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(RESEARCH ARTICLE)

Income over feed cost of the Indonesian-Bali pure breed cattle fed the formulation supplement of agricultural by-product in the urea red palm sugar block

Umar Paputungan [1,*], Wapsiaty Utiah [1], Jane Silvana Iriane Tricorien Onibala [1], Agus Supandi Soegoto [2] and Jumie Sophia Lingkakoa Mokoginta [3]

[1] *Department of Animal Production, Faculty of Animal Sciences, Sam Ratulangi University, Manado, 95115, Indonesia.*
[2] *Department of Management, Faculty of Economics and Business, Sam Ratulangi University, Manado, 95115, Indonesia.*
[3] *Department of Management, Faculty of Economics, University of Dumoga Kotamobagu, North Sulawesi, Indonesia.*

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Abstract

Introduction and aim: The specific nutrients needed for tissue synthesis in ruminant animal's growth required balanced nutrients arising from ruminant animal fermentative and intestinal digestion. Thus, this study aimed to evaluate feed supplement utilization of agricultural waste ingredients providing specific valuable nutrients in balancing the absorbed products of digestion to meet animal's requirements increasing animal economical production.

Methods: Data of dried matter consumption, average daily gain feed conversion, feed cost and animal live weight price of yearling calves in Bali pure breed cattle were used to assess the economical animal production focusing on income over feed cost of different the levels of agricultural waste ingredients formulated in the urea red palm sugar block (URPS-Block). This formulated URPS-Block was fed to the Indonesian-Bali pure breed cattle with basal diets of king grass (*Pennisetum purpureum*). The unused waste of expired red palm sugar was used to change molasses function due to its unavailability and high prices in some areas. The yearling calves generated by Bali pure breed bull mated naturally with Bali pure breed cows were used in this study. Data were analyzed by a covariance model in the Double Latin Square design.

Results: The economical productivity focusing on the income over feed cost (IOFC) of both male and female yearling calves by treatment comparisons of different levels of URPS-Block feed supplement showed that the treatment of URPS-Block supplement with 300 g/animal/day (R2) produced the highest income over feed cost (IOFC) of IDR 18,975.- and 21,100.- in female and male yearling calves, respectively. This IOFC of male yearling calves indicated the comparative outstanding of 6.95 percent more efficient for economical production over female yearling calves in Bali-pure breed cattle

Conclusion: This study gives preliminary information on the treatment of the URPS-Block feed supplement of 300 g/animal/day (R2) producing the highest income over feed cost (IOFC). The results may help animal producers in planning strategies for beef farm to keep animals with the economical productivity using URPS-Block supplement from agricultural by-product for beef cattle farm sustainability.

Implications: The treatment of the URPS-Block feed supplement of 300 g/animal/day (R2) could be used as the first rank choice of the highest feed supplement, followed by the treatment of the URPS-Block feed supplement of 150 g/animal/day (R1) and 450 g/animal/day (R3) to be the alternative choices for the economical animal production compared with treatment without URPS-Block (R0) in male and female calves of Bali-pure breed cattle.

Keywords: Agricultural by-product; *Bos sondaicus*; Efficient nutrient level; Highest economical production value

* Corresponding author: Umar Paputungan

1. Introduction

The most Bali pure breed cattle in rural areas of Indonesia were owned by the household farmers. These animals of Bali pure breed cattle have adapted to produce meat and power to plough a farm land prior to planting under harsh environment of hot and humid climate as well as low-quality feed, [1]**.** Furthermore, the coconut coir can be used as a beef cattle feed supplement without harming the health and growth of beef cattle [2]. Bali pure breed cattle have represented about 27 percent of the total cattle population in Indonesia for small farmers as well as it is able to be bred with the large Ongole breed by the artificial insemination without any calving difficulty problem or *dystocia* [3]. The increasing income of smallholder animal agriculture were dominated by the Bali pure breed cattle [1] including the North Sulawesi province as the parts of Indonesia.

