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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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°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). 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
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 (Balicki 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 was declared 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 was carried 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°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. Nephrolepis biserrata, Nephrolepis cordifolia, Centotheca lapacea,
Axonopus compressus, 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 llibitum 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 milking 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 (Pavliket 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
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; Bourgonet 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 previous studies. 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>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content (g/100g)</td>
<td>2.73</td>
</tr>
<tr>
<td>Crude Protein (g/100g)</td>
<td>9.09</td>
</tr>
<tr>
<td>Crude Fat (g/100g)</td>
<td>9.09</td>
</tr>
<tr>
<td>Crude Fiber (kcal/kg)</td>
<td>4055</td>
</tr>
<tr>
<td>Crude Fiber (g/100g)</td>
<td>15.58</td>
</tr>
<tr>
<td>Ash (g/100g)</td>
<td>8.20</td>
</tr>
<tr>
<td>TDN (g/100g))</td>
<td>69.64</td>
</tr>
</tbody>
</table>

Table 1. Chemical Composition of Concentrate
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 concentration, 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.

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

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

\( a,b,c. \) Means in the same row with different superscripts were significantly different \( (P<0.05) \). 1Radostits et al. (2007); 2Latimer 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 concentration, 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 al. (2012), lower GB 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; Mohriet et al. 2007; Bourgon et al., 2017), sheep (Roubieset 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 lower.
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 difference 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 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 crossbreed cattle raised extensively in oil palm plantations.

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