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The nutritional quality of captive sambar deer (*Rusa unicolor brookei* Hose, 1893) velvet antler

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Abstract. *Semiadi G, Jamal Y. 2015. The nutritional quality of captive sambar deer (*Rusa unicolor brookei Hose, 1893*) velvet antler. Biodiversitas 16: 156-160.* Deer farming has been a well-developed agriculture diversification worldwide since 1970s. To the present time information concerning the nutrient value of velvet antler of sambar deer (*Rusa unicolor brookei* Hose, 1893) is limited. Therefore, a study on the nutritional quality of velvet antler of captive sambar deer was conducted. Velvet antlers were obtained from captive sambar deer in Penajam Paser Utara, East Kalimantan, Indonesia, and were analyzed for its nutritional quality from the hard and soft parts. The results showed that fresh weight of a pair of velvet antler (approx. 70 days post hard antler cast) was 523.1 g (SE = 49.99). In the soft part of the velvet antler, ash content was 25.9% DM (SE= 0.78) as compared to 40.4% DM (SE = 1.07) in hard part, whilst the lipid and protein contents from the soft part were 3.3% DM (SE = 0.20) and 70.8% DM (SE = 2.07), respectively, higher compared to those in the hard part being 1.9% DM (SE = 0.12) and 59.5% DM (SE = 1.92), respectively. From the study it can be concluded that the production of velvet antler from captive sambar deer seemed to be far from its genetic potency, and the nutritional qualities of the velvet antler contents were not different from the red deer *Cervus elaphus*.

Key words: nutritional quality, production, *Rusa unicolor brookei*, sambar deer, velvet antler

INTRODUCTION

Deer farming has been one of the fastest developed new livestock diversification worldwide since 1970s (van den Berg and Garrick 1997, Hoffman and Wiklund 2006). At present, the species being bred are not only limited to temperate origin species, but also from tropical part, such as rusa deer (*Rusa timorensis*) and sambar deer (*Rusa unicolor*; Sookhareea et al. 2001; Haigh 2002), although farming the sambar deer is very limited to Australia, Malaysia, and Thailand. The main products of the deer farm are venison and velvet antler, with by-products known as pitzel, dry tail and sinew are still having high market values in oriental markets, such as in Korea and China (Kong and But 1985; Kim 2001; Kim et al. 2004).

The culture of using velvet antler among Chinese medical practitioners as part of their traditional medicine has been known for hundred years. Some claims on those Chinese beliefs on the power of velvet antler in maintaining health, particularly related to rheumatism and the improvement of body vitality have been scientifically proven (Allen et al. 2002; Frolov et al. 2001; Shin et al. 2001; Sim and Sunwoo 2001). Study also showed that the extract of velvet antler of Formosan sambar deer (*Rusa unicolor swinhoei)* has the potential as the anti-infective activity against pathogenic *Staphylococcus aureus* (Dai et al. 2011). This accelerates the development of food supplement industry from velvet antler origin in the western part, in the forms of powder, slices, extract or tonic.

Indonesia has three native deer species; the Javan deer, sambar deer and Bawean deer (*Axis kuhlii),* besides the deer introduced from India, spotted deer (*Axis axis).* The distribution of sambar deer in Indonesia is limited to Sumatra and Kalimantan islands (Wilson and Reeder 2013), whereas in Kalimantan the utilization of sambar venison is very high through poaching activities. From one district, no less than 120 heads of sambar per month were poached, providing no less than 234 kg venison that was sold in traditional market. Average of carcass weight from stag was 74.99 kg and from hind was 63.06 kg (Semiadi et al. 2004).

Under the Indonesian Wildlife Law, the native deer species are protected animals. However, they are possible to be utilized once has been bred in captivity. In 2002 a Decree of the Minister of Agriculture was issued concerning the inclusion of deer as prospective livestock. However, the execution of this regulation is far from the reality. The latest Indonesian Animal Husbandry and Veterinary Law (UU no. 18/2009) has made possible for wildlife animal that has been bred in captivity, specifically for production purposes, to be adopted as a domesticated animal. The development of deer farming in Indonesia was initiated in 1990 by the establishment of a pilot project of sambar deer farm (*Rusa unicolor brookei*, Hose 1893) in Penajam Paser Utara District, East Kalimantan. At present, the number of deer being bred reaches 301 deer in an area of 15 ha paddock (IG Ngurah, pers. comm.).

