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PREDICTION OF NUTRIENT REQUIREMENTS AND COMPARISON OF ENERGY AND PROTEIN DIGESTIBILITY OF LOCAL AND IMPORTED FEEDS ON YOUNG RACEHORSES

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Abstract

The purpose of this study was to determine the standard needs of Indonesian racehorses for feed dry matter and protein, and also to determine the energy and protein digestibility of both local and imported feeds. 34 horses, body weight between 180-205 kg, 12-24 months of age were used in this study. The horses were fed daily, while feed intake and feces defecation were measured daily. The feed intake (DMI and PI) and metabolic body weight ($W^{0.75}$) (MW) data obtained were fitted to equation Y = a + bX, where Y = DMI and PI as the dependent variable (Y), and X = MW. The result shows that intake averages of DMI and PI were 5.75 kg and 494.66 gr, respectively, while MW was 51.42 kg. There was a positive correlation between DMI and MW of the horses, where r = 0,98 and R^2 = 95,86% ($p<0.01$). Likewise, between the PI and MW, where r = 0.96, and R^2 = 0.92. It is concluded that the standard requirements of dry matter and protein of Indonesian yearling racehorse can be predicted based on feed intake and metabolic body weights. Although the local feed digestibility is lower than imported feed, it is able to meet the energy and protein requirements of young racehorses.

Key words*: digestibility, feed intake, local and imported feeds, metabolic body weight, young racehorse.*

INTRODUCTION

The racehorse animals have their own uniqueness in the process of maintenance, because these animals are classified in pets. Maintenance management is different from other livestock, because the purpose of production is the achievement during the race.

Foals requires special attention in feeding because errors in feed handling will have an impact on growth and appearance while on the race.

The need for feed and nutrients for Indonesian young racehorse until now has not been standardized, so the feeding for the young racehorse by the breeders is only based on the custom which is the inheritance of the previous horse breeders. In the meantime, feed requirement standardization of Indonesia yearling racehorse (that is thoroughbred crosses with local horse) to date have not existed, so it still refers on thoroughbred racehorses feed requirement, which different of both posture and weight from Indonesia racehorses. Whereas, feed is a crucial factor in the growth process, as well as the fulfilment of nutrient feed needs is very decisive for the condition of the horse to follow the training program when prepared for the race. Another thing that needs to be studied is that until now the management of horse feeding in Indonesia, in general, still relies heavily on imported feed, both for maintenance, or in preparation for training for competitions, so an evaluation is needed to compare the effectiveness between the use of local feed and imported feed source through biological evaluation, namely digestibility tests. Based on this problem, this research was held with purpose to determine both feed dry matter and protein standard requirement of young Indonesia racehorse through a prediction model approach, and also testing the biological effectiveness of local feed and imported feed.

MATERIALS AND METHODS

This study consisted of two experiments, namely: the first experiment was conducted to predict the nutrient requirement of young racehorses; the second experiment was for biological evaluation between local feed and imported feed, through digestibility tests. This

research was conducted during six months in Tompaso district of Minahasa regency, which is the centre of racehorse farm in North Sulawesi.

Materials

34 horses, body weight between 180-205 kg, 12-24 months of age were used in this study, where 17 of them were selected for use in the first experiment, while for the second experiment all of these horses were used.

The diet applied in this first experiment was commonly used by local racehorse farmers consisted of 40% local concentrate and 60% forages (local feed), while in the second experiment, this local feed was used as treatment diet 1 (F1), and the treatment diet 2 (F2) consisted of 40% imported concentrate and 60% forages (imported feed). The forages consist of: *corn forage, and field grass* and the concentrate ingredients i.e: *corn, rice bran, coconut cake, soybean, green beans, and unhulled rice*. The treatment diets composition given in this study is shown in Table 1.

Table 1. Composition of treatment diets

Diets	Ingredients	Proportion (%)	DM (%)	Prot (%)	GE (Kcal /kg)
Local Feed (F1)	Local Concentrate	40	89.87	9.43	3.66
	Forages	60	88.46	8.26	3.56
Imported Feed (F2)	Imported Concentrate	40	91.24	11.04	3.91
	Forages	60	88.46	8.26	3.56

Note: DM (dry matter), GE (Gross Energy)

Methods

First experiment. The approach model used for data analysis was a simple linear regression method (Steel & Torrie, 1991). In this case, the feed intake (DMI and PI) and metabolic body weight (W0.75) (MW) data obtained were fitted to equation:

$$Y = a + bX$$

where:

Y = feed intake (DMI and PI);

X = metabolic body weight (MW).

