Effects of *Eurycoma longifolia* provision on blood sugar level, cholesterols, and uric acid of Etawa Crossbreed Goat

Hurip Pratomo

1Department of Biology, FMIPA State Open University/Universitas Terbuka, Pondok Cabe, Pamulang, South Tangerang 15418, Indonesia

Email: hurip@ecampus.ut.ac.id Tel: +62-21-7490941; extension 1810

Abstract. Previous research on male white rat with provision of *Eurycoma longifolia* until the 3rd days has increased significantly on the formation of final spermatid from spermatozoon, and testosterone, and increase activity of pituitary cell producing the LH hormone. However, these researches yet studied on possibility of side effects caused by provision of *Eurycoma longifolia* for 6 days on male EC goat. The research aims to measure the effect of *Eurycoma longifolia* on the levels of: 1). Blood sugar, 2). Cholesterols, and 3). Uric acid of Male Etawa Crossbreed (EC) goat. This research was conducted through two treatment groups, namely : 1). Control group (provision of aquadest) for 1 day, 3 days, and 6 days, 2) *Eurycoma longifolia* group with a dose of 90 mg/kg body weight (bb) for 1 day, 3 days, and 6 days. Measurements on the sugar blood, cholesterol and uric acid level were conducted in the 1st, 2nd and 6th days. The obtained data were analyzed using Duncan test with confidence level by 95% (α=0,05) comparing the sugar blood, cholesterol and uric acid measured from the control group in the 1st, 3rd and 6th days with the same compound level measured from the *Eurycoma longifolia* treatment group in the 1st, 3rd and 6th days. The result obtained there were no significant changes on the sugar blood, cholesterol and uric acid levels between all *Eurycoma longifolia* treatment groups compared to the control group in the 1st, 3rd and 6th days. Thus, the *Eurycoma longifolia* provision until in the 6th day did not provide any negative side effects and can be applied in the Etawa crossbreed goat farm.

Keywords: *Eurycoma longifolia*, side effect, Etawa

1. Introduction

Performance of superior male goat cannot only be seen from its body size and shape performance, however it must also be seen from its reproduction and health quality [1,2]. Goat of EC with bigger body size and weight than average Javanese goats is one of the potential alternatives in meeting meat needs in Indonesia [3,4]. Meanwhile, there were still low average rates of lamb consumption of by the public namely by 0,05 Kg/capita/year in 2007-2011 [5,6].

In order to increase masculinity, there is a finding that *Eurycoma longifolia* did increasing masculinity. The *Eurycoma longifolia* treatment by a dose of 18 mg/200 g body weight on male white mouse for three (3) days obtained findings, namely changes on the parameters of: (1) spermatozoon concentration increased, and (2) decrease on number of abnormal spermatozoon [7]. Another research, on provision of *Eurycoma longifolia* for 6 days on male EC goats with a conversion dose of white mouse into goat body weight namely a dose of *Eurycoma longifolia* by 90 mg/kg body weight
obtained findings namely increases on: 1) volume of ejaculate, 2) motility, 3) Percentage of living spermatozoon, and 4) decrease on percentage of abnormal spermatozoon [8].

Provision of *Eurycoma longifolia* for 6 days on male EC goats [8] increased some important parameters on reproduction quality. Previous research on male white rat with provision of *Eurycoma longifolia* until the 3rd days has increased significantly on the formation of final spermatid from spermatozoon, and testosterone [9], and increase activity of pituitary cell producing the LH hormone [10]. However, these researches yet studied on possibility of side effects caused by provision of *Eurycoma longifolia* for 6 days on male EC goat. So that it is necessary for a research on the possibility of side effects, namely study on the effects of *Eurycoma longifolia* provisions on the blood sugar, cholesterol and uric acid levels on male EC goat.

Provisions of *Eurycoma longifolia* on male white rat and male EC goats increase quality of the animal reproduction [7,8]. Meanwhile, quality of hormone was shown by testosterone level, not only by other hormones [11,12]. Finding on the significant effects of *Eurycoma longifolia* provisions b by a dose of 90 mg/kg body weight in 20 ml aquades until the 6th days is to increase the testosterone level and percentage of living spermatozoon, although it did not increase concentration of male EC goat spermatozoon [8].

