.577, 36.99±0.577) while T2 (39.66±0.881, 38.04±0.02, 39.21±0.01) and T3 (40.22±1.65, 39.56±0.01, 39.99±0.01) were significantly increased. HCT levels were increased by increasing concentration of methionine.

For MCV at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (84.77±0.52, 85.78±0.01, 85.91±0.01) T2 (87.23±0.43, 87.38±0.23, 85.01±0.00) and T3 (88.90±0.881, 89.99±0.14, 89.99±0.14) were significantly increased as compared to control T0 (81.49±0.34, 82.49±0.34, 82.99±0.34).

For MCH at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (28.96±0.31, 29.61±0.01, 28.81±0.03) and T2 (29.56±0.32, 29.99±0.02, 29.88±0.02) had no significant difference with respect to control T0 (28.00±0.11, 28.45±0.11, 28.09±0.11) T3 at 10<sup>th</sup> (29.99±0.28) showed no increase while at 20<sup>th</sup> and 30<sup>th</sup> day (31.00±0.02, 31.21±0.02) significant increase was observed.

For MCHC at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (30.35±0.27, 29.92±0.03, 29.88±0.01) T2 (30.66±0.21, 30.81±0.00, 30.31±0.01) and T3 (31.29±0.26, 30.78±0.01, 30.35±0.01) had no significant difference with respect to

control T0 (29.81±0.22, 29.88±0.22, 28.87±0.22).

For platelets at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (187.66±2.61, 178.00±1.15, 178.00±1.15) T2 (177.22±3.83, 145.33±0.88, 166.66±1.45) and T3 (150.33±3.91, 155.00±1.15, 159.33±1.76) were significantly decreased with respect to control T0 (200.00±1.59, 205.00±1.59, 207.00±1.59).

### Hematological parameters for cysteine

In (Table 2) it is showing the result for hematological parameters for cysteine.

For WBC at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (8.34±0.06, 8.90±0.01, 8.89±0.60) T2 (8.99±0.57, 8.24±0.09, 7.98±0.06) and T3 (7.88±0.28, 7.78±0.06, 7.92±0.08) were significantly decreased with respect to control T0 (9.21±0.29, 9.33±0.29, 9.43±0.29).

The RBCs counts at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (4.55±0.08, 4.48±0.09, 4.97±0.01) T2 (4.99±0.27, 4.77±0.07, 4.99±0.06) showed no significant difference while T3 (4.79±0.78, 4.98±0.02, 5.01±0.06) were significantly increased. However, increase in RBCs counts was observed with respect to control T0 (4.39±0.145, 4.42±0.145, 4.55±0.145).

For Hb at day 10<sup>th</sup> T1 (11.87±0.12) T2 (11.99±0.98) showed no significant difference with respect to control T0 (11.82±0.074, 11.86±0.074, 11.90±0.074) but T3 (12.45±0.28) was increased. At 20<sup>th</sup> and 30<sup>th</sup> day T1 (12.89±0.03, 12.25±0.07) T2 (12.98±0.06, 12.86±0.06) and T3 (13.01±0.08, 13.01±0.05) were significantly increased. Hb levels were increased by giving increasing concentration of cysteine.