To the present time, information related to the production of sambar deer is still very limited (Ismail and Hanoon 2008), and so does with the velvet antler quality (Jamal et al. 2005). Therefore, as part of the development strategy of deer farming in Indonesia, it is necessary that

the information related to the quality of velvet antler of sambar deer and the possibility of utilizing them as a food supplement is available. The purpose of this study was to understand the quality of captive sambar velvet antler from its nutritional values.

MATERIALS AND METHODS

The research was conducted in a sambar deer farm in Penajam Paser Utara District, East Kalimantan. Velvet antlers were harvested from eight mature (> 4 years) stags, placed in a drop floor crush while velvet antler cutting was conducted. The cutting time for velvet antler was determined based on the antler physical condition, in which the main beam has not yet branched.

Method of velvet cutting followed Wilson et al. (2000). On each of velvet antlers, around its ring block, local anesthetic injections were administered using Lidocaine (2% lidocaine hydrochloride) approximately 6-8 ml/antler. The subcutaneous injections were circled in four to five places using a syringe of 1" x 20 G. After the injection, approximately 3-5 minutes later, tourniquet was placed around each ring block and velvet antler was cut.

Once it had been cut, the harvested velvet antlers were directly turned upside down and slanted 15^0 for five minutes to avoid excessive blood lost. They were cleaned from dust, weighed, and the length and diameter of the antler were then measured using polypropylene meter tape and digital micro-caliper (Yamato, Japan), respectively, twice each, then were put into plastic bag, labeled and stored in a freezer (-5^{o}C). Velvet antler diameter was measured at the mid-point of the antler length. Prior being transported to the laboratory, the velvet antlers were put into ice boxes containing blue chips ice cooler to maintain their freezing level during the traveling. The time of arrival in laboratory was six hours with the antlers condition were still frozen, and then put into a deep freezer (-20^{o}C) until the laboratory analysis process.

Before the velvet antler being processed, the antlers were thawed and the soft hair was burnt on a pressurized gas Bunsen burner. Left and right parts of the soft velvet antler part were then manually sliced thinly with a sharp knife, with a thickness of 3-5 mm, until it reached the hard part (semi ossified) that could not be cut manually by ordinary knife. The hard part was then cut into small pieces using a chopping knife. All samples that had been cut (soft and hard parts) were freeze dried for 18-24 hours, then ground using hammer mill (Retch Muhle, Germany) to pass through a sieve of 1 mm.

Analyses of nutrient content of antler were only done on the samples taken from the right side of the antler, representing the hard and soft parts. Moisture content was analyzed by putting into a ventilated oven at 105^{o}C for 18 hours. The ash content was determined using a furnace at 550^{o}C for 12 hours (AOAC 2005). All analysis was conducted in Nutrition Laboratory, Zoological Division of the Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong Bogor, West Java.

Mineral content analysis was conducted using the Atomic Absorption Spectrometry (AAS), for amino acids with chromatography technique (HPLC), fatty acids with gas chromatography technique (GC), total lipid with soxhlet technique and total nitrogen with Kjehdhal technique (AOAC 2005), conducted at the Integrated Chemical Laboratory, Faculty of Mathematics and Natural Science, Bogor Agricultural Institute (IPB), Bogor, West Java. The conversion to crude protein content was done by a multiplying factor of 6.25 to the nitrogen content.

Analyses of chemical components of antler were done on the samples taken from the left part of the antler, representing the hard and soft parts. Each sample was extracted with ethanol absolute placed in shakers (100 rpm per minute). The addition of alcohol solvent was done three times every 24 hours, 100 ml each, until reaching a total volume of 300 ml for each sample. The result of ethanol extraction was then evaporated using rotating evaporator at 50^{o}C until it was free from the solvent. This process was conducted at the Phytochemistry Laboratory, Botany Division, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong, West Java, Indonesia.

The analysis on chemical compounds from the extract was carried out at the Department of Natural Product Chemistry, Faculty of Pharmacy and Pharmaceutical Science at Fukuyama University, Hiroshima, Japan using Gas Chromatography Mass Spectrometry (GCMS system electron impact, Shimadzu Qp-5000, Japan), using the TC-17 column (L=30 m, ∅= 0.25 mm, GL Science USA). The injection volume was 0.1 ul. The carrier gas was helium with a gas speed flow of 1.36 ml/minute and a column pressure of 90 kPa. The column temperature was programmed to be 100^{o}C to 270^{o}C with a temperature increase of 3^{o}C per minute. The detector temperature (quadruple) was programmed to be constant at 270^{o}C with energy of 1.25 kV. The injector temperature was 300^{o}C. Identification of each peak was done using spectrum mass authentic from the National Institute Standard of Technology (NIST) library, ver. 6.2. Data were analyzed using the general linear model procedure of SAS ver. 9.0 (SAS 2002). Whenever, appropriate data were analyzed either by regression for the antler morphometry, and T-test or factorial analysis between hard and soft parts against its nutrient values (Steel and Torrie 1980).

