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The Utilization of Different Protein Sources as Soybean Meal Substitution in the Flushing Diet on Reproductive Performances of Doelin

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ABSTRACT

This research aimed to evaluate the effect of different protein sources (plant or animal source) as substitution of 50% soybean meal protein in the flushing diet on early reproduction performances of doeling. The treatments were three types of flushing diet, i.e., Control diet containing soybean meal (C), diet containing Indigofera meal (IM), and diet containing cricket meal (CM). Diet IM and CM were substitution of 50% soybean meal protein in the ration. Completely randomized design was used with three treatments and four replications by using twelve Sapera doeling. The experiment with flushing diet was done started from three weeks before mating (including adaptation), during mating and following one month after pregnancy. Parameters measured were nutrient consumption, BCS, plasma glucose, cholesterol, progesterone hormone and reproductive performance. The results showed that treatments of utilization of different protein sources were not significantly affected the feed consumption, BCS and reproductive performances of doeling, but it had significant effect ($P<0.05$) on plasma glucose and cholesterol. The protein source of Indigofera and cricket meal showed in improving of progesterone status to support until 30 days pregnancy. Diet containing cricket meal could improved onset estrous and duration of estrous. It was concluded that cricket meal can be used as an alternative protein source to substitute of 50% soybean meal protein in the Sapera doeling flushing diet and it can improve the reproductive performances.

Keywords: Body condition score, Glucose, Cholesterol, Progesterone, Doeling, Reproductive performances

Introduction

Adequacy of nutrients in doe that will reproduce greatly affect the success of pregnancy and fetal growth. Body condition score (BCS) also greatly influence reproductive success. Observation of BCS is an assessment of fat reserves in the body of doe to determine the body score of livestock. Scores ranging from criteria very thin (1) to very fat (5). Female goats in Indonesia who have just started their first child have less than 2 BCS (Widayati *et al*., 2014). The value of BCS is closely related to successful reproduction of livestock such as fertility, pregnancy, the number of implanted follicles, embryonic development, the birth process, and lactation (Khotijah *et al*., 2014). The need to improve the condition of the livestock body before starting reproduction through the provision of high-quality feed (flushing). Flushing is usually given to female doe during certain periods such as, before mating until the beginning of pregnancy, during mid-pregnancy and pregnancy until late childbirth. Koyuncu and Altincekic (2012) mentioned that flushing can be given to livestock to improve body condition so that it fulfills ideal BCS value that is 2–3 before pregnant. Provision of quality feed will trigger growth and improve the body condition of doe before mated and multiply the number of follicle that is ready to be fertilized and support the development of the embryo. The benefit of flushing is that it can improve BCS as well as improve reproductive performance, fertility, prevent silent estrus, fertilization, increase twinning, and increase the amount of ovum released from the ovaries (Kusina *et al*., 2001). The introduction of nutrient needs in livestock is one of the factors that can affect the reproduction of livestock such as estrous and ovulation phases (Somchit *et al*., 2007).

Soybean meal with a protein content of 44.04% and total digestible nutrient (TDN) 86.8%, is a mixture of concentrates commonly given to ruminant livestock as a reinforcing feed ahead of reproduction. Alternative feed ingredients that can replace soybean meal in ruminant rations with similar protein and nutrient digestibility values can be derived from vegetable protein (leguminous) or animal protein (insecta) which is cheaper and easier to supply. The availability of dissolved

carbohydrate materials can anticipate problems with the degradable nature of proteins into NH_3 in the rumen as providers of carbon skeletons to be used for microbial protein synthesis (Astuti *et al*., 2016). The cultivation of leguminous *Indigofera zollingeriana* has been done nationally in Indonesia (Abdullah *et al*., 2016). The cultivation of insects (crickets, maggot, and silkworms) scattered in several cities on the island of Java (Bekasi, Depok, Bogor, Pati, Temanggung, Yogyakarta, and Sidoarjo).

Forage of legumes *Indigofera zollingeriana* has a high protein content of 27%, and low in fiber (14%), can be used as an alternative source of protein for ruminants. Indigofera expert states that this plant is one of the forages of Leguminosae which has crude protein of 29.16%, crude fiber 14.02%, crude fat 3.62% and TDN 75–78%, can be used as green concentrate feed (Abdullah *et al*. 2010; Abdullah *et al*., 2016). *Indigofera zollingeriana* production can reach 4.096 kg BK/ha/harvest with intensity cutting 68 days (Abdullah and Suharlina, 2010). Tarigan and Ginting (2011) reported that goat livestock fed with *Indigofera zollingeriana* leaves with a level of 30–45% can increase consumption, digestibility and efficient use of rations to increase the level of weight gain up to 50.5-52.4 g $head^{-1}$ day^{-1}.

