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THE IMPACTS OF AGE, SEX AND GENOTYPE ON CARCASS TRAITS, BIOCHEMICAL BLOOD PARAMETERS AND HORMONE CONCENTRATIONS OF CATTLE

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ABSTRACT

The current study was conducted to compare the carcass traits, blood biochemical parameters and hormone concentrations for different genotypes, age and sex of cattle slaughtered at Basra slaughterhouse. Total 100 animals of Brahman, cross (Jenubi x Friesian), Jenubi and Roman were randomly selected and divided into (24, 28, 26 and 22 respectively). Each studied genotype was divided into a nearly equal number of male and female. The selected animals were divided into 1, 2 and 3 years old. Carcass traits were included live body weight, carcass weight and dressing percentages. The means of blood metabolic parameters include glucose, urea, cholesterol, triglycerides, total protein, albumin, globulin and hormone insulin, thyronine (T3) and thyroxine (T4) were compared among experimental animals. The results revealed that Brahman breed recorded the highest and significant body and carcass weight with highest dressing% (424.00 kg, 279.32 kg and %66.06 respectively). Males' body weight and carcass weight were significantly higher than those of females (378.99 and 245.16 kg vs. 317.27 and 195.70 kg respectively). Body and carcass weights increased significantly with the animal's age. There were no significant differences in mean concentrations of total protein, albumin, globulin and cholesterol of different genotypes, sex and age groups. However, significant differences were observed in mean concentrations of triglyceride, glucose and urea level among genotypes. No significant differences were seen between two sexes in urea and glucose serum concentration, whereas it was significant in a triglyceride. Age has no significant effect on triglyceride, while glucose and urea serum concentration were differ significantly with age. Hormones T3, T4 and insulin were differed significantly among genotypes, but they were not between the sexes. Ages had no significant effects on T3 and T4 serum concentration.

KEYWORDS:

Age, Sex, Genotype, Carcass traits, Blood biochemical, Hormone concentrations

INTRODUCTION

Improving body live weight, carcass performance and dressing percentage are the main goals of most research carried out in the area of beef production. Enhancing the meat quality and quantity is a vital aims for breeders due to their economic impacts. The concentration compound of beef meat contains approximately 23% protein, 2.8% fat, 73% water and 1.2% minerals. The beef meat energy value is 494 KJ (116 kcal) per 100 g. Body live weight, carcass performance and dressing percentage are affected by variation factors, such as breeds, gender, age, diet and mode of production .

The determination of serum biochemical parameters can provide useful information as relative to body physiology and nutrition status, age and sex of the animal. Measuring and comparing the values of serum biochemical parameters may give a clear image about animals' health and metabolic status. Blood analyses are one of most important procedure to diagnose the abnormalities in body metabolic status between healthy and unhealthy animals. The changes in the level of serum biochemical parameter values are due to the animals' body metabolic responses to several of body functions. It is well known the benefits of those parameters to evaluate animals' body conditions. The aim of the present study was to examine the effects of age, sex and genotypes on carcass traits, biochemical blood parameters and hormone concentrations of cattle at Basra Slaughterhouse.

Materials and methods

Animals

The study was randomly selected 100 animals slaughtered at Basra slaughterhouse. Selected cattle's were different in genotypes, sex and age. The cattle genotypes included Brahman, cross (Jenubi x Friesian), Jenubi and Roman which divided into (24, 28, 26 and 22 respectively). Each studied genotype was divided into a nearly equal number of male and female. The selected animals were divided into 1, 2 and 3 years old depending on the breeders' information and dentition.

Live body weight and carcass traits

Animals of the above four genotypes of cattle were brought to Basra's abattoir. Live body weight was recorded at the slaughter house. The carcass and dressing percentages were also calculated by using the formula in the Excel program as used by Rahman *et al*., (2012a).

Carcass Weight = Live weight – {skin weight + blood weight + head weight + hooves weight + visceral organs weight}.

$$\text{Dressing percentage} = \frac{carcass\ weight}{live\ weight} X\ 100$$

Blood samples collections

One hundred blood samples were taken from experimental animals at the Basra slaughter house. Using evacuated gel tubes 20 ml of blood were taken from each slaughter animal between 0400 h and 0700 h a.m. Blood tube were immediately cooled down utilizing ice box and left for 20 minutes to clot. Then, Blood tube samples were centrifuged for 15 min at 3500 x g to collect serum and plasma was stored at – 20 °C until use as described by Graber *et al*., (2010).

