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# Effect of age on serum metabolites of female Brahman crossbred cattle raised in an integration system of cattle-oil palm plantation in Central Kalimantan

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## ABSTRAK

Penelitian ini ditujukan untuk mengetahui pengaruh umur terhadap metabolit sapi Peranakan Brahman betina yang dipelihara secara ekstensif dalam sistem integrasi sapi-sawit selama 3 bulan. Sebanyak 30 ekor pedet berumur 3-6 bulan, 30 ekor sapi remaja berumur 12-18 bulan, dan 30 ekor sapi dewasa berumur 48 bulan yang secara klinis sehat dipilih untuk penelitian ini. Pengambilan darah (4 mL) dilakukan dari vena koksigea. Serum dipisahkan secara sentrifugasi dan disimpan pada suhu -20$^{o}$C sampai analisis kimia darah dilakukan. Pemeriksaan kimia darah dilakukan dengan menggunakan autoanalyzer (The Roche/Hitachi Cobas 6000 analyzer). Konsentrasi albumin (ALB), kalsium (Ca), forsor (P), natrium (Na), kalium (K), dan klorida (Cl) serum pada pedet secara signifikan lebih tinggi dibanding pada remaja dan dewasa (P<0,05), sedang konsentrasi kreatinin, total protein, *blood urea nitrogen* (BUN) dan globulin serum pada hewan dewasa lebih tinggi dibanding pada pedet (P<0,05). Konsentrasi glukosa pada pedet dan remaja berada pada level yang lebih tinggi dibanding pada hewan dewasa (P<0,05). Dapat disimpulkan bahwa faktor umur harus dipertimbangkan dalam interpretasi hasil pemeriksaan metabolit serum sapi Peranakan Brahman yang dipelihara secara ekstensif di perkebunan kelapa sawit.

*Kata kunci : umur, metabolit serum, sapi Peranakan Brahman, sistem integrasi sapi-sawit*

## ABSTRACT

The study was aimed to evaluate the effect of age on the serum metabolite of female Brahman crossbred cattle raised extensively under the cattle-oil palm integrated system for 3 months. Thirty calves aged 3-6 months, 30 heifers aged 12-18 months, and 30 cows aged 48 months which were clinically healthy were selected and used in this study. Blood samples were collected from coccygeal vein. The serum was separated by centrifugation and stored at -20$^{o}$C until the time of analysis. Blood samples were collected from coccygeal vein as much as 4 mL. Serum metabolites were determined using an autoanalyzer (The Roche/Hitachi Cobas 6000 analyzer). Serum concentration of ALB, Ca, P, Na, K, and Cl in calves were higher than heifers and cows (P<0.05), while serum creatinine, total protein, blood urea nitrogen (BUN) and globulin concentration in cows were higher than those of calves (P<0.05). Serum glucose concentration in calves and heifer was higher than that in cows (P<0.05). It could be concluded that the age factor must be considered in the interpretation of the results of the examination of the serum metabolites of Brahman crossbred cattle raised extensively in oil palm plantations.

*Keywords: age, cattle-oil palm integration, crossbred Brahman cattle, serum metabolite*

## INTRODUCTION

Metabolic profile testing is a series of blood chemistry tests on animals that are important to determine the health conditions of individuals or groups of animals (García *et al.*, 2017). However, a number of previous studies have shown that blood chemical parameter values significantly indicate variations between species, sexes (Stojevic *et al.*, 2008; Balicki *et al.*, 2007), age (Addass *et al.*, 2012; Balicki *et al.*, 2007; Sarmin and Widiyono, 2007; Widiyono and Sarmin, 2012), reproductive status, stress, transportation (Balicki *et al.*, 2007), and several other factors such as animal origin, management, geography (Watanabe *et al.,* 2013), and stages of development (Balikci *et al.*, 2007; Stojevic *et al.*, 2008; Addas *et al.*, 2012). Obese *et al.* (2018) and Adjorlolo *et al.* (2019) reported that supplementation with concentrate feed has a significant effects on profile of blood chemistry parameters in free-ranging animals. Management system has also a significant influence on blood chemistry parameters. The cows which were maintained on pasture showed a different level of some blood chemistry parameters in comparison to the cows confined to a barn (Radkowska and Herbut, 2014). Furthermore, serum metabolite concentrations in free-ranging animals showed seasonal variation (Pambu-Gollah *et al.*, 2000).

The integration of oil palm plantations and the development of cattle farms have the potential to support economic improvement, community welfare, and environmental preservation. Cattle-oil palm integration is one form of implementation of livestock and plant integration system. The concept of integration is very prospective because in some regions, such as Indonesia, there is quite large oil palm plantation area, i.e 14,996,010 hectares with huge biomass potential (Gartina and Sukriya, 2019). With this area, theoretically it can accommodate at least 29 million cattle, assuming 2 cattle/ha (Mathius *et al.*, 2008). Moreover, oil palm co-products caould be utilized as feed for livestock (Zahari *et al.,* 2012; Abdeltawab and Khattab, 2018). The potential for breeding cattle under this integrated system certainly needs to be supported by an establishment of some metabolic parameters of livestock for its health and nutritional assessment. Until now, the blood chemistry parameters of beef cattle reared extensively in the cattle-oil palm integration system and supplemented with concentrate in the tropical regions of Indonesia has never been studied and reported. Thus, the aim of this study was to evaluate the effect of age on the blood chemistry parameters of female Brahman crossbred cattle that were raised extensively in the cattle-oil palm integration system in Central Kalimantan, Indonesia

## MATERIALS AND METHODS

This research wasdeclared eligible for research on experimental animals by the Ethical Clearance Commission, Integrated Quality Testing and Testing Laboratory, Universitas Gadjah Mada on December 14, 2018 with certificate number of 00132/04/LPPT/XII/2018.