Feed ingredients from animal protein can be used as an alternative to substitution in the form of insects, i.e., crickets. Crickets are one of the insects that are edible and potentially a source of protein because they contain 54.09% crude protein and 26.94% fat (Astuti *et al*., 2016). According to Jayanegara *et al*. (2017) cricket flour contains high enough amino acids such as aspartic acid, glutamic acid, histidine, glycine, threonine, arginine, serine, and lysine. Cricket flour can be made from rejects of crickets that have lay eggs 4 to 5 times and are not productive anymore (egg production less than 40%), so it is very cheap price, even often thrown away by cricket farmers because it is waste. The use of cricket meal (*G. bimacullatus*) as feed ingredients in growing sheep can replace the use of soybean meal and increase daily weight gain consecutively for 57–70 $g^{-1}h^{-1}$ d^{-1} (Astuti *et al*., 2016).

This study was aimed to assess the potential of Indigofera meal and cricket meal as an alternative to 50% protein from soybean meal in flushing ration mixture for Sapera goat in improving nutrient adequacy status, BCS value, and reproduction performance success.

Materials and Methods

This research was conducted for six months starting from the preparation of the ration to the data analysis. Livestock breeding was conducted in field laboratory of the cage A. The sample analysis was conducted in the laboratory of Meat and Livestock Nutrition, Department of Nutrition and Feed Technology, Faculty of Animal Husbandry IPB Bogor. A total of 12 doeling of goats Sapera (crossbred of Peranakan Etawah and Saanen) ten months old with BW 17.33±1.48 kg, which is divided randomly into three treatments and four replications. Animals were kept in individual cages during research completed with feeding and drinking water. The main equipment used is a weighing scale of 130 kg, spectrophotometer, and ultrasound (USG) type SSD 500 instrument. This research has been approved by the Ethical Use of Animal Trials Number: 76-2017- IPB.

Method

Goats fed twice daily, giving flushing concentrate in the morning (at 07.00) and field grass in the day (12:30 pm), while ad libitum gave drinking water. Adaptation process of the cage and feed treatment for seven days, then doeling given special feed (flushing) from before mated to 30 days pregnancy. Synchronization of estrus was done two weeks after the adaptation period was completed by injecting PGF2α hormone as much as two $mL^{-1}h^{-1}$ intramuscularly. After 24 hours, observation of the behavior of estrous. Livestock combined for seven days with male and female ratio 1: 4. A pregnancy examination with an ultrasound device (USG) is performed at 35 days after mated.

Research ratio

Basal ratio is distinguished for doeling with *flushing* ratio with forage ratio 30:70 concentrate based on dry ingredients. The forage used is grass field, flushing ratio mixer from soybean meal, corn, pollard, onggok, premix, CaCO3 and NaCl, indigofera meal and cricket meal as substitution (50%) of protein soybean meal. This research on 3 treatment *flushing* : Control (C) control diet containing soybean meal, (IM) diet containing indigofera substitute 50% of protein soybean meal, (CM) diet containing cricket meal substitute 50% of protein soybean meal. Rations are prepared in and isoprotein. So, used of protein source material varies on ratio, according to the protein content of each ingredient. The nutrient content of each treatment on Table 1 and Table 2.

Parameters measured

The parameters measured on the research: consumption of dry matter intake and nutrient (crude protein, ether extract, and nitrogen-free extract). Body weight gain ($g.h^{-1}d^{-1}$), body condition score (BCS), glucose (mg dL^{-1}), cholesterol (mg dL^{-1}), progesterone (ng dL^{-1}) and performance reproductive.