Blood biochemical parameters analyses

Blood biochemical parameters include albumin, cholesterol, glucose, triglycerides, total protein and urea were measured by using a specialized kit from BIOLABO SA, Maizy, France. The absorbance of above parameters were recorded by spectrophotometer instrument at a wavelength of 630 nm, 540 nm, 505 nm, 500 nm, 546 nm and 600 nm respectively. The calculation of plasma biochemical concentration was resulted as follows:

1. $Albumine(\text{g/100ml}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
2. $Cholesterol\ (\text{mg/100ml}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
3. $Glucose\ (\text{mg/100ml}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
4. $Triglycrride\ (\text{mg/100L}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
5. $Protien\ (\text{g/100ml}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
6. $Urea\ (\text{mg/dL}) = \frac{Abs\ (Assay)}{Abs\ (Standard)} \times Standard\ concentration$
7. Globulin (g/100ml) = Total protein – Albumin

Analysis of thyroxin hormone metabolites

Total thyroxin hormone metabolite concentration in cattle serum was measured by a Microplate Enzyme Immunoassay using an Eliza kit from Monobind Inc., lake Forest, CA 92630, USA, product code 225-300, following the manufacturer's instruction.

Analysis of thyroid hormone metabolites

Total thyroid hormone metabolite concentration in cattle serum was measured by a Microplate Enzyme Immunoassay using an Eliza kit from Monobind Inc., lake Forest, CA 92630, USA, product code 125-300, following the manufacturer's instruction.

Analysis of insulin hormone metabolites

A quantitative determination of insulin levels in cattle serum was tested by a Microplate Eliza kit from Monobind Inc., lake Forest, CA 92630, USA, product code 5825-300. Following the manufacturer's instruction.

Statistical analyzes

T-test sample or ANOVA was used to compare the evaluated parameters among studied genotypes, sexes and ages. A difference at (P<0.05) was considered to be significant. All statistical tests were estimated within the SPSS program (version, 21).

Results

Live body weight and carcass traits

Significant differences ($P<0.05$) were observed in the means of body and carcass weight and dressing percentages of different genotypes (Table 1). Brahman showed the highest body and carcass weight with highest dressing% (424.00 kg, 279.32 kg and %66.06 respectively). While, all other genotypes showed approximately the similar body weight. Cross and Roman carcasses were heaver ($P<0.05$) than that of Jenubi (204.39 and 198.27 respectively vs. 173.81 kg). Dressing percentage of Brahman breed (66.06 %) differed significantly ($P<0.05$) than other studied genotype. However, cross, Jenubi and Roman genotypes showed no significant differences in dressing percentage (61.46, 57.72 and 59.95% respectively).

In regards to sex differences, male body and carcass weight were significantly higher ($P<0.05$) than those of females (378.99 and 245.16 kg vs. 317.27 and 195.70 kg respectively). Despite the fact that, there were no significant differences were detected in dressing% of males and females, males had mathematically higher dressing than females (64.62% and 61.93% respectively).

Table 1. Mean of body weight at slaughtering, carcass weight and dressing% of different genotypes, gender and age (±SD)

Genotypes	Body weight (Kg)	Carcass weight (Kg)	Dressing (%)
Brahman	a 424.00. ±26.42	a 279.23±14.44	a 66.06±5.84
Cross	b 334.43±12.17	b 204.39±7.59	b 61.46±5.19
Jenubi	b 303.38±17.39	c 173.81±10.84	b 57.72±5.71
Roman	b 330.72±27.44	b 198.27±17.10	b 59.95±5.69
Gender			
Female	b 317.27±19.10	b 195.70±11.68	61.93±5.89
Male	a 378.99±13.45	a 245.16±8.10	64.62±5.35
Age (Year)			
1	c 304.94±11.34	c 188.66±6.89	62.04±5.16
2	b 350.76±14.84	b 220.65±8.73	63.03±4.50
3	a 388.70±16.38	a 251.97±10.00	64.75±5.63

- **Means with different subscripts within each trait differ significantly at 5%**

Animals' ages were also shown clear differences (P<0.05) in the above parameters. It was noticed that the body and carcass weights increased significantly (P<0.05) within the animal's age. Similarly, dressing proportion showed the same pattern as the body and carcass weights, however the results were not significant (P>0.05) even there were a mathematical increase as age advance.