The required quality of male EC Goats for EC goat population increase in mass scale is male EC with proper and health reproduction quality. Related to the health of male EC goats given *Eurycoma longifolia* provision for 6 days, based on outside morphology observation, there are no disorder or diseases on the bodies [8]. But, there will obtain more valid health characteristic presentation, if it is reviewed on some standard characters to assess the body health, for example, based on blood sugar, cholesterol and uric acid levels [13]. Although there are yet any standard on blood sugar, cholesterol and uric acid levels on male EC goats, but it can be assumed that the male EC goats with no provisions of *Eurycoma longifolia* (as control groups) are representation of health EC goat groups. So, the blood sugar, cholesterol and uric acid levels can be used as a comparison on the *Eurycoma longifolia* treatment group.

The research aims to measure the effect of *Eurycoma longifolia* on the levels of: 1). Blood sugar, 2). Cholesterol, and 3). Uric acid of Male Etawa Crossbreed (EC) goat.

2. *Eurycoma longifolia* Contents, and The Blood Standard Characters of The Body Health

The *Eurycoma longifolia* or also known as *Eurycoma longifolia* Jack is a tree with a slim shape with a height can reach 15 m, the leaves are in type of pinnate lined, with a length from the base to the stalk is 20-40 cm. The *Eurycoma longifolia* is dioecious or two houses. The ripe fruit is dark reddish green. Roots of the *Eurycoma longifolia* has its hard inside yellowish [14,15].

The *Eurycoma longifolia* Jack contains a variety of compounds. The phytochemical components extracted from the *Eurycoma longifolia* roots in a variety of solvents such as methanol, dichloromethane, chloroform, with water containing: Terpenoid, stigmasterol, sitosterol, sterols, saponins, Melian, longilen, longilactone A and B, hidroxy eurycomalactone, hidroxy santin-mono-oxide, hidroxy dehidro eurycomalactone, hispidone, eurilene, durilactone, eurycomanol-oD-glikopiranosid, eurycomanol, dihidro-eurycomalactone. Most of the *Eurycoma longifolia* contents are having characteristics as polar, so it is appropriate if extracted / brewed with water solvents [16, 14, 17,18]. In addition, there are three types of eurycolatone quasinoid namely A, B and C that were isolated from the *Eurycoma longifolia* roots [19, 20, 21].

The blood standard characters of the body health that are: level of Glucose, Cholesterol, and Uric acid.

2.1 Blood Sugar (Glucose)

Blood sugar in the form of glucose with high or cumulative level is called as hyperglycemia. Hyperglycemia is caused by Diabetes Mellitus (DM). Diabetes patients cannot produce insulin in adequate number, so that there is excessive glucose in the body. Chronical excessive glucose in the blood (hyperglycemia) is poisonous for the body [13, 22].
2.2 Cholesterol
Cholesterol is a metabolite containing sterol fat found out in membrane cell and circulated in blood plasma. Cholesterol is particular type of lipid called as steroid. Other Steroid include hormonal steroid such as cortisol, estrogen, and testosterone. The steroid hormones are made by changes on cholesterol basic chemical structure [13, 23].

The cholesterol attached in the wall of blood vessel after immune reaction will form foam cells clogging artery blood vessel and block the flow of oxygen causing to heart failure. Another complication is stroke. Number of appropriate cholesterol for human body is recommended to be 300 mg/dl every day [24].

2.3 Uric Acid
Uric acid is the end substance product of or waste products of purine in the body as a result of purine catabolism aided by guanase and xanthine oxidase enzymes [25]. This uric acid is brought to the kidneys through the bloodstream to be excreted with urine, if there is any disruption on urinary tract elimination occurs through the kidneys, it causes decrease uric acid secretion into the kidney tubule [26], so that there will be increased levels of uric acid in the blood, this condition is called as hyperuricemia. Further hyperuricemia can develop into gout namely a disease attacking on the joint. Hyperuricemia is at high risk for some disorders such as arthritis gout, kidney stones, kidney damage, and hypertension [23].