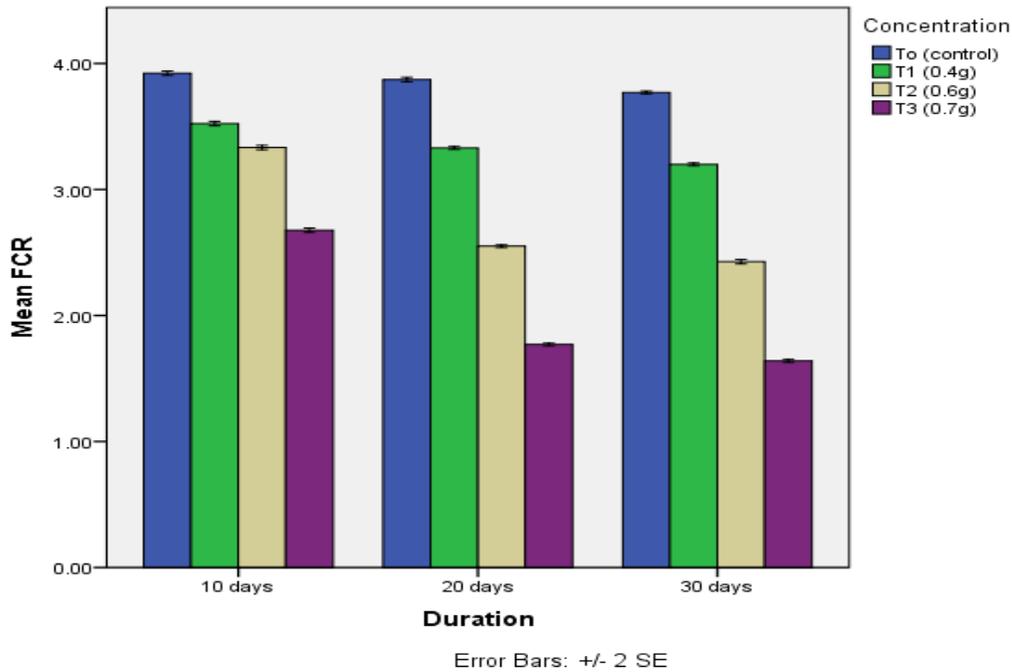
HCT levels at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (37.08±0.45, 37.87±0.01, 37.88±0.05) had no increase as compared to control T0 (36.21±0.577, 36.55±0.577, 36.99±0.577) while T2 (39.89±0.10, 38.98±0.06, 39.31±0.08) and T3 (39.09±1.45, 39.87±0.06, 39.89±0.06) showed significant increase. Overall HCT levels were increased.

For MCV at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (82.87±0.45, 82.88±0.05, 82.89±0.01) showed no difference with respect to control T0 (81.49±0.34, 82.49±0.34, 82.99±0.34) but T2 (84.87±0.98, 85.68±0.88, 84.01±0.06) and T3 (87.09±0.36, 88.21±0.05, 88.90±0.15) were significantly increased by increasing concentration of cysteine.

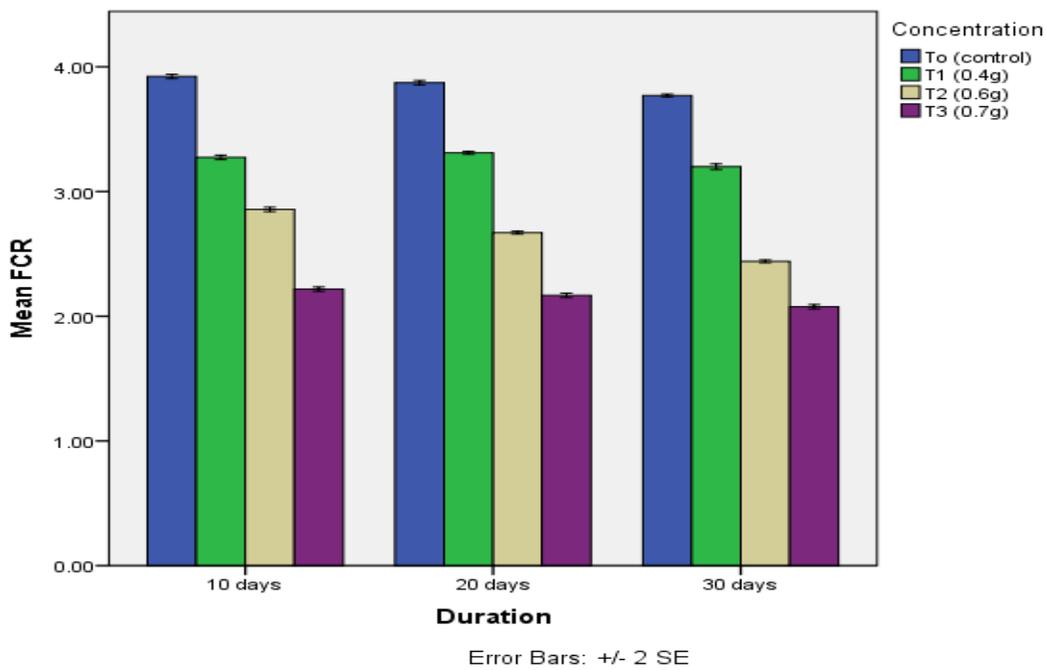
MCH at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> days T1 (28.78±0.27, 29.76±0.06, 28.81±0.03) T2 (29.98±0.06, 29.88±0.02, 29.87±0.02) and T3 (29.56±0.93, 30.89±0.05, 30.21±0.06) showed slightly increase as compared to control T0 (28.00±0.11, 28.45±0.11, 28.09±0.11).