### Place and Time of the Study

This research wascarried out in an oil palm plantation located in Kotawaringin Barat District, Central Kalimantan Province, Indonesia. The location of this plantation is at level of 0-500 m above sea level with an area of around 2700 Ha which was divided into 90 blocks, each of which had an area of 30 Ha. The research took place in January-March 2019. During the research period, the region had air temperatures from 25-33$^{o}$C, humidity ranged 87% -92% and rainfall ranged 16 - 487 mm.

### Animals and the Raising

The animals used in the recent study were female Brahman crossbred (BX) cattle. All animals were raised under the auspices of oil palm at the same location extensively for 3 months with a rotational grazing block model. Each grazing rotation consisted of 90 grazing blocks. Each block was 30 hectares in size and was filled with about 350 head of cattle for 1-2 days. Cows were reared on pasture/forages/vegetation between oil palm plants (e.g. *Nephrolepsis biserrata, Nephrolepsis cordiofolia, Centotheca lapacea,* *Axonopus compresus, Ottocloa nodosa*, etc.) and supplemented with concentrate approximately 3 kg/head/day two times daily (at the morning and evening) consisted of oil palm cake (50%), solid palm oil (25%), cassava dregs (15%), molasses (8%), salt 0.8%, and lime (1.2%). Results of the nutritional analyses of this concentrate were presented in Table 1. Drinking water was provided on an ad libitum basis. Before releasing the animals into grazing areas, each animal was examined for its health condition and given antiparasitic medication (ivermectin) and multivitamins. The animals were reared for 3 months and monitored 24 hours a day. At the end of the rearing period, the animals were clinically examined. Only animals with a good health condition and BCS 3 (on a scale of 1-5) were used in this study. A total of 30 animals aged 3-6 months (calf), 30 animals aged 18-24 months (heifer), and 30 animals aged 48 months (cow) were incorporated in this study.

**Collection, Preparation, and Analysis of Samples**

At the end of the rearing/herding period, a cow milling was carried out and 4 mL of blood sample was collected using 10 mL BD Vacutainer tube (Becton Dickinson, US) through the coccygeal vein in the morning before feeding. The serum was separated by centrifugation at a speed of 2000 rpm for 10 minutes and stored at -20°C until the analyses of blood chemical parameters were conducted. Serum blood chemical analysis [glucose (GLU), triglycerides (TAG), blood urea nitrogen (BUN), creatinine (CRT), total protein (TP), albumin (ALB), globulin (GLB), calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), sodium (Na), and chloride (Cl)] was performed spectrophotometrically using an autoanalyzer (The Roche/Hitachi Cobas 6000 analyzer).

**Statistical Analysis**

Statistical analyses were conducted using Statistic Analysis Software (SAS) with error level of 0.05. Data were expressed as mean ± standard deviation. The influence of age on metabolite parameter was analyzed using one way analyses of variance (ANOVA). The mean difference between age group was analyzed using Least Significant Different (LSD).

## RESULTS AND DISCUSSION

The concentrations of serum metabolites of female Brahman crossbred cattle that were extensively reared under oil palm plantations were presented in Table 2. Most of the examined blood chemistry parameters show the average concentration values that were within the range of physiological reference values for cattle (Latimer *et al.*, 2011) and beef cattle (Radostits *et al.*, 2007). The mean value of triglycerides concentrations in serum in all age groups shows a higher value than the reference value. Meanwhile, the mean values of serum ALB, P, Na, and K concentrations in calf were higher than the upper limit value of the reference value for cattle.

The highest blood glucose concentration was recorded in the heifer group (63.90 mg/dL), followed by calf (56.03 mg/dL) and cow (50.20 mg/dL). The results revealed a significant effect of age on glucose concentration in BX cattle. The glucose concentrations in the calf and heifer were significantly higher than that of cow ($P<0.05$), whereas the glucose concentration of the calf and heifer group did not show any significant different ($P>0.05$). The influence of age on blood glucose concentration in the recent study is in line with the results of Doornenbal *et al.* (1988) which indicated a high glucose concentration in newborn calf until 1 year of age. Similar reports were also submitted by Mohri *et al.* (2007) in Holstein dairy cows, Kley *et al.* (2003) in dogs, Levy *et al.* (2006) in cats, and Zinkl *et al.* (1990) in donkeys. The higher serum glucose concentration of female BX cattle in the heifer group in this study may be related to the increased glucose metabolism to obtain energy during growth as stated by Roubies *et al.* (2006). Meanwhile, in adult animals, energy is in majority used for maintenance of daily needs (Reynolds *et al.*, 2003). Another possibility, differences in age-related glucose concentrations in BX cattle could be related to increased insulin level in response to the increase in feed intake (Pavlik*et al.*, 2010) or obesity levels (Ban-Tokuda *et al.*, 2007).

