Supplementation of Jackfruit (*Artocarpus heterophyllus* Lam.) By-Product Concentrate for Early Weaning of Kids

Emely J. Escala[1], and Lolito C. Bestil[2]

Abstract**—**The experiment was conducted to assess the potential of jackfruit by-product concentrate for early weaning of suckling kids. Rumen fermentation capacity was evaluated in suckling kids fed napier grass (*Pennisetum purpureum*) soilage as basal diet supplemented with jackfruit by-product concentrate (JBC), with age to start giving JBC supplement (15 days and 30 days old) as factor A and feeding frequency (daily or three times weekly) as factor B, in a 2x2 factorial in randomized complete block design (RCBD). Results showed that giving of JBC supplement at three times weekly promoted significant increases in the voluntary dry matter intake of the basal napier grass soilage and weight gain of suckling kids than daily supplementation across ages to start feeding. Daily feeding frequency significantly lowers rumen pH than three times weekly, especially when JBC supplementation starts at 15 days old. Differences in rumen microbial population (in colony forming units/mL rumen fluid) across treatments were not significant, with higher counts coming from three times weekly than once daily feeding frequency across ages to start feeding.

Keywords**—**Jackfruit by-product concentrate, Feeding frequency, age to start, suckling and growing kids

I. Introduction

GOATS are one of the first animals domesticated by man and continue to hold an important niche particularly as farm livestock in subsistence agriculture in developing countries [10]. Proper feeding management is an essential aspect of goat production, and supplementary feeding to achieve early-weaning must be given impetus. Early-weaning enables the lactating does to maintain good body condition with potentially high conception rate for the next mating season. Also, it develops the kids to be prepared for a shift from milk to solid food. When the kid begins to eat solid feed, especially starter concentrate and forages, the rumen begins to supply nutrients produced from fermentation and the population of rumen bacteria grows rapidly [7].

Fibrous feedstuffs (forages) encourage rumen development in terms of size and capacity, and appear to speed up the development of the muscles of the rumen wall [7]. Fermentation of the starch component of the grain or concentrate produces volatile fatty acids (VFA), particularly butyrate, which stimulates growth of rumen papillae and metabolic activity in the rumen. After about 3 weeks of eating grain, the kid's rumen will have enough bacteria fermenting the feed to supply a substantial amount of energy. The rumen bacteria themselves also serve as an important source of nutrition for the kid—microbial protein. The sooner starch is digested by rumen microorganisms, the faster the development of the rumen occurs. It is important to remember that early weaning cannot succeed without early rumen development [4].

By-product feeds offer opportunities for producers to reduce supplemental feed costs while maintaining good kid performance. Jackfruit has been utilized as livestock feed; its leaves are commonly used for feeding goats as these are well-liked, and a good source of protein and energy [6]. The potential of jackfruit wastes (JFW) consisting of skin, aerial part, seed and pith, as feed for ruminants is great [5]. It contains 8.6% of dry matter (DM) as crude protein (CP) and has a high value of organic matter digestibility (OMD) at 70-78% as well as metabolizable energy (ME) of 11-12 MJ/kg DM. It is a non-conventional feed for ruminants, but the extraction rate of wastes from the whole fruit is estimated at 50% by weight. Being high in starch and metabolizable energy contents, jackfruit by-product concentrate supplementation has a great potential not only to supply the deficient nutrients but also promote early development of the reticulo-rumen, allowing early weaning. Hence, this study was conducted to determine the potential of jackfruit by-product concentrate supplement for early-weaning of suckling kids, specifically to evaluate rumen fermentation capacity of suckling kids given jackfruit by-product concentrate daily or three times weekly starting at either 15 days or 30 days old.

II. Methodology

A. Preparation of Jackfruit by-product concentrate, dietary treatments, and experimental setup

Jackfruit by-products including the skin, pith and rugs were chopped into smaller pieces. These were then dried to contain about 10-14% moisture, milled and stored in a bag. Sixteen (16) suckling kids were grouped based on date of birth and sex as blocks and were randomly assigned to the different dietary treatments laid in randomized complete block design. While the kids were still suckling from their dams, they were given chopped Napier soilage (at *ad libitum*) at 15 days old for all treatments and jackfruit by-product concentrate (JBC)

[1]Department of Agriculture, College of Agriculture and Fisheries, Capiz State University, Pontevedra, Capiz, Philippines 5802. (Cell: 09485243870, 09155274219; E-mail: Amescala87@yahoo.com).

[2]Department of Animal Science, Visayas State University, Visca, Baybay City, Leyte, Philippines 6521-A (Cell: 09177052058, E-mail: litobestil@yahoo.com).

supplement (1% BW, DM basis) considering two factors: age to start giving JBC supplement (15 days and 30 days old) and feeding frequency (once a day or three times weekly).