3. Research Method
The research was conducted in the EC goat farm from the group of livestock of Ciampea Bogor by Dompet Dhuafa Foundation guidance.

3.1 Making Powder Eurycoma longifolia Root
The roots of Eurycoma longifolia are processed following modified procedure [27, 28], as follows: the roots are skinned; inside parts in the form of wood are washed and then drained and cut into pieces. The pieces were dried in an oven at 50ºC for five days, then ground into powder using a Wiley USA grinder, then sieved with Mesh 50 sieves.

3.2 Designing in Two Treatment Groups
Based on the dose of 90 mg / kg body weight for 6 days [8], the treatment design in the study is 2 groups with 5 replications (n = 5 goats, 1.5 years old) as follows:

Group 1 (n=5 male EC goat): The Control group with 20 ml oral aquades provision every morning at 09.00 am. for the first (1st), 3rd and 6th days

Group 2 (n=5 male EC goat): The experimental group, using the dose of Eurycoma longifolia is 90 mg / kg body weight in 20 ml oral aquades every morning at 09.00 am. for the first (1st), 3rd and 6th days.

Measurements of blood sugar, cholesterol, and uric acid levels were performed on the the first (1st), 3rd, and 6th days at 17.00 am. Blood sampling is taken from the earlobe veins.

3.3 Measurements on Blood Sugar Level
Before the measurement on blood sugar level, the experimental animals are fasted for a half of day. During the fasting, any grasses are taken out from the cages, so that these are not eaten by the experimental animal namely EC male goat. Measurement on the blood sugar is using tool similar to Mini Accutrend namely Easy touch GCU [29]. Measurements on blood glucose level are conducted in the 1st, 3rd, and 6th days.

3.4 Measurement on Cholesterol Level
Measurements on cholesterol level are conducted in the 1st, 3rd, and 6th days. The goats are measured their level of HDL (High Density lipoprotein) cholesterol in their blood or measuring using apolipoprotein, so that it is not necessary to measure triglyceride. Apolipoprotein is a protein in the
body assisting to transport the cholesterol. The blood samples are absorbed by 15 µl into the tip of measurement tool, and then put aside for around 3 minutes so that it can be read the measurement results of cholesterol level in the tool screen [29].

3.5 Measurement on Uric Acid Level
Measurements on uric acid level are conducted in the 1st, 3rd, and 6th days. The blood samples of EC goat are taken using disposable syringe of 3 ml, then dropped into surface of measurement tool tip of uric acid (Nesco multi check), particularly used to only measure the uric acid (Uric Acid only selftesting). After it is put aside for around 3 minutes, measurement of uric acid can be read in the tool screen of Easy touch GCU similar to Nesco multi check [23].

3.6 Data Analysis
Data obtained were processed using SPSS 17 program. Then data obtained are analyzed using Duncan test with α=0.05 (confidence level = 95%). The quantitative data compared are: data on measurement results of blood sugar, cholesterol, uric acid levels from the experimental groups of Eurycoma longifolia (G2) compared to the data on measurement results of control groups (G1) in the 1st, 3rd, and 6th days.

4. Results and Discussions
4.1 Blood Sugar Level (Glucose) of ECMale Goat
Measurements on blood sugar level were conducted in the 1st, 3rd, and 6th days at 05.00 pm. Which are presented in table 1.

Table 1. The Blood sugar level of EC male goat of Control (G1) and Eurycoma longifolia Treatment (G2)

| TREATMENTS           | Average of Glucose Level mg/l , n=5 |
|----------------------|------------------------------------|
|                      | 1st day | 3rd day | 6th day |
| Control (G1)         | 58.8    | 58.7    | 58.7    |
| Eurycoma longifolia  by 90 mg/kg body weight (G2) | 57*     | 59      | 61      |

Note: Duncan Test, α=0.05 (confidence level 95%), * stating significant differences on the similar column (1st day).