The goal of animal breeders was the rapid genetic improvement [4]. The accurate prediction of parental performance record is the most crucial factor in animal breeding program [5]. While selecting those with the best evaluation as replacements, the outstanding animals would be ranked by breeders and culled those with the poorest evaluations [6, 7]. Selection and use of high growth rates and mature weights sires reproduced correlated responses in birth weight and accordingly higher growth rate without more incidence of calving difficulty of dams [8, 9].

The growth traits of animals as the primary goal were always concerned at the breeding program for determinant economical value in animal industry. There was no risk of selecting Bali pure breed cows mated artificially by heavier breed of either Brahman, Limousine or Simmental sires in term of calving difficulty (*dystocia*) and the mothering ability during milking period of Bali cow pure breed as found in some reports [3, 10].

The forages are only “low quality” because the nutrients arising from fermentative and intestinal digestion are not balanced particularly to meet the specific nutrients needed for the “building blocks” of tissue synthesis for growth [11, 12, 13] and reproductive system requirement [14, 15]. This means that an energy supplement is not the logical supplement to animals on these feeds []. Consequently, a feed supplement should provide specific nutrients to balance the absorbed products of digestion to meet the animal's requirements [16, 17]. There were some researches using the urea molasses multi nutrient block (UMMB) used to provide specific nutrients in ruminant animals [18]. However, the molasses availability was limited in some part areas causing higher prices to be ingredient of the feed supplement. Thus, it should be changed with the alternative ingredient closed to its function as source of energy and block material in form of feed supplement preparation [19].

The alternative ingredient changing molasses function was the unused waste abundance of expired red palm sugar with lower price and being available in some local areas mainly at market places. Therefore, the feed supplement in this study was provided in form of the urea red palm sugar block (URPS-Block) as the quantities of nutrients required to correct an imbalance appear to be relatively small the term “catalytic supplement” and to emphasize the role of specific nutrients in increasing efficiency of use of the basal feed [20]. It had been stated that more importantly terms emphasizing these supplements should be effective in small quantities [21]. In addition, the use of unused waste of expired red palm sugar available at the market places as part of feed supplement ingredient for economical cattle production in local beef cattle production had not been well documented and studied scientifically. Therefore, the objectives of this study were to assess the economical cattle production focused on the income over feed cost (IOFC) of yearling calves fed different levels of feed supplement in form of the urea red palm sugar block (URPS-Block) formulated from other agricultural waste product with basal diets of king grass (*Pennisetum purpureum*) in the Indonesian Bali pure breed cattle.

2. Material and Methods

2.1. Animal location and measurement

The Indonesia-Bali pure breed cows mated naturally with the same pure breed bull as the initial parental generation (G_0) had been involved to generate Bali-pure breed generation at both Boltim and Bolmut regencies in North Sulawesi province of Indonesia. All cows were reared in private areas belonging to household farmers which were completed the units of animal pens. The location of research study was conducted during 120 days of data collections divided into four periods. Each period of thirty days was divided into fifteen days for preliminary treatments and fifteen days for data collection started from April to August 2023.

Data collection of body weight and feed consumption of the animals were taken at each period of feeding treatment used. The observation involved all eight yearling calves (four animals in each sex of male and female animals). Total of

four male and four female calves of Bali pure breed at the ages of 12 months old (yearling calves) generated by cows mated with the same breed of adult sires were used in this study. The live weight average of female calves ranged from 100 to 120 kg and the yearling male calves ranged from 150 to 180 kg. Each animal was raised in each pen with size of 1x2 m.