B.Data Gathered

1. Dry Matter Intake (kg) of Soilage

This was determined bi-weekly with the following formula:

DMI = (Feed given x %DM of feed given) – (Feed refused x %DM of feed refused)

2. Cumulative Weight Gain (kg)

This was computed on a bi-weekly basis using the formula:

$CWG\ (kg) = \sum (BWi - BW_o)$

Where:

$\sum$ = summation

BW_i = final body weight at i^{th} period of measurement

BW_o = initial body weight

3. Rumen pH

Rumen pH was measured at 60 days old (approximate weaning time) at two (2) hours before and two (2) hours after the experimental animals were fed. Rumen flui was collected using a stomach tube (CH/FR 18). A digital (JENCO) pen-type pH meter reader was used to determine the rumen pH of the animals.

4. Rumen Microbial Population (cfu/mL)

Fresh rumen fluid samples were immediately brought to the laboratory for analysis of bacterial population. The rumen fluid was diluted at different rates, and bacterial colonies were then counted using a Suntex Colony counter, expressed as colony forming units/mL fluid sample (cfu/mL), and computed using the following formula:

Bacterial count (cfu/mL) = number of bacterial colonies x dilution rate

III. Results And Discussion

A. Voluntary Dry Matter Intake of the Basal Diet

Results on the voluntary dry matter intake (DMI) of the suckling kids presented in Table I showed that giving of jackfruit by-product concentrate three times weekly promoted significant increases in DMI of the basal diet than giving the supplement daily across ages to start feeding ($P<0.003$). The same pattern of differences were observed when dry matter intake of napier grass soilage was express as daily average based on 45 days feeding period ($P<0.019$). On the contrary, highest DMI of the supplement was obtained when it was given daily starting at 15 days old, followed by the daily feeding starting at 30 days old, compared to three times weekly. It should be noted that daily feeding of JBC supplement which gave higher total DMI values of the supplement, resulted to lower DMI of the basal diet.

The reduction in DMI of the basal diet in animals with high DMI of the JBC supplement could be due to reduction in rumen pH as shown in Table III. In a feeding trial with grazing goats, increased levels of dietary energy supplementation significantly decreased intake of green grass dry matter [3]. Frequent and, thus, higher excessive intakes of supplements high in nonstructural carbohydrates like starch and sugars result in low rumen pH which can reduce growth of fibrolytic and cellulolytic bacteria, consequently reducing voluntary intake of basal roughage diets. Thus, it would be better to feed jackfruit by-product concentrate three times weekly than daily, regardless of age to start, in the light of promoting higher DMI of the basal diet and savings on the cost of the supplement.

TABLE I
CUMULATIVE DRY MATTER INTAKE (KG) OF BASAL NAPIER GRASS IN SUCKLING KIDS SUPPLEMENTED WITH JACKFRUIT BY-PRODUCT CONCENTRATE DAILY OR THREE TIMES WEEKLY STARTING AT 15 OR 30 DAYS OLD.

Treatment	Napier (kg)		Supplement (kg)	
	Total	Daily Average	Total	Daily Average
T_1 = 15 days old given JFC daily	0.54^{c}	0.01^{b}	3.51	0.024
T_2 = 30 days old given JFC daily	0.66^{bc}	0.02^{ab}	2.51	0.022
T_3 = 15 days old given JFC three times weekly	0.98^{a}	0.023^{a}	1.75	0.02
T_4 = 30 days old given JFC three times weekly	0.81^{ab}	0.018^{ab}	1.14	0.021
p-value	*0.003*	*0.019*		

Means with different letter superscripts within a column are significantly different

B.Cumulative Weight Changes of Kids with Jackfruit By-Product Concentrate Supplementation

Results on cumulative weight gain (CWG) at 4, 6, and 7 weeks of measurement showed interaction between age to start giving the supplement and feeding frequency. Highest CWG was observed with three times weekly feeding starting at 15 days of age than daily offering of the supplement (Table II). The same pattern of differences in average daily gain (ADG) was observed as that of CWG across weeks of measurement with Treatment three having the highest values. Such pattern of differences in CWG and ADG would be more of the consequence of the significantly higher DMI of the basal diet than DMI of the supplement.

TABLE II
CUMULATIVE WEIGHT CHANGES OF SUCKLING KIDS FROM 4, 6, AND 7 WEEKS FED WITH NAPIER GRASS SUPPLEMENTED WITH JACKFRUIT BY-PRODUCT CONCENTRATE DAILY OR THREE TIMES WEEKLY STARTING AT 15 DAYS 30 DAYS OLD.