The average glucose level of male goat in the control group (G1) that resulted by given aquadest treatment in the 1st day namely 58.8 mg/l compared to the 3rd day namely 58.7 mg/l and the 6th day namely 58.7 mg/l (table 1), were insignificantly different statistically. Average glucose level on EC male goat in control groups is higher in the 1st day than in the 3rd day and 6th day, it is caused by less variation on physiology process in digestion metabolism between individuals in the control groups. Normal glucose level by 57.8 until 58.8 mm/l in the control group of EC male goat living in Bogor area in this research was relatively not different to the results of glucose measurement on EC male goat living in Bali area namely 62.633 mg/l [30].

Measurement on glucose level of EC male goat research found out that there are 62.633 mg/l normal glucose without any treatment; there are less changes increasing to be 63.367 mg/l after it was given optizym enzyme by 0.25 kg for 100 kg feed for one day and there is no significant difference statistically [30]. A research using EC male goat was conducted to measure the glucose level after the provision of optizym enzyme. Optizym functions to assist the digestion because it lyses cellulose and lignin in plant leaves and stems [30].

Average glucose level of male EC goat in Eurycoma longifolia provision treatment group (G2) increases from the first day until the sixth day namely by 57 mg/l into 61 mg/l, however there is no
significant difference statistically. Small increase on glucose level may be caused by the compound contained in the *Eurycoma longifolia* that assists the carbohydrate digestion in the feed of EC male goat that it results in the increased glucose formation. Increased glucose in tolerated number by goat body will be useful for energy supply in meeting activity needs and reproduction physiology [12].

Comparison of average glucose level of EC male between G1 control and G2 *Eurycoma longifolia* treatment, provides significant differences statistically in the 1*st* day (58.8 mg/l vs 57 mg/l), meanwhile, there is no significant difference on the 3*rd* day and 6*th* day. Glucose level in control group G1 by 58.8 mg/l on the 1*st* day decreased to 57 mg/l in G2. The decrease in glucose levels is caused by the *Eurycoma longifolia* provision given only on the 1*st* day; this may be caused by less optimal physiological process of *Eurycoma longifolia* fibers, so that it is necessary for more energy for the metabolism which resulted in lower glucose levels on the 1*st* day. While the glucose levels of male goat PE on 3*rd* day and 6*th* day are statistically not significantly different between G1 and G2.

The slightly decreased average glucose levels of EC goat at G2 in the 1*st* day compared to G1 on 1*st*, 3*rd*, and 6*th* days and G2 on 3*rd* and 6*th* days indicates that there is excessive production of insulin by β cells of pancreatic tissue secreted beyond the levels compared to G1 levels on 1*st* day. The relatively increased insulin secretion on 1*st* day in *Eurycoma longifolia* treatment group (G2) is the body’s response due to the *Eurycoma longifolia* provision with the chemical compounds contained. Glucose levels in G2 on 3*rd* day and 6 days are normally because of equilibrium process performed by the body called as the homeostasis process. Insulin is a hormone functioning to reduce blood glucose levels [31, 32].

In addition, glucose is required in the reproductive physiology process by the mechanism of glucose change reaction to any necessary compounds in the testicular epididymis. The epididymis secretes compounds such as carnitine, glycerophosphorylcholine, fructose, and glycoprotein. The last two compounds enclose the surface of the spermatozoon. The maturation process of spermatozoon in the epididymal duct is related to biochemical changes and spermatozoon morphology. After inhabiting the caudal epididymis, there is an increase on the volume of semen fluid, allowing the spermatozoon to be active for swimming and fertilization [33, 34]

### 4.2 Cholesterol Level of EC Male Goat

Measurements on Cholesterol Level are conducted in the 1*st*, 3*rd*, and 6*th* days. Results of the measurements in the G1 control group and G2 *Eurycoma longifolia* provision treatment group are presented in table 2.