2.2. Formulation of urea red palm sugar block (URPS-Block) feed supplement

In this study, the ingredient of all local agricultural waste products were formulated in form of the urea red palm sugar block (URPS-Block) producing feed supplement with the composition and procedures as follows: (1) Material feed ingredients were weighed with the compositions of waste red palm sugar (50%), urea (4%), rice bran waste product (26%), coconut meal waste product (9%), animal bone meal waste product (6%), salt (2%), cattle mineral (3%), (2) Waste palm red sugar was added with fresh water (ratio of 1:2), (3) Rice bran waste product, coconut meal waste product, animal bone meal waste product, salt and cattle mineral were homogeneously mixed. (4) The mixtures of expired waste red palm sugar and water were gradually filled into the mixtures in the third procedure by gradually shaking them to form homogeneous batter and heated above fire heater for about 3 to 4 minutes, and thereafter fire heater was turned off. (5) Batter of urea palm sugar block was weighed in three formulation weights of 150 g, 300 g and 450 g and wrapped into plastic bag. (6) The urea palm sugar block batter wrapped in the plastic bag was pressed by pressing tool for five minutes to form URPS-Block feed supplement.

The urea was used to make the block with red palm sugar (high energy content) and was essential in improving digestibility and providing non protein nitrogen (NPN) for rumen microbes with the maximum amount of 10 percent to avoid poisoning [22, 23]. The purpose of feed supplement was to provide nutrients that are deficient in the basal diet and nutrients needed by ruminal microbes supporting nutrients availability for production of ruminant animal [21]. The nutrient contents of the ingredient of all local agricultural waste products were shown in Table 1.

Table 1 Nutrient contents of the ingredient ration of the yearling calves on locations of the smallholder farmers

Ingredient	Nutrient contents (%)*					
	Crude Protein	Fat	Crude fiber	Cal-cium	Phos-phorus	Gross Energy (kcal/ kg)
King grass (*P. purpureum*)	13.3	3.2	31.6	0.42	0.17	3304
Rice bran waste product	10.3	8.2	18.9	1.01	8.91	2412
Coconut meal waste product	19.1	11.6	12.7	0.81	0.87	2410
Waste red palm sugar	0.67	0.13	0.28	0.14	0.15	3863

*) Results of laboratory analysis of the Faculty of Animal Science, Sam Ratulangi University, Manado, Indonesia (2022).

2.3. Ration treatment

Rations fed to animals were formulated as follows:

- URPS-Block (R0): Fresh King grass (*Pennisetum purpureum*) *ad libitum* without urea red palm sugar block
- URPS-Block (R1): Fresh King grass (*Pennisetum purpureum*) *ad libitum* + 150 g of urea red palm sugar block
- URPS-Block (R2): Fresh King grass (*Pennisetum purpureum*) *ad libitum* + 300 g of urea red palm sugar block
- URPS-Block (R3): Fresh King grass (*Pennisetum purpureum*) *ad libitum* + 450 g of urea red palm sugar block.

Yearling calves were weighed directly using the indicator digital electrical scale with capacity of 2000 kg for each period of observation. The average daily gain (ADG) was measured as the difference of live weight between the initial and the end of period measurement divided by fifteen days of data collection in each period. Fresh king grass (*Pennisetum purpureum*) was weighed and chopped prior to being fed to yearling calves. Drinking fresh water was provided *ad libitum* to the trial animals. Feed treatment levels of the URPS-Block were fed daily to animals based on treatment levels. At the initial and end of the study in each period of treatment, samples of fresh King grass (*Pennisetum purpureum*) and URPS-Block feed supplement were collected to be analyzed their nutrient contents. The nutrient compositions of the ration fed to all yearling calves in both different sex of male and female animals is shown in Table 2. The unconsumable grass feeding was collected daily. The animal feed consumption was defined as the daily difference between feed consumed and the unconsumable grass feeding (ration). Animal feed consumption was converted into dry matter consumption (kg/animal/day).

Table 2 Samples of nutrient compositions of the ration fed by the yearling calves on locations of the smallholder farmers

Ingredient of ration	Dried matter (%)	Protein (%)	Energy (kcal/kg)
King grass *(Pennisetum purpureum)* ($UPSB_0$)	19.1	10.3	2793
P.purpureum + 150 g of urea red palm sugar block (URPS-$Block_{150}$)	30.2	11.9	2953
P.purpureum + 300 g of urea red palm sugar block (URPS-$Block_{250}$)	40.4	13.6	2994
P.purpureum + 450 g of urea red palm sugar block (URPS-$Block_{350}$)	51.3	14.4	3074
Urea red palm sugar (URPS)	80.7	5.38	3671

Results of laboratory analysis of the Faculty of Animal Science, Sam Ratulangi University, Manado, Indonesia (2022).