For MCHC at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> days T1 (30.87±0.87, 29.99±0.03, 29.85±0.08) T2 (30.89±0.27, 30.78±0.09, 30.30±0.04) and T3 (30.78±0.93, 30.65±0.04, 30.78±0.06) showed no significant difference as compared to control T0 (29.81±0.22, 29.88±0.22, 28.87±0.22).

For Platelets at day 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> T1 (194.00±0.67, 167.00±1.15, 189.00±1.15) T2 (178.22±0.78, 155.33±0.80, 176.66±1.67) and T3 (166.33±0.45, 134.00±1.67, 150.34±1.98) were significantly decreased with respect to control T0 (200.00±1.59, 205.00±1.59, 207.00±1.59).



**Figure 1. Concentration and duration dependent effect of methionine on feed conversion ratio (FCR) of RIR chicks at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> day of exposure**



**Figure 2. Concentration and duration dependent effect of cysteine on feed conversion ratio (FCR) of RIR chicks at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> day of exposure**

**Table 1. Effect of different dosage of methionine on blood parameters in RIR chicks at 10th, 20th and 30th days (mean±S.E.M)**

Parameters	Duration	Concentrations Used			
		T0 Control	T1 0.4g/kg BW	T2 0.6g/kg BW	T3 0.7g/kg BW
WBCs (x103/ $\mu$ l)	<b>10th Day</b>	9.21±0.29 <sup>a</sup>	8.68±0.09 <sup>b</sup>	8.11±0.48 <sup>c</sup>	7.25±0.46 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.39±0.145 <sup>a</sup>	4.45±0.078 <sup>b</sup>	4.79±0.296 <sup>c</sup>	5.01±0.264 <sup>c</sup>
Hb (g/dL)		11.82±0.074 <sup>a</sup>	11.91±0.14 <sup>b</sup>	12.96±0.577 <sup>b</sup>	12.37±0.360 <sup>b</sup>
HCT (%)		36.21±0.577 <sup>a</sup>	37.02±0.296 <sup>b</sup>	39.66±0.881 <sup>b</sup>	40.22±1.65 <sup>c</sup>
MCV (fL)		81.49±0.34 <sup>a</sup>	84.77±0.52 <sup>a</sup>	87.23±0.43 <sup>b</sup>	88.90±0.881 <sup>b</sup>
MCH (pg)		28.00±0.11 <sup>a</sup>	28.96±0.31 <sup>b</sup>	29.56±0.32 <sup>b</sup>	29.99±0.28 <sup>c</sup>
MCHC (g/dL)		29.81±0.22 <sup>a</sup>	30.35±0.27 <sup>b</sup>	30.66±0.21 <sup>b</sup>	31.29±0.26 <sup>b</sup>
Platelets (x103/ $\mu$ l)		200.00±1.59 <sup>a</sup>	187.66±2.61 <sup>b</sup>	177.22±3.83 <sup>b</sup>	150.33±3.91 <sup>c</sup>
WBCs (x103/ $\mu$ l)	<b>20th Day</b>	9.33±0.29 <sup>a</sup>	8.25±0.01 <sup>b</sup>	6.78±0.067 <sup>c</sup>	6.22±0.01 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.42±0.145 <sup>a</sup>	4.46±0.01 <sup>b</sup>	4.99±0.01 <sup>c</sup>	5.18±0.02 <sup>c</sup>
Hb (g/dL)		11.86±0.074 <sup>a</sup>	11.95±0.02 <sup>b</sup>	12.99±0.01 <sup>b</sup>	12.99±0.01 <sup>b</sup>
HCT (%)		36.55±0.577 <sup>a</sup>	37.73±0.01 <sup>b</sup>	38.04±0.02 <sup>b</sup>	39.56±0.01 <sup>c</sup>
MCV (fL)		82.49±0.34 <sup>a</sup>	85.78±0.01 <sup>a</sup>	87.38±0.23 <sup>b</sup>	89.21±0.01 <sup>b</sup>
MCH (pg)		28.45±0.11 <sup>a</sup>	29.61±0.01 <sup>b</sup>	29.99±0.02 <sup>b</sup>	31.00±0.02 <sup>c</sup>
MCHC (g/dL)		29.88±0.22 <sup>a</sup>	29.92±0.03 <sup>b</sup>	30.81±0.00 <sup>b</sup>	30.78±0.01 <sup>b</sup>
Platelets		205.00±1.59 <sup>a</sup>	178.00±1.15 <sup>b</sup>	145.33±0.88 <sup>b</sup>	155.00±1.15 <sup>c</sup>
WBCs (x103/ $\mu$ l)	<b>30th Day</b>	9.43±0.29 <sup>a</sup>	8.21±0.00 <sup>b</sup>	7.54±0.00 <sup>c</sup>	7.29±0.01 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.55±0.145 <sup>a</sup>	4.97±0.01 <sup>b</sup>	4.99±0.01 <sup>c</sup>	5.01±0.01 <sup>c</sup>
Hb (g/dL)		11.90±0.074 <sup>a</sup>	11.99±0.00 <sup>b</sup>	12.56±0.02 <sup>b</sup>	13.01±0.00 <sup>b</sup>
HCT (%)		36.99±0.577 <sup>a</sup>	37.11±0.01 <sup>b</sup>	39.21±0.01 <sup>b</sup>	39.99±0.01 <sup>c</sup>
MCV (fL)		82.99±0.34 <sup>a</sup>	85.91±0.01 <sup>a</sup>	85.01±0.00 <sup>b</sup>	89.99±0.14 <sup>b</sup>
MCH (pg)		28.09±0.11 <sup>a</sup>	28.81±0.03 <sup>b</sup>	29.88±0.02 <sup>b</sup>	31.21±0.02 <sup>c</sup>
MCHC (g/dL)		28.87±0.22 <sup>a</sup>	29.88±0.01 <sup>b</sup>	30.31±0.01 <sup>b</sup>	30.35±0.01 <sup>b</sup>
Platelets		207.00±1.59 <sup>a</sup>	178.00±1.15 <sup>b</sup>	166.66±1.45 <sup>b</sup>	159.33±1.76 <sup>c</sup>

**Table 2. Effect of different dosage of cysteine on blood parameters in RIR chicks at 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> days**