Biochemical parameters and hormones concentrations

Serum proteins

Table (2) shows there were no significant differences (P>0.05) in mean concentrations of total protein, albumin and globulin of different genotypes, sex and age groups. The concentration of plasma total protein among 4 different genotypes were quite similar. Although, there was no significant difference, the mean concentrations of total protein in Brahman genotype was less than others studied genotypes by approximately 1 gm/ml.

Table 2. Means (±SD) of total protein, albumin and globulin (gm/100 ml)

Breed	Total protein	Albumin	Globulin
Brahman	5.35±0.61	2.40±0.41	2.95±0.42
Cross	6.34±0.34	3.07±0.23	2.27±0.23
Jenubi	6.22±0.48	2.97±0.32	3.43±0.33
Roman	6.13±0.76	2.10±0.51	4.04±0.53
Gender			
Female	6.04±0.52	2.75±0.35	3.29±0.36
Male	5.99±0.36	2.43±0.24	3.55±0.25
Age (Year)			
1	6.13±1.30	2.74±0.20	3.38±0.21
2	5.86±1.39	2.65±0.26	3.21±0.27
3	6.05±1.44	2.38±0.30	3.67±0.31

Even though, a negligible difference was observed in albumin and globulin plasma concentrations among all studied genotypes. The mean concentration of globulin in cross genotype was the lowest 2.27 gm/ml comparatively to other genotypes. Whereas the highest was Roman genotype (4.04 gm/ml). Mean albumin concentration in cross genotype was higher than other studied genotypes (3.07 gm/ml). Similar sex and age pattern were observed among the mean concentration of total protein, albumin and globulin (Table 2).

Cholesterol and Triglyceride

The data found in table (3) revealed the mean concentration differences of cholesterol and triglyceride syntheses among four different genotypes, sex and ages. No significant differences (P>0.05) were observed in mean plasma concentrations of cholesterol among genotypes. Cross breeding showed mathematically higher serum cholesterol concentration followed by Roman genotype (121.56 and 115.99 mg/100 ml respectively) compare with other genotypes. Whereas, the results appear in the table (3) showed significant differences (P<0.05) in mean concentrations of triglyceride between Brahman, cross, Jenubi genotypes and Roman (100.70, 112.72, 103.66 mg/100 ml and 73.61 mg/100 ml respectively).

Table 3. Means (± SD) of serum cholesterol and triglyceride (mg/100ml)

Breed	Cholesterol	Triglyceride
Brahman	103.27±12.00	a100.70±12.00
Cross	121.56±6.64	a112.72±6.64
Jenubi	106.54±9.49	a103.66±9.48
Roman	115.99±14.97	b73.61±14.96
Gender		
Female	110.70±7.04	a106.46±10.19
Male	112.97±10.19	b 88.89±7.03
Age (Year)		
1	113.72±5.90	100.58±5.90
2	122.88±7.63	91.30±7.63
3	98.92±8.71	101.16±8.70

- **Means with different subscripts within each trait differ significantly at 5%**

A slight differences in cholesterol concentration were observed between male and female in testing animals. Mean plasma concentration of triglyceride was significantly ($P<0.05$) higher in females 106.46 mg/ml, compared to males 88.89 mg/100 ml.

It was also noticed that (table 3), the mean cholesterol and triglyceride concentration were non-significantly impacted by animals' age. Animals at 3 years old was observed to be mathematically higher plasma cholesterol concentration (98.92 mg/100 ml) and lower triglyceride concentration (101.16 mg/100 ml).

Urea and glucose

Table (4) shows the comparison of urea and glucose serum concentration values among 4 different genotypes, ages and sex. A significant differences ($P<0.05$) in the mean of urea concentration (36.32 mg/dl) were observed in Roman genotype compare to all other studied genotypes, whereas there were no significant differences ($P<0.05$) among Brahman, cross and Jenubi (18.67, 24.48 and 20.89 mg/dl respectively). On the other hand, the highest mean (91.58 mg/100 ml) of plasma glucose concentration ($P<0.05$) was detected in Brahman genotype, while the lowest mean of glucose concentration (57.70 mg/100ml) was in Roman genotype.