Consumption of dry matter and nutrient ($g.h^{-1}d^{-1}$) was evaluated every day during experiment to 30 days pregnancy. Daily weight gain of goats ($g.h^{-1}d^{-1}$) was evaluated every 2 week from the first experiment to 30 days pregnancy used the scales of capacity 130 kg. BCS of goats was evaluated on backbone, loin, rump. The BCS value star from 1.0-5.0, very thin (1.0), thin (2.0), medium (3.0), fat (4.0), very fat (5.0) (Berry *et al.,* 2007). Glucose (mg dL^{-1}) and cholesterol plasma (mg dL^{-1}) analyzed with KIT

Table 1. Nutrient of flushing concentrate and mixed grass

Nutrient[1]	C	IM	CM	Grass
		%		
Dry matter	80.57	82.29	79.32	36.95
Crude protein	17.07	17.53	17.59	6.17
Ether extract	4.32	4.64	8.83	1.01
Crude fiber	8.86	9.78	7.96	20.44
Nitrogen free extract	55.56	52.65	53.58	67.24
TDN	74.00	72.21	73.31	69.06

[1] Analysis of Laboratory, research center for Biological Resources and Biotechnology, IPB (2017) and laboratory of husbandry animal and technology. C: control diet containing soybean meal, IM: diet containing Indigofera z.substitute 50% of protein soybean meal CM: diet containing cricket meal substitute 50% of protein soybean meal.

Table 2. Nutrient composition of the ration

Nutrient	C	IM	CM
		%	
Dry matter	67.48	68.68	66.61
Crude protein	13.80	14.12	14.16
Ether extract	3.33	3.55	6.48
Crude fiber	12.33	12.98	11.70
Nitrogen free extract	59.06	57.03	57.68
TDN*	72.52	71.26	72.03

[1]ratio concentrat and grass 70:30 . C: control diet containing soybean meal, IM : diet containing indigofera z.substitute 50% of protein soybean meal CM : *diet containing cricket meal substitute 50% of protein soybean meal*. * The calculation results using the formula wardeh 1981 TDN = 2,6407+0,6964 (%CP)+0,9194 (NFE)+1,2159 (EE)-0,1043 (%CF).

Reg. no 112 101 and Reg. no 101 592 used spectrophotometer, progesterone hormone (ng mL^{-1}) analyzed with DRG Germany EIA 1561 used ELISA reader automatic.

Performance of reproductive such as onset estrous, duration estrous, response estrous, and percentage of gestation. Onset oestrus evaluated from the first time goats indication estrous (hour) after injection PGF2α hormone. The duration estrous (hour) evaluated from the first indicated estrous to end indicated estrous. Response of estrous and gestation calculated from the comparison of the number of estrous and dos gestation with the number of does on the group.

Response of estrous (%)

$$\text{Response estrous (\%)} = \frac{does\ of\ estrous}{number\ of\ does\ on\ the\ group} \times 100$$

Percentage of pregnancy (%)

$$\text{Pregnancy (\%)} = \frac{the\ does\ of\ pregnancy}{number\ of\ does\ pregnancy\ on\ the\ group} \times 100$$

Experiment design and data analysis

The experimental design used was a completely randomized design with 3 treatments and 4 replications. The data obtained were tested statistically with ANOVA, and the difference was tested using Duncan multiple range test with SPSS version 16.0 software.

Result and Discussion

Consumption of dry matter intake and nutrient

Substitution of *indigofera* and cricket meal on ratio of flushing od doeling early gestation not significant on consumption DMI and crude protein (CP), but *indigofera* significant effect (P<0.05) lower than other treatment on consumption of ether extract before mating (Table 3).

Mean of dry matter intake (DMI) was around 2,59-3,58% of BW. Substitutions of *indigofera* and cricket meal on ratio didn't decrease of palatability. Consumption DM of goat before mating was around 448,89 – 529,24 $g.h^{-1}d^{-1}$. The value of DMI on *indigofera* (IM) and cricket meal (CM) lower than NRC (2007) recommendation that goat with 15-20 kg BW require dry matter intake about 650 $g.h^{-1}d^{-1}$ or 3,26% of BW. Dry matter intake on IM higher than (Tarigan dan Ginting, 2011) were 440,9 $g.h^{-1}d^{-1}$ *Indigofera* is plant with low antinutritional and have god palatability (Abdullah *et al.,* 2016).

Treatment on this research not significant on consumption of protein, caused ration on flushing used similar protein (± 17%), so with similar DMI on this research then protein consumption is also not significant. Mean protein consumption on each is 63,58-85,71 $g.h^{-1}d^{-1}$. Average of consumption were more than standard NRC (2007) that is 40-44 $g.h^{-1}d^{-1}$ for goat pregnancy with BW 20 kg.