Parameters	Duration	Concentration Used			
		T0 Control	T1 0.4g/kg BW	T2 0.6g/kg BW	T3 0.7g/kg BW
WBCs (x103/ $\mu$ l)	10th Day	9.21 $\pm$ 0.29 <sup>a</sup>	8.34 $\pm$ 0.06 <sup>b</sup>	8.99 $\pm$ 0.57 <sup>b</sup>	7.88 $\pm$ 0.28 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.39 $\pm$ 0.145 <sup>a</sup>	4.55 $\pm$ 0.08 <sup>b</sup>	4.99 $\pm$ 0.27 <sup>c</sup>	4.79 $\pm$ 0.78 <sup>c</sup>
Hb (g/dL)		11.82 $\pm$ 0.074 <sup>a</sup>	11.87 $\pm$ 0.12 <sup>b</sup>	11.99 $\pm$ 0.98 <sup>b</sup>	12.45 $\pm$ 0.28 <sup>b</sup>
HCT (%)		36.21 $\pm$ 0.577 <sup>a</sup>	37.08 $\pm$ 0.45 <sup>b</sup>	39.89 $\pm$ 0.10 <sup>b</sup>	39.09 $\pm$ 1.45 <sup>c</sup>
MCV (fL)		81.49 $\pm$ 0.34 <sup>a</sup>	82.87 $\pm$ 0.45 <sup>a</sup>	84.87 $\pm$ 0.98 <sup>a</sup>	87.09 $\pm$ 0.36 <sup>a</sup>
MCH (pg)		28.00 $\pm$ 0.11 <sup>a</sup>	28.78 $\pm$ 0.27 <sup>b</sup>	29.98 $\pm$ 0.06 <sup>b</sup>	29.56 $\pm$ 0.93 <sup>b</sup>
MCHC (g/dL)		29.81 $\pm$ 0.22 <sup>a</sup>	30.87 $\pm$ 0.87 <sup>b</sup>	30.89 $\pm$ 0.27 <sup>b</sup>	30.78 $\pm$ 0.93 <sup>b</sup>
Platelets (x103/ $\mu$ l)		200.00 $\pm$ 1.59 <sup>s</sup>	194.00 $\pm$ 0.67 <sup>b</sup>	178.22 $\pm$ 0.78 <sup>b</sup>	166.33 $\pm$ 0.45 <sup>c</sup>
WBCs (x103/ $\mu$ l)	20th Day	9.33 $\pm$ 0.29 <sup>a</sup>	8.90 $\pm$ 0.01 <sup>b</sup>	8.24 $\pm$ 0.09 <sup>b</sup>	7.78 $\pm$ 0.06 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.42 $\pm$ 0.145 <sup>a</sup>	4.48 $\pm$ 0.09 <sup>b</sup>	4.77 $\pm$ 0.07 <sup>c</sup>	4.98 $\pm$ 0.02 <sup>c</sup>
Hb (g/dL)		11.86 $\pm$ 0.074 <sup>a</sup>	12.89 $\pm$ 0.03 <sup>b</sup>	12.98 $\pm$ 0.06 <sup>b</sup>	13.01 $\pm$ 0.08 <sup>b</sup>