The average triglycerides concentration in the three age groups is above the normal range for cattle. This is most likely related to supplementing feed from oil palm waste (mud/solid and palm kernel meal). Ramos *et al.* (1994) reported that triglycerides concentrations were related to the type and pattern of feed given. Elisabeth and Ginting (2003) suggested that oil palm/solid mud and palm kernel oil cake had high crude fat content, up to 14.78% and 6.49%, respectively. The triglycerides concentration of Brahman

Table 1. Chemical Composition of Concentrate

| Parameter | Value |
|---|---|
| Water content (g/100g) | 2.73 |
| Crude Protein (g/100g) | 9.09 |
| Crude Fat (g/100g) | 9.09 |
| Crude Fiber (kcal/kg) | 4055 |
| Crude Fiber (g/100 g) | 15.58 |
| Ash (g/100g) | 8.20 |
| TDN (g/100g)) | 69.64 |

crossbred cows in this study was at the level of 23.77 mg/dL in the cow group, 23.76 mg/dL in the calf, and 22.73 mg/dL in the heifer. The serum triglycerides concentrations in these three age groups were not significantly different (P>0.05) so it could be said that the age factor had no significant effect on serum triglycerides concentrations. The results of studies on BX cattle were in line with the reports of Dokovic *et al.* (2010) in beef cattle, Pavlik (2009) in Aberdeen Angus cattle, and Husakova *et al.* (2014) in alpaca.

The highest BUN concentration of BX cattle that were raised in oil palm plantations was found in the cow group (18.76 mg/dL), followed by heifer (15.20 mg/dL) and calf (13.76 mg/dL). The statistical analysis showed a significant influence of age on BUN concentration in the female BX cattle (P<0.05). BUN concentrations in the cow group were significantly higher than that in the calf and heifer group (P<0.05), whereas between the heifer and calf group were not significantly different (P>0.05). This finding was in line with the findings of Madziga *et al.* (2013) in beef cattle that BUN concentrations showed an increase with age. Similar reports were also submitted by Kley *et al.* (2003) that the lowest BUN concentration in dogs was at the age of <6 months. A number of researchers also report that BUN concentrations increase with age (Doornenbal *et al.*, 1988; Otto *et al.*, 2000; Pavlik, 2009). Changes in BUN level in female BX cattle in this study might be related to higher protein intake in adult cattle groups as suggested by Mohri *et al.* (2007) in Holstein cows. It is reported that palm mud and palm kernel cake have a high protein content i.e. 14.58% and 16.30%, respectively (Elisabeth and Ginting, 2003). Low BUN concentrations in young animals in the present study could also occur due to the high level of efficiency, in terms of changing nitrogen into amino acids and higher protein, which has the effect on protein turnover in the blood and has therefore the potential to improve performance and productivity (Pavlik *et al.*, 2010; Bourgon*et al.*, 2017).

Based on the results of statistical analyses, there was a significant age related changing in serum creatinine concentration in female BX cattle raised in oil palm-cow integration system (P<0.05). The serum creatinine concentrations in the cow group (1.87 mg/dL) were significantly higher than the serum concentrations in the calf (1.56 mg/dL) and heifer group (1.38 mg/dL) (P<0.05). This is most likely related to animal body size and muscle mass. Previous researchers reported that creatinine concentration was closely related to body size and muscle mass (Kley *et al.*, 2003; Yeom *et al.*, 2012; Giambelluca *et al.*, 2016). Carlos *et al.* (2015) and Santo da Cruz *et al.* (2017) suggested that the high creatinine concentration in adult animals also has to do with the demand for phosphocreatinin for muscle mass gain. Furthermore, the status of creatinine concentration in the serum is also influenced by muscle mass and exercise (Baxman *et al.*, 2008).

The age factor had a significant effect on the concentration of TP of the female BX cattle raised in oil palm plantations (P<0.05). The serum TP concentration of the cow group (7.88 g/dL) was significantly higher than that of calf (7.25 g/dL) and heifer (6.97 g/dL) (P<0.05), whereas the level of the heifer and calf group did not differ significantly (P>0.05). This results were different from the findings in the previousstudies. Patel *et al.* (2016) have found in buffalo that the serum concentration of TP in calves was significantly lower than that in adult animal. Furthermore, Doornenbal *et al.* (1988) reported that young beef cattle had lower TP concentrations than the older. Age-related TP concentrations were also found by a number of previous researchers in bulls (Irfan, 2014), dairy cows (Mohri *et al.*, 2007), sheep (Ottesile and Kasali, 1992; Roubies *et al.*, 2006), camels (Ahmadi-Hamedani *et al.*, 2014), buffalo (Khan *et al.*, 2009), pigs (Yeom *et al.*, 2012), alpaca (Husakova *et al.*, 2014), and dogs (Mundim *et al.*, 2006). According to Pavlik (2009), the TP concentration increases gradually with growth. This is likely due to the increased demand of protein for animal tissue growth