2.4. Experimental procedures

Treatments were applied using double Latin Square design of 2 (4x4) with the period of 15 days for preliminary period and 15 days for data collection. Fresh King grass (*Pennisetum purpureum*) was prior to being fed to animals weighed and chopped. Drinking fresh water was provided *ad libitum* to the trial animals. Feed supplement of URPS-Block was fed daily to animals based on treatments (150 g, 300 g, 450 g, per animal per day). The yearling calf weights of Bali pure breed were determined by using a digital weighing scale when animals were standing constantly. The average body weights of 320 kg of the Indonesian Bali breed cow (G_0) were adjusted for their ages of five years old [8]. Mating systems were in single sire groups, within each sire group to produce Bali pure breed progeny generation from the Bali pure breed cows (G_0).

In this study, the research design was applied in double grouping of Latin Square design (24) using two squares representing two animal sex groups (yearling male calves and yearling female calves). Rows within squares (sex groups) represented four animals within sex, columns within squares represented four periods within sex and finally four treatments consisted of four ingredient levels of the URPS-Block supplement fed to each animal per day included in the research design. Each treatment occurred once and only once in each row (animal) and column (period) (24). Each period of thirty days was divided into fifteen days of preliminary feeding treatments and fifteen days of data collection [24].

2.5. Management of experimental animals

The Bali pure breed cows with their calves were raised under traditional management using feeds of the local king grass (*Pennisetum purpureum*) planted around coconut plantations and open grass fields surrounding rural areas of the household farmers in North Sulawesi province of Indonesia [5]. The breeding herd managements of the cows were supervised by the animal owners. When they showed signs of estrus, the cows were mated naturally by the same Bali pure breed bull. The average of the services per conception (S/C) were 1.21, based on the annual data at the Agricultural office in regencies of North Bolaang Mongondow and East Bolaang Mongondow, North Sulawesi province of Indonesia. The value of S/C indicated that 100 pregnant cows needed 121 services of mating bull. These values were classified as moderate to high reproductive performance of the cows [10].

2.6. Statistical analysis

The analysis of variance (ANOVA) was applied to analyze the data collected [24, 25]. Dry matter consumption, ADG and feed conversion were included as dependent variable, while two different sexes of yearling male and female calves of Bali-pure breed cattle, four animals, four periods and four treatments were included as independent variables in the analysis of variance (ANOVA) model [24, 25]. The significant difference in the model of treatments was tested using *honestly significant difference* [25]. Data on the phenotypic weights of the yearling calves of Bali-pure breed cattle were analyzed by covariance analysis, using the General Linear Models (GLM) procedure of SAS (2003) with mathematical model [24] as follows:

$$Y_{ijklm} = \mu + B_i + A_{j(i)} + C_{k(i)} + T_l + E_{ijklm}$$

Where: Y_{ijklm} = the value of the observation of the yearling calves (male and female) in the i^{th} sex groups, the j^{th} animal, k^{th} period; μ = the overall mean to all animals in the experiment; B_i= the deviation from μ of the i^{th} sex group mean (i=2, male yearling calves, female yearling calves); $A_{j(i)}$ = the deviation from μ of the j^{th} animal mean (j= 4, animal 1, animal 2, animal 3, animal 4 within sex) $C_{k(i)}$ = the deviation from μ of the k^{th} period mean (k= 4, period 1, period 2, period 3, period 4 within sex); T_l = the deviation from μ of the l^{th} treatment mean (l = 4, treatment 1 (R0), treatment 2 (R1), treatment 3 (R2), treatment 4 (R3) and E_{ijklm} = random effects peculiar to each individual male and female calves. Other effects such as the age of local pure breed of Bali cows (G_0) were trait specific and considered for the analysis of particular traits. Least-squares analyses of variance, means and standard errors were derived and least-square means tested using PDIFF option.