Table 4. Means (±Standard Deviation) of Urea and Glucose values in serum

Breed	Urea (mg/dl)	Glucose (mg/100ml)
Brahman	b 18.67±5.39	a 91.58±7.28
Cross	b 24. 48±5.97	b 74.40±7.35
Jenubi	b 20.89±5.26	b 72.41±7.50
Roman	a 36.32±6.71	c 57.70±6.56
Gender		
Female	21.87±4.57	81.08±11.28
Male	28.31±6.16	66.97±7.79
Age (Year)		
1	b 21.49±3.65	a 79.82±6.53
2	ab 25.97±3.42	a 80.28±8.45
3	a 27.80±3.330	b 61.98±9.64

- **Means with different subscripts within each trait differ significantly at 5%**

The comparison between males and females in urea and glucose concentrations were displayed in table 4. No significant differences ($P < 0.05$) were seen between two groups (males and females) in urea and glucose serum concentration. Males had shown mathematically higher urea concentration than females (28.31 and 20.87 mg/dl respectively). However, glucose concentration compared higher in females (81.08 mg/100ml) than males (66.87 mg/100ml).

Regarding to animal ages, there were significant differences ($P<0.05$) in urea and glucose concentration among groups of different animal ages had displayed in table 4. The means of urea concentration were significantly increased with animal's age. In addition, glucose concentration in animals of 1 and 2 years old were significantly higher ($P<0.05$) from 3 years old (79.82, 80.28 and 61.98 mg/100ml) respectively.

Hormones concentrations

The results appear in the table (5) highlighted the means differences of T3, T4 and Insulin concentration of genotypes, sex and ages. Similar and no significant concentration of T3 were observed in Brahman, cross and Jenubi (85.46, 81.60 and 88.33 nmol/l) which all were significantly ($P<0.05$) different from Roman genotype (58.79 nmol/l).

Insulin blood concentration in Roman genotype was significantly differ ($P<0.05$) from Cross genotype (116.37 and 99.25 nmol/l respectively).

No group differences and no significant effect of T4 concentration were observed in cross and Jenubi genotypes. Whereas, blood T4 concentration in Brahman and Roman genotypes were significantly ($P<0.05$) higher than cross and Jenubi genotypes.

No significant differences of T3, T4 and insulin serum concentration were observed between males and females (Table 5). Females showed a slight increase in T3 concentrations compared with males (82.62 and 74.47 respectively). In contrast, males revealed a nearly similar level of T4 (1.37) with females (1.30). No effect of insulin concentrations had seen on sex differences.

Table 5. Means (±Standard Deviation) of T3, T4 and insulin in blood serum (nmol/l)

Breed	T3	T4	Insulin
Brahman	a 85.46±6.00	a 1.44±0.07	ab 111.10±10.44
Cross	a 81.60±3.53	b 1.26±0.04	b 99.25±6.15
Jenubi	a 88.33±4.76	b 1.28±0.06	ab 104.91±8.30
Roman	b 58.79±7.44	a 1.37±0.09	a 116.37±13.72
Gender			
Female	82.62±5.32	1.30±0.07	107.62±9.34
Male	74.47±3.53	1.37±0.04	108.19±6.26
Age (Year)			
1	78.57±2.96	1.34±0.04	b 103.14±5.28
2	78.73±3.89	1.31±0.05	b 101.99±6.87
3	78.34±4.44	1.36±0.06	a 118.58±7.81

- Means with different subscripts within each trait differ significantly at 5%

Regarding to ages, no significant differences of T3 and T4 concentrations were observed between 1 to 3 years (Table 5). However, significantly ($P<0.05$) higher concentration of insulin was measured in three years old animals (118.58 nmol/l) compared with one and two years old (103.14).