Table 2. Serum Metabolite Concentrations of Female Brahman Crossbred in Various Groups of Age

| Parameter | Age | | | Reference Value |
|---|---|---|---|---|
| | 3-6 weeks (Calf) (n=30) | 18-24 weeks (Heifer) (n=30) | 48 weeks (Cow) (n=30) | |
| Glucose (mg/dL) | 56.03± 17.52[ab] | 63.90±17.60[a] | 50.20±18.03[b] | 40-100[2] |
| Triglycerides (mg/dL) | 23.76± 12.3[a] | 22.73± 7.30[a] | 23.77± 9.02[a] | 0 - 14[1] |
| BUN (mg/dL) | 13.76± 4.84[b] | 15.20± 3.28[b] | 18.76± 3.25[a] | 6.0 - 27[1] |
| Creatinine (mg/dL) | 1.56± 0.35[b] | 1.38± 0.13[c] | 1.87± 0.30[a] | 1.0 - 2.0[1] |
| TP (g/dL) | 7.25± 1.07[b] | 6.97± 0.57[b] | 7.88± 0.74[a] | 5.7 - 8.1[1] |
| ALB (g/dL) | 4.26± 0.70[a] | 3.30± 0.29[c] | 3.87± 0.51[b] | 2.1 - 3.6[1] |
| GLB (g/dL) | 2.99± 0.73[c] | 3.67± 0.43[b] | 4.01± 0.56[a] | 2.9 - 4.9[1] |
| Ca (mmol/L) | 2.69± 0.39[a] | 2.24± 0.12[b] | 2.37± 0.17[c] | 2 - 2.85[2] |
| P (mg/dL) | 9.98± 1.19[a] | 8.39± 1.02[b] | 8.03± 1.01[b] | 5.6 - 8.0[2] |
| Mg (mg/dL) | 2.45± 0.29[a] | 1.97± 0.21[c] | 2.17± 0.23[b] | 1.5 - 2.9[2] |
| Na (mmol/L) | 159.60±18.15[a] | 149.20± 7.39[b] | 143.88± 9.48[b] | 132 - 152[1] |
| K (mmol/L) | 6.43± 0.81[a] | 5.03± 0.53[b] | 4.96± 0.56[b] | 3.9 - 5.8[1] |
| Cl (mmol/L) | 109.84±1.38[a] | 107.3± 5.57[a] | 98.95± 6.88[b] | 95 -110[1] |

[a,b,c.] Means in the same row with different superscripts were significantly different ($P<0.05$). [1]Radostits *et al.* (2007); [2]Latimer *et al.* (2011).

(Singh and Choudhary, 1988). High blood protein concentrations may also reflect efficient use of protein and the development of immunity and growth (Herdt, 2000; Otomaru *et al.*, 2015)

Statistical test results showed that age had a significant influence on serum ALB concentration ($P<0.05$). ALB concentrations in the calf age group (4.26 g/dL), cow (3.87 g/dL), and heifer (3.30 g/dL) were significantly different ($P<0.05$). The mean of serum ALB concentration in the calf was higher than that in the heifer and cow group. These results were in accordance with the results reported in various breed of cattle (Irfan, 2014). Similar findings were also documented by Franca *et al.* (2011) in buffalo, Sakha *et al.* (2008) in goats, and Santo da Cruz *et al.* (2017) in sheep. High ALB concentrations in calves might be related to high amino acid supply for ALB synthesis in the liver and the consumption of colostrum or milk (Herosimczyk *et al.,* 2011). The increased ALB level of the adult group of the female BX cows in comparison to the level of the heifer group might be associated to increase in concentrate consumption in the adult group. Xuan *et al.* (2018) found in cattle that supplementation with the high level of concentrate resulted in the high level of serum ALB concenteration, whereas the supplementation with lower level of concentrate came to the lower serum ALB level.

The age factor had a significant effect on GLB concentrations in BX cattle raised in oil palm plantations ($P<0.05$). Similar results were also reported by Roubies *et al.* (2006) in sheep, Mohri *et al.* (2007) in dairy cows, Yeom *et al.* (2012) in pigs, Villarroel *et al.* (2013) in the FH and Jersey calf, Husakova *et al.* (2014) in the alpaca. The highest GLB concentration was found in the cow group (4.01 g/dL), followed by heifer (3.67 g/dL) and calf (2.99 g/dL). These results were in accordance with the report of Irfan (2014) and Otomaru *et al.* (2015) that the mean GLB concentration in cattle showed a significant difference between the age group. The older the cow, the higher the GLB concentration. Ahmadi-

Hamedani *et al.* (2014) reported that an increase in the average GLB concentration in older animal was thought to be due to an increasingly maturation of the immune system. In addition, differences in GLB concentration might also be related to nutritional status and organic development of animals. According to Yeom *et et al.* (2012), lower GLB concentrations in piglets compared to adult pigs were associated with protein deficiency and the gastrointestinal system which was not functioning optimally.

The age of BX cattle raised in oil palm plantations greatly showed a significant influence on the concentration of Ca in the blood (P<0.05). These results were consistent with the findings in dairy cows (Mohri *et al.*, 2007; Herosimczyk *et al.*, 2011) and beef cattle (Doornenbal *et al.*, 1988; Jezek *et al.*, 2006). Similar results have also been reported by Kley *et al.* (2003) in dogs, Roubies *et al.* (2006) in sheep, Yeom *et al.* (2012) in pigs, Irfan (2014) in breeds of bulls, Husakova *et al.* (2014) in the alpaca, Mikniene *et al.* (2014) in horses, and Hafid *et al.* (2013) in goats. Serum calcium concentrations in calves (4.01 mmol/L) were found to be higher than the concentrations in cows (3.67 mmol/L) and heifers (2.99 mmol/L) (P<0.05). According to Jezek *et al.* (2006), the high Ca concentration in calves have close association to Ca absorption from colostrum and mother's milk. In addition, younger animals could absorb Ca and P from feed more efficiently and optimally in comparison to older ones (Feldman *et al.,* 2006). Furthermore, Rosol and Capen (1997) and Herosimczyk *et al.* (2011) suggested that high Ca concentrations in calves might be related to the stimulation of osteoblast activity in the process of bone mineralization.