3. Results

3.1. Economical productivity in term of income over feed cost (IOFC)

Some animal calves after weaning period were sold by the household farmers in North Sulawesi province. The feeding costs of the calf after weaning period were calculated to make the implication of price prediction for their calves weaned by the cows. The income over feed cost in this study was calculated as difference between price of ADG and daily feed consumption costs of King grass (dry matter weight), the feed supplement composed from the local agricultural waste product ingredients, all in the Indonesian currency of rupiah (IDR) per animal per day (IDR/animal/day) consumed by the male and female Bali-pure breed yearling calves (Table 3).

Table 3 Income over feed cost (IOFC) derived from consumption costs of King grass (*P. purpureum*), URPS-Block feed supplement, prices of animal live weight and average daily gain

Cost and Price Components	**Feed Treatments**			
	Non URPS-Block, R0	**URPS-Block (150 g/ animal/day), R1**	**URPS-Block (300 g/ animal/day), R2**	**URPS-Block (450 g/ animal/day), R3**
[1] Cost of Grass dried matter content (GDMC-Cost) (IDR/kg/animal/day)	2,500.-	2,500.-	2,500.-	2,500.-
[2] Treatment Cost of URPS-Block feed supplement in IDR (*Indonesian currency of rupiah*)	0	2,250.-	4,500.-	6,750.-
Male Bali-Pure Breed Yearling Calves				
[3] Consumption of GDMC (kg/animal/day)	3.07	4.14	4.16	4.20
[4] Feed cost of GDMC Consumption (IDR/animal/day), [1] x [3]	7,675.-	10,350.-	10,400.-	10,500.-
[5] Feed cost of GDMC and URPS-Block Consumption (IDR/animal/day), [2] + [4]	7,675.-	12,600.-	14,900.-	17,250.-
	Average = 13,106.25			
[6] ADG (kg/animal/day)	0.32	0.43	0.48	0.49
	Average = 0.43			
[7] Price of animal live weight (IDR/kg)	75,000.-	75,000.-	75,000.-	75,000.-
[8] Price of ADG (IDR/animal/day), [6] x [7]	24,000.-	32,250.-	36,000,-	36,750,-
	Average = 32,250			
[9] Income over feed cost (IOFC) of male Bali breed (IDR/animal/day), [8] – [5]	16,325.-	19,650.-	21,100.-	19,500.-
	Average = 19,144.-			

Female Bali-Pure Breed Yearling Calves				
[10] Consumption of GDMC (kg/animal/day)	3.02	3.90	4.11	4.13
[11] Feed cost of GDMC Consumption (IDR/animal/day), [1] x [10]	7,550.-	9,750.-	10,275.-	10,325.-
[12] Feed cost of GDMC and URPS-Block Consumption (IDR/animal/day), [2] + [11]	7,550.-	12,000.-	14,775.-	17,075.-
	Average = 12,850.-			
[13] ADG (kg/animal/day)	0.31	0.41	0.45	0.47
	Average = 0.41			
[14] Price of animal live weight (IDR/kg)	75,000.-	75,000.-	75,000.-	75,000.-
[15] Price of ADG (IDR/animal/day), [13] x [14]	23,250.-	30,750.-	33,750.-	35,250.-
	Average = 30,750.-			
[16] Income over feed cost (IOFC) of female Bali breed (IDR/animal/day), [15] – [12]	15,700.-	18,750.-	18.975.-	18,175
	Average = 17,900.-			

Note: Ingredients and processing costs of the URPS-Block feed supplement from agricultural waste product = IDR 15,000.-/kg; Price of 20 kg King grass (*P. purpureum*) with 20% dried matter content = IDR 10,000.- or Price of grass dried matter content (GDMC) = IDR 2,500.-/kg.