**Table 2.** Cholesterol level in Control (G1) and *Eurycoma longifolia* Treatment (G2) groups

| TREATMENTS                          | Average of Cholesterol Level mg/dl , n=5 |
|-------------------------------------|------------------------------------------|
|                                     | 1*st* day | 3*rd* day | 6*th* day |
| Control ( G1 )                      | 108       | 148       | 149       |
| *Eurycoma longifolia* by 90 mg/kg body weight ( G2 ) | 149*      | 149       | 150       |

Notes: Duncan Test, α=0.05 (confidence level 95%), * stating significant differences on the similar column (1*st* day).

The average cholesterol level of EC male goat in control group (G1) in the 1*st* day is 108 mg/dl, 3*rd* day is (148 mg/dl) until the 6*th* day is (149 mg/dl). There is relatively lower cholesterol level in the 1*st* day compared to the 3*rd* day and 6*th* day for the goats in the control group and there is no statistically significant difference; these may be caused by variation of internal individual by each goat. There is relatively higher normal cholesterol level for EC goat in Bogor area compared to normal cholesterol level for goat PE in Bali Area. The cholesterol normal cholesterol level for EC goat without treatment in a research in Bali was ranging from 116.67 mg/dl until 121.00 mg/dl [30]. Differences on normal
cholesterol level for male goat PE in Bogor and Bali areas may be caused by: 1). Differences on feed contain of plant or grass given, 2). Differences on goat internal genetic namely differences on origin parent genetic and original living place of EC Goat.

There are no statistically significant differences of cholesterol level average for male goat PE with provision of Eurycoma longifolia ranging from the 1st day 1 (149 mg/dl), 3rd day (149 mg/dl), until the 6th day namely 150 mg/dl. There are no changes on the average cholesterol level of G2 of EC male goat for 6 days of Eurycoma longifolia provisions; this indicates that chemical compound contained in the Eurycoma longifolia provisions given to the goats has no physiological effects on cholesterol formation in the blood of EC male goat. G2 cholesterol level by 149 – 150 mg/dl is till the same to the G1 normal cholesterol level in the 3rd day and 6th day.

Roots of Eurycoma longifolia are known to contain many fibers, tannin [35], and unique other compounds such as eurycomanone, longilactone and its derivatives [8]. Fiber indicates its ability to regulate energy supply so that it can decrease body weight or maintain health body weight [36]. In the intestine, there are difficult fiber substrate reactions and digestion so, the absorption of nutrients will be delayed [37]. The effects of dietary fiber intake on body weight are suspected to be associated with intestinal hormone, energy intake, and / or pancreatic function and control cholesterol levels [38].

There is an increase on average cholesterol level of EC male goat with Eurycoma longifolia treatment (G2); only in the 1st day, there is statistically significant difference, meanwhile in the 3rd day and 6th day, there is no significant difference (Duncan test α=0.05). The cholesterol level in the 1st day in G1 group by 108 mg/dl increases significantly different to the G2 namely 149 mg/dl; this may be caused by increase on Eurycoma longifolia feed supply by a dose of 90 mg/kg body weight. The Eurycoma longifolia provision also contains other compounds such as: Terpenoid, stigmasterol, sitosterol, sterol, saponin, quassinoid, campesterol [16, 18]. Some compounds with sterol chemical structures will be easily metabolized by the heart into cholesterol. However, there is no continuous cholesterol increase, the cholesterol level will be remain or stable in the 3rd day and 6th day of Eurycoma longifolia provision.

Decrease of control of cholesterol level in the blood is served by heart enzymatic reaction [39]. Decreased cholesterol in the blood to stimulation of enzymatic activity of 3-hidroksi-3-metilglutaril co-enzyme A (HMG-CoA) reductase for increase the endogen cholesterol synthesis. Increased bile acid excretion containing HMG-CoA enzyme will lead to decreasing number of bile acid in the enterohepatic. So the heart will produce the bile acid by pulling more cholesterol in the blood, so that the cholesterol concentration in the blood is decreasing [39].

4.3 Uric Acid Level of EC Male Goat

Measurements on uric acid level are conducted in the 1st, 3rd, and 6th days. Results of the uric acid measurements in the G1 control group and G2 Eurycoma longifolia provision treatment group are presented in table 3.