The regression analysis also tested the regression coefficients, which were intended to test the significance of the relationship between feed intake (Y variable) and the feed requirement based on MW (X variable) of young racehorse, or to test whether feed intake actually affected the horse feed requirement. The test was performed using t - test on the hypothesis of the research:

H0: $\beta = 0$ (there is no relationship between variables X and Y)

H1: $\beta \neq 0$ (there is a relationship between variables X and Y)

Second experiment. It was arranged in two treatment groups according to t-test (assuming unequal variance). The treatment diets consisted of F1 = 40% local concentrate + 60% forages and F2 = 40% imported concentrate + 60% forages The variables measured were crude protein and energy digestibility.

Procedure of the study

First experiment, the horses were fed ad libitum three times a day, and fresh water was available all times during the whole experiment. Feed intake were measured daily in order to obtain both of dry matter intake (DMI) and protein intake (PI) averages per head.

Second experiment, the horses were fed restricted, and fresh water was available all times during the experiment. Feed intake and feces defecated were measured daily in order to obtain the energy and protein digestibility of both experimental diets. Measurement of feed digestibility based on the formula:

$$Digestibility = \frac{Nutrient\ Intake - Nutrient\ in\ Feces}{Ntrient\ Intake}\ X\ 100\%$$

RESULTS

The first experiment

The metabolic weights and feed consumption of dry matter and horse protein intake for 6 months of study were presented in Table 2.

Regression analysis of metabolic body weight (X) and feed intake (Y) were performed in Table 3.

Table 2. Metabolic body weight, dry matter intake (kg) and protein intake (g)

	Body weight (BW) (kg)	Metabolic weight (MW) (kg)	Dry matter intake (DMI) (kg)	Protein intake (PI) (g)
Minimum	180	49.14	5.42	462.57
Maximum	205	54.18	6.11	528.00
Mean ± SEM	191.24 ± 1.90	51.42 ± 0.38	5.75 ± 0.01	494.66 ± 4.45

Table 3. Regression analysis of metabolic body weight and feed intake

Assay		Equation	Significance	Multiple R (r) (%)	R^2 (%)	RSD (g)
1.	DMI vs MW	Y = 127.31X - 791.08	P<0.01	97.90	95.86	43.27
2.	PI vs MW	Y = 11.19X - 80.52	P<0.01	96.12	92.39	5.23

Notes: r = Correlation; R^2= Coefficient of Determination; RSD = residual standard deviation

Metabolic weight versus dry matter intake

The regression analysis towards metabolic body weight and dry matter intake turned out that values of multiple R (r), R^2, and RSD were 97.90%, 95.86% and 43.27 g respectively, with equation Y=127.31X–791.08 that indicates estimated regression line (Figure 1). The regression coefficient test also shows t-stat value (18.64) > t - table (1.74), which means H0 is rejected, whereas H1 is accepted.

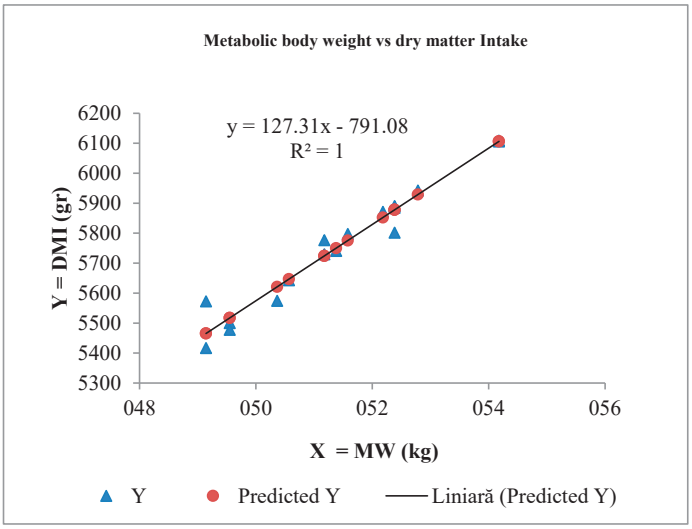

Figure 1. Estimated regression line of MW and DMI

With the value of multiple R (r) of 97.90%, the level of correlation between the metabolic weight and dry matter intake variables were very close. Meanwhile, from the value of coefficient of determination (R^2) shows that 95.86% of variation in DMI can be explained by the value of metabolic body weight of yearling racehorse. Furthermore, the RSD value explains that the value of the distribution around the Y variable was 43.27g, where the smaller the RSD value the smaller the real Y spreads the regression line.