HCT (%)		36.55 $\pm$ 0.577 <sup>a</sup>	37.87 $\pm$ 0.01 <sup>b</sup>	38.98 $\pm$ 0.06 <sup>b</sup>	39.87 $\pm$ 0.06 <sup>c</sup>
MCV (fL)		82.49 $\pm$ 0.34 <sup>a</sup>	82.88 $\pm$ 0.05 <sup>a</sup>	85.68 $\pm$ 0.88 <sup>a</sup>	88.21 $\pm$ 0.05 <sup>a</sup>
MCH (pg)		28.56 $\pm$ 0.11 <sup>a</sup>	29.76 $\pm$ 0.06 <sup>b</sup>	29.88 $\pm$ 0.02 <sup>b</sup>	30.89 $\pm$ 0.05 <sup>b</sup>
MCHC (g/dL)		29.88 $\pm$ 0.22 <sup>a</sup>	29.99 $\pm$ 0.03 <sup>b</sup>	30.78 $\pm$ 0.09 <sup>b</sup>	30.65 $\pm$ 0.04 <sup>b</sup>
Platelets		205.00 $\pm$ 1.59 <sup>a</sup>	167.00 $\pm$ 1.15 <sup>b</sup>	155.33 $\pm$ 0.80 <sup>b</sup>	134.00 $\pm$ 1.67 <sup>c</sup>
WBCs (x103/ $\mu$ l)	30th Day	9.43 $\pm$ 0.29 <sup>a</sup>	8.89 $\pm$ 0.60 <sup>b</sup>	7.98 $\pm$ 0.06 <sup>b</sup>	7.92 $\pm$ 0.08 <sup>c</sup>
RBCs (x103/ $\mu$ l)		4.55 $\pm$ 0.145 <sup>a</sup>	4.97 $\pm$ 0.01 <sup>b</sup>	4.99 $\pm$ 0.06 <sup>c</sup>	5.01 $\pm$ 0.06 <sup>c</sup>
Hb (g/dL)		11.90 $\pm$ 0.074 <sup>a</sup>	12.25 $\pm$ 0.07 <sup>b</sup>	12.86 $\pm$ 0.06 <sup>b</sup>	13.01 $\pm$ 0.05 <sup>b</sup>
HCT (%)		36.99 $\pm$ 0.577 <sup>a</sup>	37.88 $\pm$ 0.05 <sup>b</sup>	39.31 $\pm$ 0.08 <sup>b</sup>	39.89 $\pm$ 0.06 <sup>c</sup>
MCV (fL)		82.99 $\pm$ 0.34 <sup>a</sup>	82.89 $\pm$ 0.01 <sup>a</sup>	84.01 $\pm$ 0.06 <sup>a</sup>	88.90 $\pm$ 0.15 <sup>a</sup>
MCH (pg)		28.09 $\pm$ 0.11 <sup>a</sup>	28.81 $\pm$ 0.03 <sup>b</sup>	29.87 $\pm$ 0.02 <sup>b</sup>	30.21 $\pm$ 0.06 <sup>b</sup>
MCHC (g/dL)		28.87 $\pm$ 0.22 <sup>a</sup>	29.85 $\pm$ 0.08 <sup>b</sup>	30.30 $\pm$ 0.04 <sup>b</sup>	30.78 $\pm$ 0.06 <sup>b</sup>
Platelets		207.00 $\pm$ 1.59 <sup>a</sup>	189.00 $\pm$ 1.15 <sup>b</sup>	176.66 $\pm$ 1.67 <sup>b</sup>	150.34 $\pm$ 1.98 <sup>c</sup>