**Table 3. Uric Acid level in Control ( G1 ) and Eurycoma longifolia Treatment ( G2 ) group**

| TREATMENTS                      | Average of Uric Acid level mg/dl , n=5 |
|---------------------------------|---------------------------------------|
|                                 | 1st day  | 3rd day  | 6th day  |
| Control ( G1 )                  | 18       | 19       | 18.7     |
| *Eurycoma longifolia* by 90 mg/kg body weight ( G2 ) | 19.3     | 19       | 20       |

Notes: Duncan Test, α=0.05 (confidence level 95%), * stating significant differences on the similar column (1st, 3rd and 6th days).

The average uric acid level of male goat PE in control group (G1) in the 1st day is 18 mg/dl, 3rd day is (19 mg/dl) until the 6th day is (18.7 mg/dl). There is relatively lower cholesterol level in the 1st day compared to the 3rd day and 6th day for the goats in the control group and there is no statistically
significant difference; these may be caused by variation of internal individual by each goat. There is relatively lower normal uric acid level for EC goat in Bogor area compared to normal cholesterol level or EC goat in Bali Area. The uric acid normal level for EC goat without treatment in a research by 30Yuphardi et al. (2013) in Bali was ranging from 44,567 mg/dl. Differences on normal uric acid level for EC male goat in Bogor and Bali areas may be caused by: 1). Differences on feed contain of plant or grass given, 2). Differences on goat internal genetic namely differences on origin parent genetic and original living place of EC Goats.

There are no statistically significant differences of uric acid level average for male goat PE with provision of Eurycoma longifolia ranging from the 1st day 1 (19,3 mg/dl), 3rd day (19 mg/dl), until the 6th day namely 20 mg/dl. There are no changes on the average uric acid level of G2 of EC male goat for 6 days of Eurycoma longifolia provisions; this indicates that chemical compound contained in the Eurycoma longifolia provisions given to the goats has no physiological effects on cholesterol formation in the blood of EC male goat. G2 uric acid level by 19.3 – 20 mg/dl is till the same statistically to the 1 normal uric acid in the 3rd day and 6th day, namely by dosages of 18 mg/dl – 19 mg/dl.

The digestion stability maintaining uric acid levels relates to the fiber and tannin content. Roots of Eurycoma longifolia are known to contain many fibers, tannin [35], and unique other compounds such as eurycomanone, longilactone and its derivatives [8]. Fiber indicates its ability to regulate energy supply so that it can decrease body weight or maintain health body weight [36]. In the intestine, there are difficult fiber substrate reactions and digestion, so the absorption of nutrients will be delayed so that there is no production of protein metabolism disposal namely uric acid [37].

Provision of Eurycoma longifolia until the 6th days for EC male goat describes the Eurycoma longifolia performance namely to decrease the glucose level in the 1st day, increase cholesterol level in the 1st day, however, both levels are insignificantly different statistically compared to the control groups. The Eurycoma longifolia stabilizes the average level of uric acid in EC male goat by not increasing or decreasing its uric acid level.

5. Conclusion
Provision of Eurycoma longifolia with a dose of 90 mg/kg body weight for six days did not lead to negative effects on the Glucose, Cholesterol and Uric Acid level on EC male goat.

Acknowledgment
The researcher expresses his gratitude and high appreciation to the Unit of Research and Community Service at Universitas Terbuka who have provided research funding, facilities support from Dompet Dhuafa Bogor guidance livestock group, and to Mr. Yarmin who helped on the technical research.

References
[1] Novita, CL., Sudono, A., Sutama IK., Toharmat. (2006). Produktivitas kambing Peranakan etawa yang diberi ransum berbasis jerami padi fermentasi. Media Peternakan 29(2): 96-106.
[2] Yudi, Yusuf, TL., Purwantara, B., Agil, M., Wresdiyati, T., Sayuthi, D., Aditya, Manansang J., Sudarwati, R., Hastuti, YT. (2010). Morfologi dan biometri spermatozoon anoa (Bubalus sp) yang diwarnai dengan pewarna William’s dan eosin negrosin. Media Peternakan 33(2):88-94.
[3] Mardalena, Adriani, Manin, F. (2008). Peningkatan susu kambing Peranakan etawa melalui aplikasi teknologi pemberian konsentrat di kabupaten Muoro Jambi. J Pengabdian pada Masyarakat 45: 24-35.
[4] Sunarlilim, R., Triyantini, B., Setiadi, dan H, Setiyanto. (1990). Upaya mempopulerkan dan meningkatkan Penerimaan susu kambing dan domba. [proceeding] sheep and goat farming workshop approaching the PJPTII ISPI and PDHF era, Bogor
[5] General Directorate of Animal Husbandry and Health of Indonesia (2013). Ministry of Agriculture RI, Sub sector of husbandry: Production, Consumption, Population.