Metabolic weight versus protein intake

The regression analysis on metabolic body weight and crude protein intake shows that values of multiple R (r), R^2, and RSD were 96.12%, 92.39% and 5.23 respectively, with equation Y=11.19X – 80.522 that indicates estimated regression line (Figure 2). The regression coefficient test also shows t-stat value (13.50) > t - table (1.74), which means H0 is rejected, whereas H1 is accepted.

With the value of multiple R (r) of 96.12%, the level of correlation between the metabolic

weight and the protein intakes variables were very close. Meanwhile, from the value of coefficient of determination (R2) shows that 92.39% of variation in intake protein can be explained by the value of metabolic body weight of yearling racehorse. Furthermore, the RSD value explains that the value of the distribution around the Y variable was 5.23g, where the smaller the RSD value the smaller the real Y spreads the regression line.

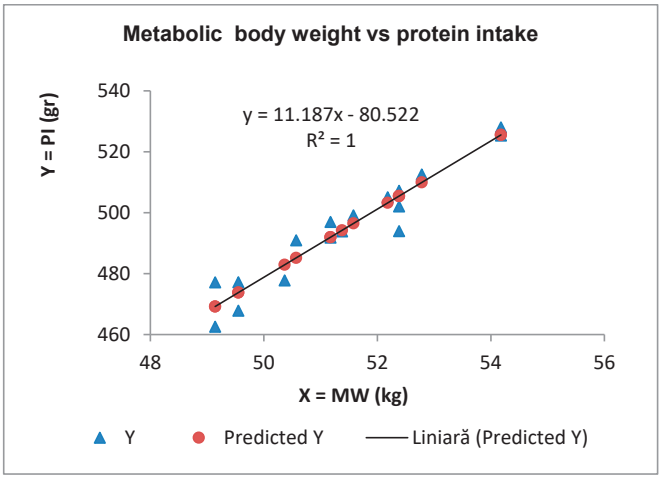

Figure 2. Estimated regression line of MW and PI

Second experiment

Energy and protein digestibility: Energy and protein digestibility data of the two experimental diets are presented in Table 4.

Table 4. Average energy and protein digestibility of the two experimental diets

Digestibility	Local diet (F1) (%)	Imported diet (F2) (%)
Energy	72.67[a]	84.74[b]
Protein	64.55[a]	75.20[b]

Table 4 shows, the average energy digestibility of local feed was 74.67%, while imported feed was 84.74%. The t test results showed that the energy digestibility of imported feeds was higher and significantly different ($P<0.05$) compared to the local feed. Likewise, protein digestibility, where the protein digestibility of imported feed reached 75.20%, was higher than that of local feed.

DISCUSSIONS

First experiment

Dry matter intake: The results showed that the average of dry matter intake of 1-2 years old horses in this study was 5.75 kg of tail^{-1} day^{-1} or 2 to 3% of body weight, in which comparison of forage and concentrate consumption were 30:70%, with the pattern of feeding 3 times a day, that is morning, afternoon and afternoon. Pilliner (1992), suggests that the amount of feeding of thoroughbred horse is 2 to 3% of body weight. Further, Anderson & McIlwraith (2004) suggests that the amount of dry matter intake of foal is 3% of body weight with a balanced nutrient content. This is similar to Ralston (2016), who reports that the average maximum daily dry matter intake is 2.5% -3% body weight (although some breeds and age groups, notably ponies and weanlings, can exceed those maximums if on good pastures). Thus, the feeding program conducted by horse farmer in North Sulawesi has similarities with feeding programs in some countries of the world that are already very advanced in race horse farming.