Used different of protein (P<0.05) on ether extract consumption before mating was around 16,61-29,11 $g.h^{-1}d^{-1}$. Ether extract of consumption on ratio control (C) and cricket meal (CM) more than higher (P<0.05) for IM. Caused cricket meal have more fat (6.48%) than indigofera (3.55%). The treatment ratio with soybean meal (C) have similar fat IM but higher dry matter. The Energy of fat more than higher 2,25 than energy in carbohydrate and protein. The more energy consumed accelerates the adequacy of energy requirements, this is make lower consumption of ratio. Sudarman *et al.* (2008) stated that sheep rations with lemuru oil and Ca containing the high fat and energy can decrease of DMI. Accordance with (Purwobakti *et al.,* 2003) increased energy in the ratio can decrease consumption.

Tabel 3. Nutrient consumption and performance of goat

Parameters	After flushing 21 days to before mating		
	C	IM	CM
Dry matter (g.h^{-1}d^{-1})	592.24±68.21	4468.32±51.15	448.89±74.82
Crude protein (g.h^{-1}d^{-1})	81.71±18.82	66.12±7.22	63.58±10.60
Ether extract (g.h^{-1}d^{-1})	19.69 ±4.54 ^{ab}	16.61±1.81^{b}	29.11±4.85^{a}
NFE (g.h^{-1}d^{-1})	349.78±40.28	267.09±29.17	258.92±43.16
	After mating to 30 days pregnancy		
Dry matter (g.h^{-1}d^{-1})	665.91±124.66	569.62±110.77	608.59±60.69
Crude protein (g.h^{-1}d^{-1})	91.87±29.79	80.01±15.93	86.11±8.51
Ether extract (g.h^{-1}d^{-1})	22.15±7.18	19.92±4.15	33.18±9.42
NFE(g.h^{-1}d^{-1})	393.28±73.62	327.48±61.67	349.65±33.78
	Performance of goat with flushing to mating		
Body weight before (kg)	17.50±1.68	17.25±1.14	17.25±1.47
Body weight after (kg)	20.75±4.63	19.88±2.93	18.87±1.46
Daily weight gain (g.h^{-1}d^{-1})	154.76±42.44	125.40±27.68	77.38±47.84
BCS before	1.63±0.08	1.71±0.16	1.71±0.08
BCS after	2.63±0.16	2.33±0.30	2.33±0.24
Δ BCS	1.00	0.62	0.62

C: control diet containing soybean meal, IM: diet containing Indigofera z.substitute 50% of protein soybean meal CM: diet containing cricket meal substitute 50% of protein soybean meal.

Nitrogen-free extract (NEF) is required carbohydrate of early gestation on goat as a glucose precursors. The flushing treatment with *indigofera* and cricket meal as substitution protein of soybean meal not significant on NEF consumption. Caused, ratio on flushing treatment containing similar NEF and DMI not significant (Table 3). The consumption of NEF was not significant around treatment, NFE consumption was around 258,92-349,78 g.h^{-1}d^{-1} (Table 3).

Consumption nutrients of goat after mating to 30 days pregnancy

The consumption of DM to 30 days pregnancy around to 569,62–665,91 g.h^{-1}d^{-1}. Replacement of protein source with *indigofera* (IM) and cricket meal (CM) does no significant effect on DMI. Dry matter intake on this phase increased up to 26% compared with DMI before mating. The proves the pregnant goat consume more higher nutrients to requirement for fetal development. Lozano *et al.* (2003) reported that energy deficiencies in goat during embryo development can lead to luteolysis and embryonic death, return of estrous cycles and unable to maintain pregnancy. Consumption of protein and fat were no significant, protein consumption after pregnancy was increase around 21-27% compared to before pregnancy. The value of protein consumption in this research was slightly higher than the recommended standard of NRC (2007) which ranged from 58-63 g.h^{-1}d^{-1}.

The consumption value of nitrogen-free extract (BETN) in early pregnant goats around to 327.28 - 393.64 g.h^{-1}d^{-1}. The suggests the soluble carbohydrates (the subsequent glucose precursors to energy) consumed by goat to support early fetal growth. Nitrogen-free extract consumption will affect the blood glucose level readily absorbed through the uterus for the fetus (Table 4). These soluble carbohydrates will also be absorbed directly by the intestine of glucose to be used by goat.

Performance of doeling during flushing

Flushing during 2-3 weeks before mating were no significant differences in daily weight gain of doeling. The average BW of goat before mating was around 77,38-154,76 g.h^{-1}d^{-1}. The average value of this daily weight gain varies greatly due to the influence of each doeling before flushing.