[6] Suharto & Marhaeniyo, (2010). Sinkronisasi Estrus dengan Implant Controlled Internal Drug Release Intravagina pada Kambing Peranakan Etawa. Buana Sains 10 (1): 1-7

[7] Pratomo, H., Supriatna, I., Winarto, A. dan Manalu, W. (2012). Tingkat aktifitas sel endokrin penghasil Folicle Stimulating Hormone (FSH) terkait pemberian pasak bumi (Eurycoma longifolia, Jack). J. Kefarmasian Indonesia 1 (1): 1-11

[8] Pratomo, H., and Yudi. (2016). Pemberian Pasak Bumi Memengaruhi Kadar Testosteron dan Spermatozoon Kambing Peranakan Etawa. Jurnal Kedokteran Hewan. 10 (2): 148-152.

[9] Pratomo, H. (2016). Evaluation of The Effect of Pasak Bumi (Eurycoma longifolia Jack) to Increase Androgen Levels. International Series on Interdisciplinary Research (INSIST). 1(1) ISSN Online: 2502-8588

[10] Pratomo, H. (2017). Eurycoma longifolia extract increases intracellular production activity of luteinizing hormone (LH) in pituitary. AIP Conference Proceedings, 1862. Issue 1. 10.1063/1.4991216

[11] Yudi, Y., Yusuf T.L., Purwantara B., Agil M., Wresdiyati, A., Aditya A., Manansang J., Sudarwati R., dan Hastuti Y.T. (2010). Morfologi dan biometri spermatozoa anoa (Bubalus sp) yang diwarnai dengan pewarna William’s dan eosin negrosin. Media Peternakan 33(2):88-94

[12] Bearden, HJ., John, W. Fukuyuk, Scott, TW. (2004). Applied animal reproduction 6th ed. New Jersey: Pearson Prentice Hall

[13] Squires, EJ. (2003). Applied animal endocrinology. Wallingford UK: Cabi Publishing

[14] Lemmens, RHMJ. (2003). Eurycoma Jack. in: Lemmens RHMJ and N Bunyapraphatsara, Editor. Medicinal and poisonous plants 3. Plants Resources of South East Asia. 12 (3). Leiden, Backhuys Publishers.

[15] Wijayakusuma, Hembing. (1994). Tanaman berbhasiat obat di Indonesia. 3rd edition. Jakarta: Pustaka Kartini.

[16] Kardono, LBS., Artanti, N., Dewiyanti, ID., Basuki, T. (2003). Selected Indonesian medicinal plants: monographs and descriptions vol 1. Jakarta: PT Gramedia Wijasasara Indonesia.

[17] Adimoelja, A. (2000). Phytochemical and the breakthrough of traditional herbs in the management of sexual dysfunction. Int J Androl 23 (2): 82-84

[18] Ang, HH., and Lee, KL. (2002). Effect of Eurycoma longifolia Jack on orientation activities in middle-aged male rats. [Abstract] Fund & Clin Pharmacol 16 (6): 479

[19] Ang, HH., Hitotsuyanagi, Y., Takeya, K. (2000). Eurycolactones A-C, novel quassinoids from Eurycoma longifolia. Tetrahedron Pytochem 41(35): 6849-6853

[20] Itokawa, H., Kishi, E., Morita, H., Takeya, K. (1992). Cytotoxic quassinoids and tirucallane type triterpenes from the woods of Eurycoma longifolia. Chem Pharm Bull 40(4): 1053-1055.