BX cattle that were raised under oil palm plantations and supplemented with concentrate had concentrations that were equivalent to the reference value for beef cattle and showed an age related changing. Statistical test results showed that age factor had a significant effect on serum P concentrations (P<0.05). It supports the findings of previous studies in goats (Widiyono and Sarmin, 2012), sheep (Roubies *et al.* 2006), beef cattle (Doornenbal *et al.,* 1988), dairy cows (Mohri *et al.,* 2007), donkeys (Zinkl *et al.,* 1990), dogs (Kley *et al.,* 2003), cats (Levy *et al.,* 2006), pigs (Yeom *et al.,* 2012), alpaca (Husakova *et al.,* 2014), and buffalo (Patel *et al.,* 2016) that serum P concentrations were significantly influenced by age. The calf group had the highest serum P concentration (9.98 mg/dL) and was significantly different from that of the heifer (8.39 mg/dL) and adult group (8.03 mg/dL) (P<0.05), while the heifer and cow age groups did show any significant difference in serum P concentrations. The higher P concentration in young animals in BX cattle in this study is likely related to the growth hormone. Growth hormone increases the process of phosphate resorption in the kidney (Kaneko *et al.,* 1997; Gwaze *et al.,* 2012; Giambelluca *et al.,* 2016; Santo da Cruz *et al.,* 2017). Alternatively, lower serum P concentrations in the adult BX cattle group were associated with lower P absorption capacity than in young animals. In adult goats it is known that lower serum P concentrations can be related to a reduction in the gastrointestinal capacity to absorb P (Gwaze *et al.,* 2012).

Calf group had serum Mg at the level of 2.45 mg/dL which were significantly higher than that of cow/adult (2.17 mg/dL) and heifer (1.97 mg/dL) group. According to Herosimczyk *et al.* (2011), it is probably due to the consequence of the increased need for Mg for bone mineralization and Mg availability in feed. A different profile was presented by Santo da Cruz *et al.* (2017) that the young sheep have lower Mg concentrations than the older one. Sheep that were fed high concentrated feed had higher Mg concentration in comparison to young sheep which were fed only mother's milk containing Mg in low level. The results of the statistical analyses showed that serum Mg concentration of BX cattle raised extensively under the integrated system was significantly influenced by the age factor. These findings support the previous findings in dairy cows (Mohri *et al.,* 2007; Herosimczyk *et al.,* 2011) and goats (Hafid *et al.,* 2013).

The serum concentration of Na in female BX cattle raised under oil palm plantations was significantly influenced by the age (P<0.05). This finding is different from the results of the previous studies in cattle (Bide and Tumbleson, 1976; Mohri*et al.* 2007; Bourgon *et al.,* 2017), sheep (Roubies*et al.,* 2006; Santo Da Cruz *et al.* 2017), and buffalo (Patel *et al.* 2016) which show that age does not affect the concentration of Na in the serum. Na concentration in the calf group (159.60 mmol/L) was significantly higher than the heifer group (149.20 mmol/L) and cow (143.87 mmol/L) (P<0.05), while the heifer and cow groups were not significantly different.. The mean of serum Na concentrations in the heifer and cow groups were at the range of the reference value, while the serum Na concentration in calf was above the reference value for cattle. The high serum Na value was not related to the presence of electrolyte imbalance that may occur due to gastrointestinal disease (Giambelluca *et al.* 2016). Herosimczyk *et al.* (2011) suggested that the highest Na concentration found in calf was related to the high serum level of aldosterone.

The average of serum K concentration of female BX cattle raised under oil palm plantations in the heifer and cow age groups was in the range of reference values for cattle, while the K concentration in calves is above the upper limit of reference values for cattle (Latimer *et al.* 2011) and beef cattle (Radostits *et al.* 2007). The results of statistical analyses showed that the age had a significant effect on the concentration of K ($P<0.05$). The serum concentration of K in the calf group (6.43 mmol/L) was significantly higher than that of the heifer (5.03 mmol/L) and cow group (4.96 mmol/L) ($P<0.05$), while there was no significant differenece in serum K concentration between heifer and cow groups ($P>0.05$). These findings were in accordance with the findings reported by Jezek *et al.* (2006) that serum K was at the high level in calves aged 2 to 6 weeks, subsequently decreased after 8 weeks of age and then reached constant level at the age of 24 weeks. Furthermore, Pavlik *et al.* (2010) and Bourgon *et al.* (2017) also reported that serum K concentrations in in adult bulls were lower than that in young cattle. The higher level of serum K in the young animal compared to that of the older one is also reported in monogastric animal. Yeom *et al.* (2012) found that serum K concentrations were higher in piglets than in adult pigs in which kidney were working less optimally.

The mean serum Cl concentrations in all age groups were in the range of physiological values for cattle (Latimer *et al.* 2011; Radostits *et al.,* 2007). The highest Cl concentration was found in the calf group (109.83 mmol/L), followed by heifer (107.30 mmol/L) and cow group (98.95 mmol/L). Age has a significant effect on serum Cl concentration in female BX cattle raised under oil palm plantations ($P<0.05$). The serum Cl concentration in the calf and heifer groups did not show a significant difference, while the Cl concentration in the cow group showed a significantly lower value than the values in the previous 2 other age groups ($P<0.05$). These results were in accordance with the report of Bide and Tumbleson (1976) and Clinkon and Jezek *et al.* (2006) that high Cl concentrations found in calves would then decrease after the weaning process and subsequently in the adult period were not influenced by age factors. Similar phenomenon has also been found in buffaloes that the physiologic high level of serum Cl could be found at the age of one to six months (Khan *et al.,* 2018).