RESULTS AND DISCUSSION

Due to the lack of good management practice in managing stags for velvet antler production, it was difficult to obtain accurate data concerning the age of velvet antler growth when it was harvested. Therefore, observation on the shape of the main beam which almost to branch was used as an indicator for the optimum cutting time to obtain the best quality of velvet antler. On red deer (*Cervus elaphus*), cutting age of velvet antler was at 60-65 days post hard antler drop (Sunwoo and Sim 2001), coincided with unbranched condition of the main beam. However, from this study it was predicted that the ages of velvet

antler of sambar deer that were harvested had never been more than 70 days old post antler cast (A Trasodiharjo pers. comm.)

The fresh mean weight of a pair sambar deer velvet antler was 523.1 g (SE = 49.99; n = 8) with the average overall moisture content of the velvet antler being 74.1 % (SE = 1.78; n= 8). The soft part of the velvet antler had its moisture content of 30.1% (SE = 4.0; n= 8) of the total dry matter weight. The velvet antler dimensions of the right and left parts showed a symmetrical shape, therefore no significant differences were found (Table 1). However, one antler did not have its first tine. The correlation between the length and diameter of the main beam was much higher (R^2= 0.75; p<0.001) compared to that of the first tine (R^2= 0.55; p<0.008). A symmetrical shape of antler was also showed in majority of wild Javan deer (Semiadi 1997).

The production of velvet antler cut that only reached 0.5 kg fresh weight per cutting time, indicated that the genotype quality of sambar stags as velvet antler producer was far from the expected. In Thailand, sambar deer velvet antler at 74-92 days of harvest age, could weight 820-1,640 g per side, with the length and circumference were 41-63 cm and 11.5-17.2 cm per side, respectively (Liangpaiboon et al. 1996). While in farmed red deer, the velvet antler production can reach up to 2.0 kg/cutting time (Haigh and Hudson 1993; Jeon and Moon 2001) and can be predicted from the age with an average genetic correlation of 0.74 with heritability estimates age from 2 to 8 years being 0.43 to 0.85 (van den Berg and Garrick 1997). Ismail and Jiwan (2013) suggested that the best velvet antler harvest time in sambar deer is at 49-63 days post hard antler casting when the antler length is 25-30 cm.

The low antler production in this study seems to be related with the unselected breeding system of sambar stags being managed in the premises. From the body weight condition, sambar deer were about 30-40% heavier than red deer, therefore it was still possible to have a higher velvet antler production, once the breeding system has been set up. In red deer industry, grading system of velvet antler was based on the combinations between the length, diameter and weight. Similar system must also be started to be developed for the velvet antler of sambar deer.

The results of ash, lipid and protein contents showed a very significant differences between parts of the antler (soft and hard) on the ash and lipid (p<0.001) and protein contents (P<0.005; Table 2). In the soft part, ash content was 36% lower, but lipid and protein contents were approximately 74% and 19%, respectively, higher than those were in the hard part. Values for protein and ash contents in this study were close to that of wapiti, sika and its hybrid deer species velvet antlers, except for ash, the current study tended to have 45% lower (Wang et al. 2004). While from the Formosan sambar deer, the protein content of velvet antler was reported as 64% DM at the harvesting age of 75 ± 2 days (Yun et al. 2009).

The best grade of velvet antler under the Korean market system is when the soft part of antler has the ash content below 25% DM (Kang et al. 2001). In this study, the soft part contained 25.9% DM ash, in which it was 30.1% of the antler total dry weight. Therefore, as a starting step, the use of physical parameter in cutting time on the velvet antler in this study had a practical good indicator and almost fulfilled the quality requirement under the Korean standard.

There was no interactive correlation obtained between parts of antler (hard and soft) and the types of fatty acid, however, the concentrations of fatty acid was significantly different (p<0.001) between the two antler part, as well as the type of fatty acid contents (p<0.1085; Table 3). Palmitic acid was the highest, while mistiric acid being the lowest concentration.