[21] Bhat, R., and Karim, AA. (2010). Tongkat Ali (Eurycoma longifolia Jack) a review on its etnobotany and pharmacological importance. Fitotherapia 81(7): 669-679

[22] Tjay, TH., dan Rahardja, K. (2007). Obat-obat Penting: khasiat, Penggunaan dan efek-efek samping. Ed.VI. Jakarta: Elex Media Komputindo, pp. 748-749

[23] Walker, R. and Edward, C. (2003), Clinical Pharmacy and Therapeutics, 3rd edition. Churchill Livingstone. USA.

[24] Agoreyo, FO., Agoreyo, BO., Onuorah, MN. (2008). Effect of Aqueous extract of Hibiscus sabdafa, on Blood cholesterol and Glucose levels of Rats. African J of Biotechnology. 7 (21): 3949-3951

[25] Shamley, D. (2005). Pathophysiology an Essential Text for the Allied Health Professions, Elsevier Lima. USA

[26] Mutschler, E. (1991). Dinamika Obat Buku Ajar Farmakologi dan Toksiologi. ITB. Bandung

[27] Pratomo, H. (1987). Efek rimpang kunyit (Curcuma domestica Val) sebagai anti piretik pada tikus putih jantan yang didemankan [Thesis]. Jakarta: Faculty of Biology UNAS
[28] Department of Health. (2003). Standarisasi Sediaan Obat Herba. Seminar Dan Pameran Nasional papers. National Work Group of Indonesian Medical Plants. Jakarta March 25-26, 2003.

[29] Fahri, C., Sutarno, Shanti, L. (2005). Kadar glukosa & kolesterol total darah tikus putih (Rattus norvegicus L) hiperglukemik setelah PEmberian ekstrak metanol akar meniran (Phyllantus niruri L). Biofarmasi, 3 (1):1-6

[30] Yupardi Wayan Sayang, Oka I Gusti Lanang, Mantra Ida Bagus. (2013). Hematologi dan kimia klinik darah kambing peranakan etawah yang diberi pakan produk sampingan Pertanian dan enzim optizym. Jurnal Veteriner 14 (1): 99-104

[31] Röder Pia V, Wu Bingbing, Liu Yixian, and Han Weiping (2016). Pancreatic regulation of glucose homeostasis. Exp Mol Med. 48(3): e219-222

[32] Lenzen, S. (2007), The mechanisms of alloxan-and streptozotocin-induced diabetes. Diabetologia. 51, 216–226

[33] Solihati N., Lestari T.D., Setiawan R., Arifin J., dan Hariyanti T. (2008). Penggunaan Albumen untuk Separasi Spermatozoa Epididymis Domba Garut (The Use of Albumen for Epididymal Sperm Separation of Garut Ram). Jurnal Ilmu Ternak 8(1): 95 – 100

[34] Johnson MH. and Barry JE. (1998) Essential reproduction. London: Blackwell Science Ltd.

[35] Supardi, S. dan Pratomo, H. (2003). Indigofera l, Indigofera linifolia Retz., Indigofera linnaei Ali, Indigofera oblongifolia Forssk. Plant Resources of South East Asia 12 (3) : 261-263

[36] Lattimer JM, Haub MD. (2010). Effects of dietary fiber and its components on metabolic health. Nutrients. 2(12):1266–89

[37] Babio N, Balanza R, Basulto J, Bulló M, Salas-Salvadó J. (2010) Dietary fibre: influence on body weight, glycemic control and plasma cholesterol profile. Nutr Hosp. 25(3):327–40.

[38] Aleixandre A, Miguel M. (2008). Dietary fiber in the prevention and treatment of metabolic syndrome: a review. Crit Rev Food Sci Nutr. 48(10):905–12.

[39] Van Bennekum AM, Nguyen DV, Schulthess G, Hauser H, Phillips MC. (2005). Mechanisms of cholesterol-lowering effects of dietary insoluble fibres: relationships with intestinal and hepatic cholesterol parameters. Br J Nutr. 94(3):331–7.