## CONCLUSION

It could be concluded that the age factor must be considered in the interpretation of the results of the examination of the serum metabolites of Brahman crossbred cattle raised extensively in oil palm plantations.

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## REFERENCES

Abdeltawab, A.M. and M.S.A. Khattab. 2018. Utilization of palm kernel cake as a ruminant feed for animal: A review. Asian J. Biol. Sci. 11(4):157-164.

Addass, P.A., A. Midau, Y.M. Muktar, and Z.B. Mahelia. 2012. Assessment of breed, age and body condition score on hematology, blood chemistry and fecal parasitic load of indigenous bulls in Adamawa State, Nigeria. Int. J. Agric. Sci. 2(1):087-089.

Adjorlolo, L., Y.F. Obese and P. Tecku. 2019. Blood metabolite concentration, milk yield, resumption of ovarian activity and conception in grazing dual purpose cows supplemented with concentrate during the post-partum period. Vet. Med. Sci. 5:103–111.

Ahmadi-Hamedani, M., K. Ghazvinian, P. Kokhaei, M. Barati and A. Mahdavi. 2014. Comparison of effects of age and sex on serum protein electrophoretic pattern in one-humped camels (*Camelus dromedarius*) in Semnan, Iran. Open Vet. J. 4(1):4-8.

Balikci, E., A. Yildiz and F. Gurdogan. 2007. Blood metabolite concentrations during pregnancy and post-partum in Akkaraman ewes. Small Rumin. Res. 67:247-251.

Ban-Tokuda, T., E.A. Orden, A.N. Barrio, R.M. Lapitan, C. Delavaud, Y. Chilliard, T. Fujihara, L.C. Cruz, G. Homma and Y.

Kanai. 2007. Effects of species and sex on plasma hormone and metabolite concentrations in crossbred Brahman cattle and crossbred water buffalo. Livest. Sci. 107:244–252.

Baxmann, A.C., M.S. Ahmed, N.C.Marques, V.B. Menon, A.B. Pereira, G.M. Kirsztajn and I.P. Heilberg. 2008. Influence of muscle mass and physical activity on serum and urinary creatinine and serum cystatin C. Clin. J. Am. Soc. Nephrol. 3(2):348-354.

Bide, R.W. and M.E. Tumbleson. 1976. Age related variations in plasma electrolytes of Hereford cattle under range conditions. Comp. Biochem. Physiol. Part A 54(3):365-371.

Bourgon, S.I., M.D. De Amorim, S.P. Miller and Y.R. Montanholi. 2017. Associations of blood parameters with age, feed efficiency and sampling routine in young beef bulls. Livest. Sci. 195:27–37.

Carlos, M.M.L., J.H.G.M. Leite, D.F. Chaves, A.M. Vale, D.A.E. Facanha, M.M. Melo and B. Soto-Blanco. 2015. Blood parameters in the Morada Nova sheep: influence of age, sex, and body condition score. J. Anim. Plant Sci. 25(4):950-955.

Dokovic, R., Z. Ilic, V. Kurcubic, V. Doskovic and B. Jasovic. 2010. Blood biochemical parameters and enzyme activity in beef cattle. Acta Agric. Serb. XV(29):47-54.

Doornenbal, H., A.K.W. Tong and N.L. Murray. 1988. Reference values of blood parameters in beef cattle of different ages and stages of lactation. Can. J. Vet. Res. 52(1):99-105.

Elisabeth, J and S.P. Ginting. 2003. Pemanfaatan hasil samping industri kelapa sawit sebagai bahan pakan ternak sapi potong. Prosiding Lokakarya Nasional Sistem Integrasi Kelapa Sawit-Sapi. Lokakarya Nasional Sistem Integrasi Kelapa Sawit-Sapi, Bengkulu, Indonesia, September 9-10, 2003. P.110-119.

Feldman, F.B., G.J. Zinkl and N.C. Jain. 2006. Schalm's veterinary hematology. 5$^{th}$ ed. Blackwell publishing. Philadephia. P.1232.

Franca, R.T., M.M. Costa, D.B. Martins, M. Pagnoncelli, M.L. Leal, C.M. Mazzanti, H.E. Palma, C.P. Kunert, F.C. Paim and S.T.A. Lopes. 2011. Protein profile of buffaloes of different ages. Acta Sci. Vet. 39(4):995.

García, C.A.C., F.M. Prado, L.L. Galicia and T.F. Borderas. 2017. Reference values for biochemical analytes in Mexican dairy farms: interactions and adjustments between production groups. Arq. Bras. Med. Vet. Zootec. 69:445–456.

Gartina, D and R.L.L. Sukriya. 2019. Tree Crop Estate Statistics of Indonesia 2018-2020. Secretariate of Directorate General of Estates, Directorate General of Estates, Ministry of Agriculture-Republic of Indonesia, Jakarta.

Giambelluca, S., E. Fiore, A. Sadocco, M. Gianesella, I. Vazzana, T. Orefice and M. Morgante. 2016. Evaluation of venous blood gas levels, blood chemistry and haemocytometric parameters in milk fed veal calves at different periods of livestock cycle. Pol. J. Vet. Sci.19(4):745–752.