Discussions

The findings of the current study show significant differences between breeds in the body and carcass weight as well as dressing percentage. This result agrees with several studies (Albertí *et al.*, 2008, Iwanowska and Pospiech, 2010, Zardari *et al.*, 2017). It can be explained the high dressing percentage and significant values in live and carcass weight in the Brahman breed compare to other breeds (cross, Jenubi and Roman) may due to the Brahman breed is a typical beef cattle, whereas the other studied genotype is a dual purpose breed. Similar findings were observed in the study conducted by Wanowska and Pospiech (2010). It was also reported that, dressing percentage is greater in bulls than cows, beef cattle than dairy cattle, intensively raised cattle comparing with extensive grassing management, heavy and aged comparing with light and young cattle (Iwanowska and Pospiech, 2010). Harris (2006) has also exhibited that dressing percentage of Zebu cattle were lower by about 5-6 % than the beef breeds of America and Europe cattle. This result may due to the genetic difference. Animal sex and age were also shown a significant difference in live body and carcass weight. These results come in agreement with many studies in this area (Zardari *et al.*, 2017, Lukic *et al*., 2017, Rahman *et al.*, 2012b). In addition, Harris (2006) found sex differences within breeds at similar age, Bos Taurus steers have 1.5 to 2% higher dressing percentage than the heifers at the same age. In contrast, Rahman *et al*., (2012b) found that male animals were slightly lower than female animals in the mean of dressing percentage. The same author was also found that breed and sex have influenced significantly with a dressing percentage of zebu cattle.

The normal range and non-significant differences that observed in current results of plasma total protein, albumin and globulin between breeds, sex and age were in agreement with the finding reported by Al-Fartosi *et al.*, (2010) and Sarker *et al*., (2011b). However, it was in contrary to the finding reported by Prisacaru (2014). Also, it has been reported that as an animals age increases, there is a slight elevated in the concentrations of total protein and globulin and decreases in albumin concentrations (Onasanya *et al*., 2015). The decreasing in albumin level and increasing globulin level in blood serum is related to age advancing may have been related to a decreasing in albumin synthesis by animals liver (Dubreuil *et al.*, 2005).

In all four different studied genotypes, the mean values of blood cholesterol concentration were at the normal physiological range in cattle (65-200 mg/dl, Radostits *et al.*, 2000). The findings of current study agree with Qureshi *et al*., (2016) who found significant differences in blood biochemical parameters among four different breeds Holstein Friesian, Jersey, Achai and crossbreeding (Holstein Friesian x Sahiwal) in their early lactation. It was reported that, breeds exhibited various biochemical blood concentrations (Prisacaru, 2014). Mapiye *et al*., (2010) concluded that Nguni cattle had lower cholesterol concentration than crossbreeds. The elevation level of blood and milk cholesterol in cattle after calving may due to the coordinate induction in the expression of key hepatic regulatory genes and their enzyme activity (Viturro *et al.*, 2009). Graber, (2010) found that the cholesterol concentration in the blood increase from week 4 prior to parturition till week 13 post calving as a result of the process of body fat mobilization and β-oxidation of fatty acids. The original article proved that mammary gland shows some participation ability in cholesterol production in milk; however, the total amount of mammary gland was just 20%, the larger amount was produced by liver tissues and transmitted thru blood lipoproteins to mammary gland (Long et al., 1980, Viturro *et al*., 2009). At the present study, sex has no significant effect on cholesterol blood concentration levels. These findings agree with Al-Fartosi *et al.*, (2010) and Prisacaru, (2014). The current study also showed that no significant differences was detected between cholesterol blood level and age, which agrees with the findings of Prisacaru, (2014).

The concentration level of triglyceride was within normal physiol ogical range in cattle (0-250 mg/dL) (Radostits *et al*., 2000). Breed types have no significant ($P<0.05$) effect on triglyceride blood concentration (Al-Fartosi et al., 2010, Prisacaru, 2014, Qureshi *et al.,* 2016), except Roman breed was shows low blood triglyceride concentration. Gender shows significant differences ($P<0.05$) on

blood triglyceride concentration. This findings agrees with the previous study by Ban-Tokuda *et al.*, (2007) and disagrees with Prisacaru, (2014). No significant effect of age on blood triglyceride concentration, which agrees with (Prisacaru, 2014)