## Discussion

Feed conversion ratio of RIR chicks was reduced significantly which showed positive effect and better growth performance. Experimental group used higher concentrations of methionine and cysteine in comparison to control group. Increase in metabolism may be due to higher uptake of amino acids. Hematological parameters were also affected as Hb, PCV and MCV were increased.

According to a study [37] better performance and high breast muscle yield were observed in light weighed chicks as

compared to heavy chicks. In another study [38] birds who take high concentrations of methionine showed better performance and it is associated with adequate amount of essential amino acid especially methionine [39]. Methionine mixed with corn-soyabean diet results in good performance of chicks [40].

Treated groups showed decreased FCR while control group has high FCR. At 30<sup>th</sup> day, methionine having concentration (0.7g/kg) showed highly decreased FCR and this result shows compatibility with [35] who performed an experiment on broiler

chicks and chicks showed better performance when they were fed on methionine supplement.

Methionine supplement increased the blood parameters. Moreover, methionine is also involved in muscle development, synthesis of others amino acid and digestion of feed stuff [41]. Blood parameters for treated groups were compared with control group. Increases in Hb, PCV and RBCs were observed as compared to control groups [10]. Chicks showed better performance by giving cysteine [15]. Birds fed diets containing 0.35% cysteine and 0.50% methionine showed higher body weight gain and high performance as compared to other dietary treatments.

The statistical analysis depicts a decreased FCR which is showing better growth performance. RBCs, Hb and PCV were significantly increased at different concentrations of methionine (0.4g/kg, 0.6g/kg, 0.7g/kg) and cysteine (0.4g/kg, 0.6g/kg, 0.7g/kg). This result was compatible with those reported by [10] who performed an experiment on hematological parameters of chicks. A significant ( $P < 0.05$ ) increase in Hb, PCV and RBCs was observed when compared with control group.

### Conclusion

The study revealed that sulfur containing amino acid including methionine and cysteine have positive role in growth performance. FCR was reduced which indicates better growth performance of birds at all concentration of methionine and cysteine. Hematological parameters such as Red Blood Cells (RBCs), Hemoglobin (Hb), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) and Mean Corpuscular Volume (MCV) were increased for all treatment groups. This study confirms that higher amino acid concentrations are

growth enhancer and increases blood parameters.

### Author's contributions

Conceived and designed the experiments: M Haseena, R Iqbal & MF Malik, Performed the experiments: M Haseena, Analyzed the data: M Haseena, Contributed materials/ analysis/ tools: SU Haider, A Hussain, T Aziz & N Iftikhar, Wrote the paper: M Haseena.

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