In term of amino acid contents, a very strong correlation was obtained (p<0.001) between the types of amino acids and antler parts (Table 4). Velvet antler of sambar deer contained 8 out of 9 essential amino acids, with only tryptophan group undetected. There was a tendency that amino acid concentration in the soft part was higher than that in the hard part. Glycine and glutamate groups were the ones with the highest concentration, followed by alanine, arginine and aspartate. Whilst methionine had the lowest concentration.

From Table 3 it can be seen that all fatty acid in velvet antler consisted of long chain fatty acid (14-24 carbon atoms), with the highest concentration was palmitic acid. Linoleic and linolenic acids are known to function in maintaining cell structure and cell membrane. These two fatty acids are also functioned as the principle materials in synthesizing hormones, for the formation of blood coagulant, blood pressure, blood lipid concentration, immune response, responses on wounds and infections (Mahan and Arlin 1989). In the present study the content of both compounds were relatively low compared to the other fatty acid compounds.

Table 1. Fresh sambar deer velvet antler dimension used in the study.

Parts	Main beam (mean SE; n=8)		First tine (mean SE; n=7)	
	Length (cm)	Diameter (mm)	Length (cm)	Diameter (mm)
Right	22.6 (0.55)	29.9 (0.63)	13.0 (0.63)	22.5 (0.70)
Left	22.9 (0.61)	29.8 (0.60)	12.1 (0.89)	22.4 (0.67)

Table 2. Chemical compositions of sambar deer velvet antler.

Part	Ash (%DM SE; n=16)	Fat (%DM SE; n=12)	Protein (%DM SE; n=6)
Hard	40.4 (1.07)	1.9 (0.12)	59.5 (1.92)
Soft	25.9 (0.78)	3.3 (0.20)	70.8 (2.07)

Table 3. Fatty acid composition from sambar deer velvet antler.

Fatty acids	Hard part (%DM SE; n=6)	Soft part (%DM SE; n=6)
Behenic acid	2.49 (0.227)	2.60 (0.227)
Lignoseric acid	0.81 (0.033)	0.74 (0.097)
Linoleic acid	0.48 (0.113)	0.74 (0.088)
Linolenic acid	0.35 (0.022)	0.39 (0.032)
Myristic acid	0.22 (0.033)	0.26 (0.030)
Oleic acid	2.41 (0.496)	3.64 (0.561)
Palmitic acid	8.39 (0.382)	8.59 (0.315)
Stearic acid	2.96 (0.491)	3.01 (0.241)

The essential amino acids concentration showed that the soft part had higher content than that in the hard part. Jeon et al. (2004) showed that feed sources created differences in velvet protein, lipid, amino acid and mineral composition. From this study, glycine was the amino acid with the highest concentration in both parts. Comparing the amino acid composition in velvet antler from red deer and sambar deer, it shows the consistency of glycine as the highest concentration component among all amino acids. However, the concentration in red deer is higher than in sambar deer (15.58% vs. 9.07%; Sim and Sunwoo, 2001). It was further reported that the amino acid group of aspartic acid, glycine, alanine and glutamic acid were the major components in temperate deer velvet antler. By observing cholesterol concentration or its derivates, velvet antler contained relatively low cholesterol compounds compared to other saturated fatty acids. The ethanol extract of velvet antler from both the soft and hard parts, consists of unsaturated long chain fatty acids, carboxylic acids with amine chains and one compound of cholesterol derivative.

Minerals content showed that there was a high significant interaction ($p<0.001$) between antler parts with the types of minerals (Table 5). Iron (Fe) was the microelement with the highest concentration in the velvet antler, in which the concentration in the soft part was 65% higher than that in the hard part. Calcium was the macro mineral with the highest concentration. Bubenik et al. (2005) had shown that mineralization of temperate deer velvet antler was affected by the role of 17β estradiol (E_2).

The analysis of chemical compound using GCMS resulted in unsatisfying outcome, as it was only capable of detecting fatty acid groups, but not the steroid hormone groups. Analysis of both antler parts, showed that both had 14 identical chemical compounds, but in different concentrations (Table 6).

Minerals play important roles in oxygen transportation, nervous system, the formation and maintenance of the bone itself. The range of minerals content in velvet antler of red deer is very wide (Table 7), considering that these very much depend on the calcification level in antler when being cut. Calcium is the most dominant one, considering its role in the formation and maintenance of bone. In sambar deer, the mineral content in the hard part almost twice higher than that in the soft part. However, in general, the minerals content of the present sambar deer velvet antler is within that of the red deer (Table 7)(Haines and Suttie 2001).