Gwaze, F.R., M. Chimonyo and K. Dzama. 2012. Effect of season and age on blood minerals, liver enzyme levels, and faecal egg counts in Nguni goats of South Africa. Czech J. Anim. Sci. 57(10):443–453.

Hafid, N., T. Meziane, B. Maamache and M. Belkhiri. 2013. Biochemical and mineral profile of south eastern Algerian desert goats (*Capra hircus*). Iran. J. Appl. Anim. Sci. 3(3):527-531.

Herdt, T. H. 2000. Variability characteristics and test selection in herd-level nutritional and metabolic profile testing. Vet. Clin. North Am. Food Anim. Pract.16:387–403.

Herosimczyk, A., A. Lepczynski, A.D. Chalupnik, A. Kurpinska, A. Klonowska and F. Skrzypczak. 2011. Age-related Changes of Selected Blood Biochemical Indicators in DairyCalves during Their First Week of Life. Folia Biol. (Krakow). 59:1-2.

Husakova, T., L. Pavlata, A. Pechova, K. Hauptmanova, E. Pitropovska and L. Tichy. 2014. Reference values for biochemical parameters in blood serum of young and adult alpacas (*Vicugna pacos*). Animal. 8(9):1448–1455.

Irfan, I.Z. 2014. Profil Metabolic Sapi Pejantan Bibit Berdasarkan Bangsa, Umur dan BCS (Body Condition Score). Thesis. Institut Pertanian Bogor, Bogor.

Jezek, J., M. Klopcic and M. Klinkon. 2006. Influence of age on biochemical parameters in calves. Bull. Vet. Inst. Pulawy. 50:211-214.

Kaneko, J. J., J.W. Harvey and M.L. Bruss. 1997. Clinical Biochemistry of Domestic Animals. 5$^{th}$ ed. Academic Press. San Diego.

Khan, A.M., M. Younus, R.Z. Hussain and K.H.

Chughtai. 2009. A profile of serum proteins, albumin globulin ratio and total leucocytic count in 6-10 months old healthy and diseased buffalo calves. IJAVMS. 3(2):73-75.

Khan, I.S., C. Singh, S. Tejinder and K. Dua. 2018. Age related changes in blood biochemical and hematological profile of buffalo in calves. J. Vet. Sci. Technol. 9:512.

Kley, S., P. Tschudi and A. Busato. 2003. Establishing canine clinical chemistry reference values for the Hitachi® 912 using the International Federation of Clinical Chemistry (IFCC) recommendations. Comp. Clin. Path. 12:106–112.

Klinkon, M and Jezek, J. 2012. Values of Blood Variables in Calves. A Bird's-Eye View of Veterinary Medicine, Dr. Carlos C. Perez-Marin (Ed.). Intech Open, DOI: 10.5772/32100.

Latimer. K.S., J.R. Duncan, E.A. Mahafrey and K.W. Phrasse. 2011. Duncan and Prasse's Veterinary Laboratory Medicine: Clinical Pathology. 5th ed. Iowa State Press. Iowa.

Levy T.K., P.C. Crawford and L.L. Werner. 2006. Effect of age on reference intervals of serum biochemical values in kittens. J. Am. Vet. Med. Assoc. 228:1033–1037.

Madziga, I.I., C.B.I. Alawa, O.S Lamidi and D.Y. Goska. 2013. Assessing the nutritional status of four indigenous breeds of cattle using some blood metabolites in Nigeria. JBAH. 3(2):1-8.

Mathius, I.W. 2008. Pengembangan sapi potong berbasis industri kelapa sawit. Pengembangan Inovasi Pertanian 1:206-224.

Mikniene, Z., K. Maslauskas, S. Kerziene, J. Kucinskiene and A. Kucinskas. 2014. The effect of age and gender on blood haematological and serum biochemical parameters in Zemaitukai horses. Vet. Med. Zoot. 65(87):37-43.

Mohri, M., K. Sharifi and S. Eidi. 2007. Hematology and serum biochemistry of Holstein dairy calves: age related changes and comparison with blood composition in adults. Res. Vet. Sci. 83:30–39.

Mundim, A.C., A.O. Coelho, S.M. Hortencio, E.C. Guimaraes and F.S. Espindola. 2007. Influence of age and sex on the serum biochemical profile of doberman dogs in the growth phase. Comp. Clin. Path. 16:41-46.

Obese, F.Y., K. Dwumah, L.K. Adjorlolo and R.A. Ayizanga. 2018. Effects of feed supplementation on growth, blood parameters and reproductive performance in Sanga and Friesian-Sanga cows grazing natural pasture. Trop. Anim. Health Prod. 50:1739–1746.

Otomaru, K., H. Shiga, J. Kanome and K. Yanagita. 2015. Blood biochemical values in Japanese Black breeding cows in Kagoshima Prefecture, Japan. J. Vet. Med Sci. 77(8):1021–1023.

Ottesile, E.B., and O.B. Kasali. 1992. Effects of age and sex on serum proteins, urea nitrogen and transaminase concentrations in Ethiopian highland sheep. Bull. Anim. Health Prod. Afr. 40(3):181-184.

Otto, F., P. Baggasse, E. Bogin, M. Harun and F. Vilela. 2000. Biochemical blood profile of Angoni cattle in Mozambique. Isr. J. Vet. Med. 55(3):1-9.