Figure 1 clearly shows that with increasing metabolic weights the consumption and requirement of dry matter also increases according to the equation Y = 127.31X-791.08.

Protein Consumption

The average of protein intake of 1 to 2 years horses was 494.66g of tail^{-1} day^{-1}. Slade et al.

(1970) suggests that the protein requirement for horse staple life varies from 0.49 to 0.68 g/kg weight/day. Based on the estimated needs of Ralston (2016), for growing horse and pony age between 1.5 and 2 years requires protein around 320-545 g. Meanwhile, Nutrition Requirement of Horses (2007) recommends the protein requirement for foals 750-860 g of tail^{-1} day^{-1}. The higher requirement according to the NRC recommendation is because the standard protein requirement for foals is the standard of thoroughbred horse needs, whereas this study uses crosbred horses between thoroughbred and local horses that have differences in weights. Johnson et al. (2009) who states that horses need more protein when the network is being set for growth (foal), that is in a rapid growth phase. This is in line with the opinion of Freeman et al. (1988) that for the feeding of high protein content for adult horses is unfavourable because it will lead to increased body weight that affects the decrease in performance when race, vice versa. Holand (2010), Measurement of crude protein content provides an assumption about the protein requirement of feed, but does not provide much information about the quality of the protein.

Second Experiment

Energy Digestibility

The difference in energy digestibility values may be due to differences in the dry matter and protein content of the feed, where imported feed has a higher content, which in turn affects the effectiveness of energy metabolism in young racehorses. The average energy digestibility value of local feed shows 72.67%, this means that the digestible energy of young racehorses using local feed reaches 15.07 Mcal per day, where this value actually exceeds the energy adequacy recommendation by NRC (2007), which is 12.20 Mcal. Gibs et al. (2009) stated that wheat and oat feed ingredients provide carbohydrates that can be used directly or stored in muscles and liver in the form of glycogen for later use. In terms of quantity and quality, imported feed is indeed superior to local feed. Tulung (2012) states that the biological value of local feed is lower than imported feed so that even though there is a high amount of protein consumption, only a few are ready for use because of their low biological value. Gibs et al. (2009) suggest that racehorses need a lot of energy to achieve and maintain optimal body condition when participating in training and competitions. According to Lawrence (2004), horses use 80-90 percent of feed for energy metabolism by utilizing carbohydrates and fats in feed. Furthermore, it is said that during routine training, race horses take advantage of the energy supply from fat in the body. Potter et al. (1990) said that while exercising, horses are able to get enough oxygen to the tissues to burn fat as an energy source while during the race, horses cannot rely entirely on fat but they get the main energy supply stored in blood glucose and liver and muscle glycogen produced from dietary carbohydrates. Oldham et al. (1990) argued that it is very important to note that racehorses receive sufficient available energy from carbohydrates in feed to maintain blood sugar levels and store energy in the form of muscle glycogen because this is the main source of energy (fuel) for horses.

Protein Digestibility

The results showed that the protein digestibility value of local feed was lower than imported feed. This is because imported feed has a relatively higher protein content. The protein digestibility value in this study is in line with the research of Mende et al. (2015), who also used local feed and imported feed on race horses in their study, where the protein digestibility results for local feed and imported feed were 62.37% and 72.30%, respectively. Meanwhile, Manarisip et al. (2017), in their study reported higher digestibility values of local feed protein and imported feed in their study on young racehorses, 75.87% and 86.89%, respectively. Tulung (2012) states that the biological value of local feed is lower than imported feed so that even though the amount of protein consumption is high, only a few are ready for use because of their low biological value. In general, horses in the growth phase need a higher percentage of protein than adult horses. Johnson et al. (2009) stated that horses need more protein when the tissue is being regulated for growth (foals), that is, in a rapid growth phase. This is in line with the opinion of Freeman et al. (1988) stated that feeding a high protein content for adult horses is not

beneficial because it will result in an increase in body weight which results in decreased performance when driven, and vice versa.

CONCLUSIONS

It is concluded that the standard requirements of dry matter and protein of Indonesian young racehorse can be predicted based on feed intake and metabolic body weights, so that these results can be used as the basis references for feeding standard of Indonesian racehorse. Although the energy and protein digestibility of local feed is lower than imported feed, it turns out that local feed is able to meet the energy and protein requirements of young racehorses.

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