Table 4. Average of glucose, cholesterol, and progesterone on goat

Parameters	Treatment		
	C	IM	CM
	Blood metabolite before flushing		
Glucose (mg dL^{-1})	55.71±8.54	58.75±6.83	56.36±8.80
Cholesterol (mg dL^{-1})	61.70±2.52	60.71±18.00	60.76±12.17
Progesterone (ng dL^{-1})	1.20±0.00^{a}	0.60±0.23^{b}	0.80±0.23^{ab}
	After flushing to before mating		
Glucose (mg dL^{-1})	59.50±8.50	53.71±10.17	54.90±0.73
Cholesterol (mg dL^{-1})	48.46±6.30^{b}	54.85±9.97^{ab}	61.23±4.32^{a}
Progesterone (ng dL^{-1})	1.07±0.23	1.20±0.00	1.30±0.50
	30 days pregnancy		
Glucose (mg dL^{-1})	69.44±9.27^{a}	62.39±4.33^{ab}	54.80±1.60^{b}
Cholesterol (mg dL^{-1})	97.71±27.00	91.20±19.59	94.68±6.69
Progesterone (ng dL^{-1})	7.60±2.3	2.30±1.24	4.40±3.40

^{a,b} different superscripts at the row indicate significance difference P<0.05.

C: control diet containing soybean *meal*, IM: diet containing Indigofera z.substitute 50% of protein soybean meal CM: diet containing cricket meal substitute 50% of protein soybean meal.

Flushing with different protein sources in goat was not significant differences in BCS. The average BCS on goat before flushing is 1,7 and before flushing, 21 days increase to 2,3-2,6. The increased in score BCS varying caused of different nutrition before mating. Delta (Δ) BCS for all treatments around to 0,62-1,00. The result reveals that flushing can improve the BCS, this condition has met the BCS score for ready mated. According to (Koyuncu and Altincekik, 2012) reported the ideal score BCS of goat before mating is 2-3.

Glucose, cholesterol and progesterone hormone after flushing to 30 days pregnancy

The plasma level of glucose of goat before treatment was around 55-58 mg dL^{-1}, this included in normal value of glucose 35-60 mg dL^{-1} (Mc Donald *et al*., 2002). Flushing for 21 days with different protein sources no significant difference on glucose of doeling. The treatment of flushing was significant difference ($P<0.05$) of plasma on early pregnant of goat to 30 days gestation. The control (69 mg dL^{-1}) and indigofera (62 mg dL^{-1}) treatment was higher significant than cricket meal treatment (54,80 mg dL^{-1}). This condition caused consumption of NEF on cricket meal lower 26% than control, which may affect to the glucose absorbed. Mc Donald *et al*. (2002) reported that glucose on ruminants as a source of energy to requirement the growing of primary fetal in pregnancy animal. High protein source in ruminants can also be glucose through the gluconeogenesis with alanine and glutamine as its precursor.

Plasma cholesterol levels on goat before flushing no significant difference but it is within the normal range (60-61 mg dL^{-1}). According to Kiran *et al.* (2012) reported that cholesterol in female goat around 41,6-126,6 mg dL^{-1}. Flushing with substitute indigofera and cricket meal (high fat) on soybean meal for 21 days to before mating was significant differences in cholesterol plasma. Cholesterol was higher in treatment with cricket meal ($P<0.05$) than indigofera and control. It due to the high consumption of fat in cricket meal treatment. Cholesterol plasma in 30 days pregnancy stabilize and decrease with decreased fat consumption and the used of fat as a precursor of steroid hormone. Essential fatty acids are an important ratio due to the functioning of membrane mixtures and prostaglandin precursors required for growth, lactation, and reproduction (Yaqoob and Calde, 2007).