The consumption costs of King grass (*P. purpureum*) added by the UPSB with different levels of feed supplements and prices of ADG during four months of four periods which were initiated at the yearling weight animals of male and female Bali-pure breed calves were calculated to asses income over feed cost (IOFC) for their values of the economical productivity (Table 3). The variables of the grass dried matter consumption (GDMC) (kg/animal/day), the feed cost of GDMC (IDR/animal/day) and the feed supplement cost of the URPS-Block were firstly defined on the price base at the location of this study using the currency of Indonesian rupiah (IDR) as presented in Table 3.

4. Discussion

4.1. Economical productivity in term of income over feed cost (IOFC)

The price of ingredients and processing costs of the URPS-Block (1 kg) was IDR 15,000.-. Those levels of 150 g, 300 g and 450 g was IDR 2,250.-; IDR 4,500.- and IDR 6,750.-, respectively. Furthermore, the price of 20 kg King grass (*P. purpureum*) with 20% dried matter content was IDR 10,000.-/animal/day. Therefore, the price of grass dried matter (GDMC) would be IDR 2,500.-/ kg/animal/day. In the location of this study, the price of cattle live weight was IDR 75,000.- per kg.

The variables of ADG (kg/animal/day) were higher significantly (p = *0.044*) in male yearling calves than those in female yearling calves (Table 1). This higher ADG (kg/animal/day) reflected higher price of ADG (IDR/animal/day). In this study, the Income Over Feed Cost (IOFC) was calculated as difference between local price of ADG (IDR/animal/day) and feed costs of GDMC added by cost of URPS-Block feed supplement (IDR/animal/day). Therefore, the IOFC (IDR/animal/day) of the male yearling calves (IDR 19,144) were higher than the IOFC of the female yearling calves (IDR 17,900.-) for all levels in the URPS-Block feed supplement (Table 3).

The economical productivity termed by IOFC of both male and female yearling calves by treatment comparisons of different levels of URPS-Block feed supplement showed that the treatment of URPS-Block supplement with 300 g/animal/day (R2) produced the highest income over feed cost (IOFC) of IDR 18.975.- and 21,100.- in female and male yearling calves, respectively as shown at Figure 1 (to be the first rank choice of the highest economical production), followed by the treatment of the URPS-Block supplement with 150 g/animal/day (R1) producing IOFC of IDR 18,750.- and 19,650.- in female and male yearling calves, respectively and followed by the treatment of the URPS-Block supplement with 450 g/animal/day (R3) producing IOFC of IDR 18,175.- and 19,500.- in female and male yearling calves, respectively (to be alternative choice of the economical production), and followed finally by the treatment

without feed supplement (R0) producing the lowest IOFC of IDR 15,700 and 16,325.- in female and male yearling calves, respectively (Figure 1).