From this study it can be concluded that the production of velvet antler of captive sambar deer was still far from its optimum potency. Whereas, the nutrient contents were close to that of red deer velvet antler values.

Table 4. Amino acid compositions from sambar deer velvet antler.

Amino acids	Hard part (%DM SE; n=6)	Soft part (%DM SE; n=6)
Alanine	4.24 (0.135)	4.46 (0.208)
Arginine	4.10 (0.122)	4.54 (0.216)
Aspartate	3.57 (0.141)	4.63 (0.173)
Phenylalanine	1.57 (0.079)	2.19 (0.097)
Glycine	9.07 (0.226)	8.40 (0.517)
Glutamate	5.61 (0.187)	6.95 (0.249)
Histidine	0.86 (0.071)	1.36 (0.097)
I-Leuisine	0.99 (0.039)	1.43 (0.046)
Leusine	2.54 (0.133)	3.77 (0.148)
Lysine	2.37 (0.116)	3.20 (0.141)
Methionine	0.59 (0.022)	0.93 (0.021)
Serine	2.32 (0.099)	3.04 (0.125)
Threonine	1.86 (0.095)	2.56 (0.107)
Tyrosine	0.94 (0.052)	1.55 (0.041)
Valine	1.78 (0.091)	2.52 (0.106)

Table 5. Mineral compositions from sambar deer velvet antler.

Mineral	Hard part (DM SE; n=6)	Soft part (DM SE; n=6)
Ca (%)	6.87 (0.504)	3.97 (0.087)
K (%)	0.20 (0.028)	0.45 (0.039)
Mg (%)	0.35 (0.030)	0.23 (0.019)
Na (%)	0.65 (0.04)	0.94 (0.119)
P (%)	0.21 (0.005)	0.20 (0.005)
Co (ppm)	0.05 (0.000)	0.05 (0.00)
Cu (ppm)	7.91 (1.082)	9.16 (1.701)
Fe (ppm)	147.20 (23.950)	223.73 (28.328)
Mn (ppm)	3.72 (0.39)	3.80 (0.413)
Se (ppb)	1.00 (0.289)	0.85 (0.247)

Table 6. Chemical compositions from ethanol extraction of sambar deer velvet antler.

Components	Molecular structure	Molecular weight	Retention time	Proportion (%)	
				Soft	Hard
Methyl ester decanoic acid	$C_{11}H_{22}O_2$	186	18.4	2.50	2.47
Hexadecanoic acid	$C_{16}H_{32}O_2$	256	19.6	11.57	5.65
Palmitic acid	$C_{15}H_{30}O_2$	256	19.8	7.93	10.37
12-methyl-methyl ester tetradecanoic acid	$C_{16}H_{32}O_2$	256	21.1	7.71	8.22
Methyl ester 13-docosenoic acid	$C_{23}H_{44}O_2$	352	21.2	1.05	0.64
Methyl ester 11,14-eicosadienic acid	$C_{21}H_{38}O_2$	322	21.4	1.86	2.45
Oleic acid	$C_{18}H_{34}O_2$	282	22.3	17.26	16.86
Undeconoic acid	$C11H_{20}O_2$	184	22.6	8.49	10.87
2-methyl-2-(dimethylamino) ethyl ester 2-propenoic 1 acid	$C_7H_{13}NO_2$	157	23.4	3.86	2.64
2-methyl (dimethylamino) ethyl ester 2-propenoic acid	$C_7H_{13}NO_2$	143	25.8	7.09	4.85
Propyl hexedrine	$C_{10}H_{21}N$	155	26.0	1.53	1.55
9-octadecenamide	$C_{18}H_{35}NO$	281	26.4	1.42	1.21
2-(dimethylamino) ethyl ester	$C_{18}H_{35}NO_2$	157	28.3	1.72	1.94
Dicholesteryl sucsinate	$C_{58}H_{94}O_4$	854	43.0	23.17	25.20

Table 7. Mineral compositions of red deer velvet antler by infra red spectroscopy technique from freeze dry sample (Haines and Suttie 2001).

Components	Mean	Range
Ash (%)	37.0	7.6-61.0
Fat (%)	0.56	0.01-1.72
N (%)	8.5	5.3-12.6
Ca (%)	12.2	0.1-22.0
P (%)	5.9	0.3-9.6
Fe (ppm)	347	33-970

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