The hormone progesterone secreted by corpus luteum (CL) is a steroid hormone associated with the reproductive process. The results of this study indicate that at the beginning of the study the status of the hormone progesterone in the control treatment was significantly higher than for the other two treatments, due to different maintenance backgrounds. Provision of different protein sources of indigofera and crickets resulted in no difference to progesterone levels in early pregnant goats after being given flushing. It indicates that flushing treatment with indigofera and crickets meal can boost the adequacy of progesterone hormone to support pregnancy preparation (Table 4). It due to the presence of micro-macro nutrient donations in the form of high beta-carotene (indigofera meal) and high fat (cricket meal) can improve the status of reproductive progesterone hormone in the first pregnancy of doeling. Injection of prostaglandin (PGF2α) hormone in goats after flushing will inhibit blood flow in CL causing CL lysis; this condition will result in a decrease in progesterone followed by increased estrogen hormone so appeared of estrous. The progesterone hormone will then be used to maintain pregnancy and loss of embryo. In this study goats when pregnancy 30 days have a progesterone levels ranging from 2.30-7.40 ng mL^{-1}, which means lower than the normal value this is due to first time to goat pregnant so that the reproductive organs have not worked optimally. The progesterone levels in 30 days pregnancy were lower than of (Salve *et al*., 2016) reported that progesterone hormone in 28 days pregnancy is 11,39 ng mL^{-1}. Khotijah *et al*. (2016) reported that levels of progesterone hormone in 28 days pregnant sheep flushing with source of unsaturated fat from sunflower oil of 4%, ie 31 ng mL^{-1}.

Performance of reproductive

Estrous occur due to lysis of corpus luteum (CL) caused injection with prostaglandin hormone (PGF2α), onset estrous was calculated at the first time the animal showed estrous symptoms. Flushing treatment was no significant difference on onset estrous but onset estrous in goat treatment with cricket meal faster 18 hour than control and 48 hour than indigofera treatment. Duration of estrous was around 37,01-64,95 hour (Table 5) and no significant difference in all treatment. Duration estrous in goat with cricket meal treatment longer than control 21 hour and 27 hour than indigofera treatment.

The data onset and duration estrous influence by plasma cholesterol before mating. The value of cholesterol will be affect reproduction hormone such as estrogen which is one of steroid hormone to stimulate estrous. Romano *et al*. (2016) reported that duration estrous in Boer goat with synchronized was for 43,7 hour. The addition cricket meal in flushing ration of this study resulted in longer duration estrous than (Romano *et al.*, 2016). Unsaturated fatty acids (linoleic, 31%) in cricket meal affect the status of steroid hormones. Khotijah *et al*. (2014) reported that there was a close correlation between cholesterol levels and progesterone levels in pregnant sheep with flushing sources of unsaturated fats from sunflower oil.

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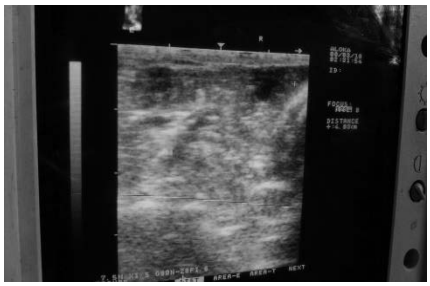
Table 5. Data of reproductive performance

Parameters	Treatment		
	C (n=4)	IM (n=4)	CM (n=3, 1 die)
Onset of estrous (hour)	41.25±10.31	69.43±35.75	23.50±5.77
Duration of estrous (hour)	43.00±11.12	37.01±14.52	64.95±28.92
Response of estrous (%)	100	100	100
Persentage of pregnancy (%)	75	100	100

C: control diet containing soybean meal, IM: diet containing Indigofera z.substitute 50% of protein soybean meal CM: diet containing cricket meal substitute 50% of protein soybean meal.

(Pregnancy with 1 fetal)



(Pregnancy without fetal)

Picture 1. USG of doeling on 35 days gestation with flushing.

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Percentage of estrous in this study had similar percentage are 100% in all treatment. The success rate of pregnancy on substitution treatment with indigofera and cricket meal has a percentage of pregnancy percentage of 100%, which is higher than the control treatment (75%). Adequate cholesterol concentrations strongly support reproductive success. In this study, there was no correlation between estrous response and pregnancy percentage in control treatment, while treatment with substitution of indigofera and cricket meal was highly correlated. Status nutritional of goat before mating, nutrient balance of both fatty acids and amino acids, BCS scores, stress conditions, pregnancy status (primiparous and multiparous) and hormone levels greatly affect the percentage of gestation. The ultrasound results obtained in flushed goats with various types of protein sources (soybean meal, indigofera and cricket meal) showed a pregnancy with the number of embryos 1 in all treatments (Picture 1).

Conclusion

The replacement of protein source of soybean meal with indigofera and cricket meal (50% of soybean meal protein) in flushing goat ration did not affect palatability and nutrient consumption except fat in cricket flour. BCS scores of doeling before mating increase with flushing treatment. The substitution treatment with cricket meal tends to improve the reproduction performance in accelerating the onset of estrous and prolong the length of estrus as well as the percentage of pregnancy.

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