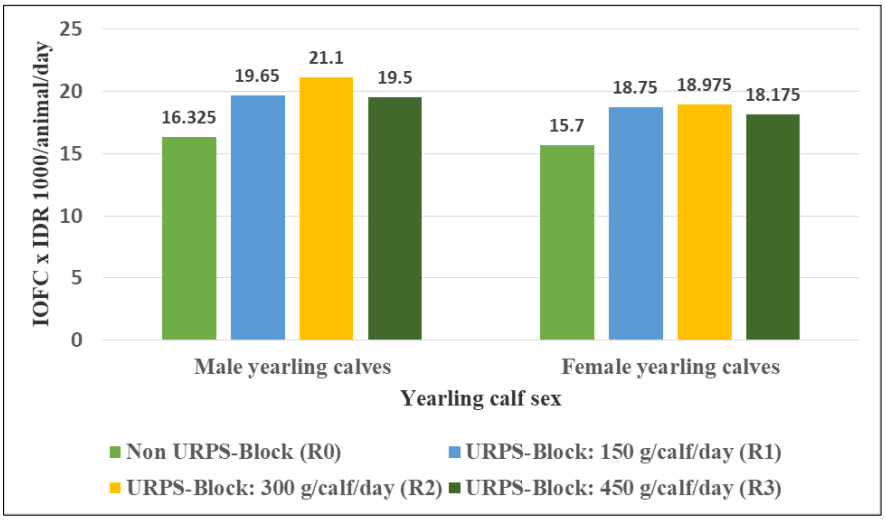

Figure 1 Income over feed cost (IOFC x IDR 1000/animal/day) of male and female yearling calves consuming grass (*P. purpureum*) dried matter content (DMC) added with feed supplement levels of R0, R1, R2 and R3 in male and female yearling calves of Bali-pure breed cattle

The comparison of economical production of both animal sex groups showed that male yearling calves of Bali pure breed performed higher income over feed cost (IOFC) of IDR 19,144.- compared with that of IDR 17,900.- produced by the female yearling calves of Bali pure breed as shown in Figure 2. This IOFC of male yearling calves indicated the comparative outstanding of 6.95 percent more efficient for economical production over female yearling calves in Bali-pure breed cattle (Figure 2). This comparative outstanding of 6.95 percent of IOFC in male yearling calves of Bali pure breed cattle was higher than the outstanding of only 5.0 percent of the IOFC in male adult Ongole-grade cattle over the female adult Ongole-grade cattle [26], indicating a higher producing ability for IOFC in the male Bali pure breed than that in the Ongole-grade cattle which was reported by the other research [27].

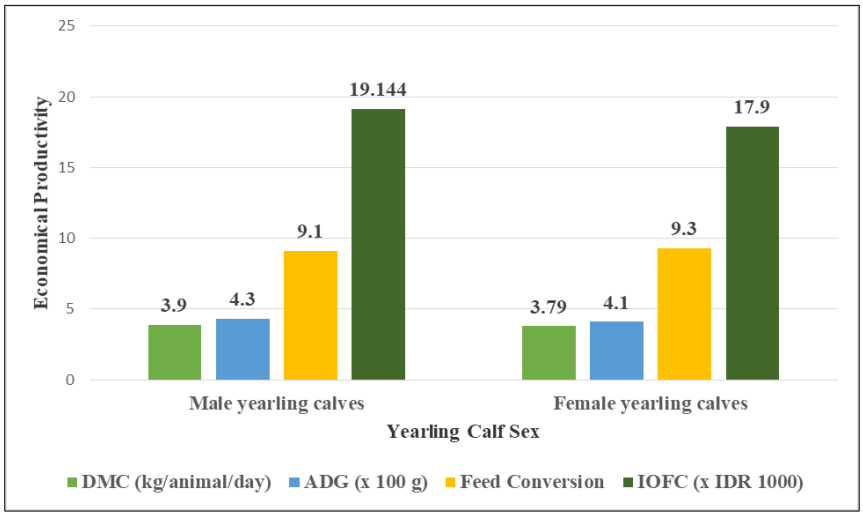

Figure 2 Economical productivity of male and female yearling calves consuming grass (*P. purpureum*) dried matter content (DMC) added with feed supplement levels of R0, R1, R2 and R3 in male and female yearling calves of Bali-pure breed. ADG = average daily gain, IOFC = income over feed cost, IDR = the currency of Indonesian rupiah

5. Conclusion

The availability of agricultural waste including the unused waste of expired red palm sugar would be able to change efficiently the molasses ingredient function of increasing yearling beef production. The treatment of the urea red palm

sugar block (URPS-Block) feed supplement of 300 g/animal/day (R2) produced the highest income over feed cost (IOFC) to be the first rank choice of the highest economical production, followed by the treatment of URPS-Block feed supplement of 150 g/animal/day (R1) and the treatment of URPS-Block feed supplement of 450 g/animal/day (R3) to be the alternative choices of moderate economical production compared with the treatment without URPS-Block feed supplement (R0) in both male and female calves of Bali-pure breed cattle.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared that there is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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