Pambu-Gollah, R., P.B. Cronje and N.H. Casey. 2000. An evaluation of the use of blood metabolite concentrations as indicators of nutritional status in free ranging indigenous goats. S. Afr. J. Anim. Sci. 30(2):115-120.

Patel, M.D., A. Lateef, H. Das, M.V. Prajapati, P. Kakati and H.R. Savani. 2016. Estimation of blood biochemical parameters of Banni buffalo (*Bubalus bubalis*) at different age, sex and physiological stages. J. Livestock Sci. 7: 250-255.

Pavlik, A. 2009. Changes of Internal Environmet Indicators of Aberdeen Angus Heifers During Rearing. Slovak J. Anim. Sci. 42 (1):76-80.

Pavlík, A., P. Jelinek, M. Matejicek and J. Illek. 2010. Blood Plasma Metabolic Profile of Aberdeen Angus Bulls during Post natal Ontogenesis. Acta Vet. Brno. 79:419–429.

Radkowska, I. and E. Herbut. 2014. Hematological and biochemical blood parameters in dairy cows depending on management system. Anim. Sci. Pap. Rep. 32(4):317-325.

Radostits, O.N., D.C. Blood, and C.C. Gay. 2007. Veterinary Medicine. A Textbook of 394 the Diseases of Cattle, Sheep, Goats and Horses. 8th ed., London.

Ramos, J.J., M.T. Verde, M.C. Marca and A. Fernandes. 1994. Clinical chemical values and variations in Rasa Aragonesa ewes and lambs. Small Rumin. Res. 13:133-139.

Reynolds, C.K., P.C Aikman, B. Lupoli, D.J. Humphries and D.E. Beever. 2003.

Splanchnic metabolism of dairy cows during the transition from late gestation through early lactation. J. Dairy Sci. 86:1201-1217.

Rosol, T.J., and C.C. Capen. 1997. Calcium-regulating hormones and diseases of abnormal mineral (calcium, phosphorus, magnesium) metabolism. In: Clinical Biochemistry of Domestic Animals 5th Edition. (Kaneko, J. J., J. W. Harvey, and M. L. Bruss ). Academic Press. London. P. 619–702.

Roubies, N., N. Panousis, A. Fytianou, P.D Katsoulos, N. Giadinis and H. Karatzias. 2006. Effects of age and reproductive stage on certain serum biochemical parameters of chios sheep under greek rearing conditions. J. Vet. Med. A Physiol. Pathol.. Clin. Med. 53(6):277–281.

Sakha, M., M. Shamesdini and Z.F. Mohamad. 2008. Serum biochemistry values in Raini goat of Iran. The Internet Journal of Veterinary Medicine 6(1). https://ispub.com/IJVM/6/1/9889. Retrieved on November 18 2020.

Santo da Cruz, R.E., F.M. Rocha, C.V.B. Sena, P.G. Noleto, E.C. Guimaraes, J.A. Galo and A.V. Mundim. 2017. Effects of age and sex on blood biochemistry of Dorper lambs. Semin. Ciênc. Agrár. 38(5):3085-3094.

Sarmin and I. Widiyono. 2007. Profile of alanine aminotransferase, aspartate aminotransferase, alkaline phophatase and plasma total protein of post natal goats. Media Kedokteran Hewan. 23(1):35-40.

Singh, A. and R.P. Choudhary. 1988. Biochemical studies in Sahiwal and crosssbred cattle. Indian Vet. J. 65(9):791-796.

Stojevic, Z., N. Filipovic, P. Bozic, Z. Tucek and J. Daud. 2008. The metabolic profile of Simmental service bulls. Vet. Arhiv. 78(2):123-129.

Villarroel, A., T.B. Miller, E.D. Johnson, K.R. Noyes and J.K. Ward. 2013. Factors affecting serum total protein and immunoglobulin G concentration in replacement dairy calves. J. Adv. Dairy Res. 1:106.

Watanabe, U., M. Takagi, O. Yamato, T. Otoi, C. Tshering dan K. Okamoto. 2013. Metabolic profile of Japanese Black breeding cattle herds: usefulness in selection for nutrient supplementation to enhance reproductive performance and regional differences. J. Vet. Med. Sci. 75(4):481–487.

Widiyono, I and Sarmin. 2012. Kadar mineral makro dalam serum kambing Peranakan Ettawa yang secara klinis sehat (Serum macrominerals concentrations in clinically healthy Ettawa crossbred goats). J. Veteriner. 13(2):176-181.

Xuan, N.H., H.T. Loc and N.T. Ngu. 2018. Blood biochemical profiles of Brahman crossbred cattle supplemented with different protein and energy sources, Vet. World. 11(7):1021-1024.

Yeom, S.C., S.Y. Cho, C.G. Park and W.J. Lee. 2012. Analysis of reference interval and age-related changes in serum biochemistry and hematology in the specific pathogen free miniature pig. Lab. Anim. Res. 28(4):245-253.

Zahari, M.W., A.R. Alimon and H,K. Wong. 2012. *Utilization of oil palm co-products as feeds for livestock in Malaysia*. In: Biofuel Co-products as Livestock Feed: Opportunities and Challenges. FAO Publications, Rome, Italy, P. 243-262.

Zinkl, J.G., D. Mae, M.P. Guzman, T.B. Farver and J.A. Humble. 1990. Reference ranges and the influence of age and sex on hematologic and serum biochemical values in donkeys (*Equus asinus*). Am. J. Vet. Res. 51:408–413.