Glucose is a crucial nutrient for the lactating cow because it considers as a major substrate requirements for milk production and it must be synthesized in the liver (Lucy *et al*., 2014). Differences in plasma glucose concentration influenced by lactation time around calving, which it decreases after calving due to a rapid and sustained increase in glucose demand for milk production (Garverick *et al.,* 2013). It was also influenced by nutrition (Moore *et al*., 2014), in addition to insulin sensitivity and cow's ability to adapt lactation and synthesize a large amount of glucose in liver (Lucy, 2016), sex and age (Sarker *et al*., 2011a). It was reported that the blood glucose concentration level is different among breed (Bossaert *et al*., 2009, Mapiye et al., 2010, Sarker *et al.,* 2011a). The present finding agrees with previous studies. Despite that, the mean value of blood glucose concentration was at the normal physiological range (45-75 gm/dL) for cattle (Radostits *et al*., 2000). The high level of glucose concentration in Brahman breed may due to the nutritional status. The results achieved from the present study found no significant differences between males and females, which agrees with the result reported by (Al-Fartosi *et al*., 2010). The mean blood glucose concentration in studying cattle decreases gradually with age advancements which revealed similarity with the findings of Doornenbal et al., (1988) and in disagreement with Kumar *et al.*, (2011).

The urea blood concentration level is elevated in response to starvation and high protein diets, The catabolic state in an animal's body due to high energy body requirement may reflect the above situation (Recktenwald *et al*., 2014). With the exception of Roman breed, the mean blood urea concentration in the present study was less than the normal physiological range for cattle (35-135 mg/dL) (Radostits *et al.*, 2000). The reduction in urea blood concentration level may due to the shortage in crude protein level in animals' diets. Recktenwald (2007) had stated that 14 percent of crude protein is the minimum value to provide ruminal nitrogen to cover the body requirement of lactating dairy cattle. Therefore, the stockholders practices nutritional mismanagement is the main reason behind the reduction of the blood urea concentration level. No significant differences were found between males and females in blood urea concentration which agrees with the findings of Al-Fartosi *et al*., (2010). In addition, the current study exhibited non-significant with a slight increases value of urea blood concentration along with animals' age. This finding supported by Knowles *et al.*, (2000) who reported that urea blood concentration increases from 40th to the 80th day of age.

Thyroid hormones, (Triiodothyronine (T3) and Thyroxine (T4)) are considered as an endogenous substances release from the thyroid gland (Kaneko et al., 2008). These hormones influence mostly all body's tissues and helps regulate growth, protein metabolism, energy balance, thermoregulation, and production (Medrano and Hua., 2016). The essential role of thyroid hormones in mammalian body is to stimulate the metabolic body activity by raising the flow of hormones, mainly T3 and T4 plasma concentrations with the purpose of maintaining and improving animal diet and production (Todini et al., 2006). The animals' body response to these physiological processes differently among breeds, age and sex (Todini, 2007). Several studies have proved that the concentration levels of T3 and T4 are influenced by factors, such as breeds, age, sex, nutrition, season, pregnancy and lactation (Todini *et al*., 2006, Todini, 2007, Eshratkhah et al., 2010, Pandita *et al*., 2016). The measurement of T3 and T4 plasma concentration in the present study agrees with the above findings. An addition support study by Dwyer and Morgan, (2006) have found that newborn Blackface lambs had greater T3 and T4 blood concentrations than Suffolk lambs.. Furthermore, Assaf ewes breed had greater blood T4 concentrations than Rasa Aragonesa and Merino ewes breeds, and they were correlated with varices in wool growth rate (Abecia *et al*., 2005). Regarding to sex differences of T3 and T4 blood concen trations, the present finding come in consent with the finding of Celi et al., (2003) on young cashmere goats which found that the levels of T3 blood concentrations were lower in males compared with females, whereas the levels of T4 blood concentrations were not affected by sex. No significant differences were observed in T3 concentration between 1 to 3 years of age and a gradual decrease and increase in T4 blood concentration between 1 to 2 and 2 to 3 years of age respectively. The gradual decrease in plasma T4 blood concentration until 2 years of age observed in the present study may be due the deficiency in feed energy supplementation and other metabolism-related factor (selenium and/or iodine) (Awadeh *et al*., 1998). These observations were in accordance with the results of similar studies conducted on Murrah buffaloes, Pandita *et al*., (2016) who study the variations in T3 and T4 concentrations between 1 and 24 months of age in Murrah buffaloes, they found out that non-significant changes in plasma T3 were observed between 1 and 24 months of age in addition to a gradual increase and decrease in T4 levels were observed between 5–11 and 12–24 months of age, respectively.

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