Treatment	Weight Gain (kg)					
	Cumulative Weight Gain			Average Daily Gain		
	4th	6th	7th	4th	6th	7th
T_1 = 15 days old given JFC daily	1.10^{b}	2.07^{b}	3.00^{b}	0.02^{b}	0.04^{b}	0.06^{b}
T_2 = 30 days old given JFC daily	1.81^{ab}	2.86^{ab}	3.40^{b}	0.04^{ab}	0.06^{ab}	0.07^{b}
T_3 = 15 days old given JFC 3 times weekly	3.0^{a}	4.22^{a}	4.85^{a}	0.06^{a}	0.09^{a}	0.11^{a}
T_4 = 30 days old given JFC 3 times weekly	2.05^{ab}	3.12^{ab}	3.77^{ab}	0.04^{ab}	0.07^{ab}	0.08^{ab}
p-value	*0.028*	*0.027*	*0.010*	*0.019*	*0.022*	*0.009*

Means with different letter superscripts within a column are significantly different

Very closely related to DMI, excessive supplementation of energy-concentrate lowers rumen pH which depresses cellulose digestion and intake of cellulolytic feeds, leading to problems of acidosis and secondary ketosis due to off-feed conditions [8]. Therefore, feeding higher levels of energy supplements such as the JBC tend to reduce voluntary feed

intake and digestibility of the basal roughage diet and, thus, weight gain.

C. Ruminal pH of Kids with Jackfruit By-Product Concentrate Supplementation

Results on rumen pH measurement in suckling kids as affected by JBC supplementation is shown in Table III. Rumen pH measurement conducted two hours before feeding time showed no significant differences across treatments, and pH values were higher compared to measurements done two hours after feeding time. The pH measurement at two hours after feeding time showed significant difference between feeding frequencies ($p<0.002$), with daily feeding as more acidic than thrice a week. As regards to the age to start giving the supplement, early feeding (15 days old) resulted to a more acidic condition than feeding at 30 days old.

These results were supported by Beauchemin (2011) as cited by reference [1], that ruminal pH is high before the morning feeding because of intensive rumination and limited feed intake at night. After feeding, however, ruminal pH drops and the extent of this decline depends on the particle size and fermentability of the feeds eaten. Hutjens (1997) as cited by reference [8] stated that growth of fiber-digesting bacteria is favored when rumen pH is between 6 and 6.8, while that of starch-digesting bacteria is favored by a pH level ranging from 5.5 to 6.

TABLE III
RUMEN PH BEFORE AND AFTER FEEDING JACKFRUIT BY PRODUCT CONCENTRATE SUPPLEMENT GIVEN DAILY OR THREE TIMES WEEKLY STARTING AT 15 DAYS OR 30 DAYS OLD

Description	Trt	Feeding JBC	
		Before	After
15 days old given JFC once a day	1	7.5	5.3[a]
30 days old given JFC once a day	2	7.4	6.0[b]
15 days old given JFC three times weekly	3	7.7	6.3[b]
30 days old given JFC three times weekly	4	7.3	6.4[b]
p-value			0.002

Daily supplementation of high energy diet tend to decrease dry matter intake owing pH level to decline which promotes the growth of amylolytic bacteria and other starch-digesting microbes. It is generally through feeding a diet with high percentage of concentrates or frequent supplementation that result in a low rumen pH and tends to be lower with a concentrate diet than with a roughage diet. Therefore, less frequent supplementation of high-energy concentrate, whether starting at 15 days or 30 days old, tend to give ample time for both amylolytic and celluloytic microorganism to grow and multiply, allowing the animal to utilize both roughage and concentrated feeds, which is beneficial for early-weaning and growth.

D. Rumen Bacterial Population of Kids with Jackfruit By-Product Supplementation

The result on rumen bacterial count as affected by JBC supplementation presented in Table IV showed no significant differences among treatments and no interaction between age to start feeding and feeding frequency. However, rumen bacterial counts were observed to be higher when feeding JBC at three times weekly than daily supplementation, especially starting at 15 days old suckling kids. Considering higher pH values in three times weekly feeding, this higher microbial population is expected to be mostly dominated by cellulolytic or fibrolytic bacteria rather than starch-splitting bacteria.

TABLE IV
RUMEN MICROBIAL COUNT (CFU/ML) OF SUCKLING KIDS FED NAPIER GRASS SUPPLEMENTED WITH JACKFRUIT BY-PRODUCT CONCENTRATE GIVEN DAILY OR THREE TIMES A WEEKLY STARTING AT FIFTEEN AND THIRTY DAYS OLD.

Age	Feeding Frequency		Average
	once a day	thrice a week	
15 days old	208,775.75	388,835.00	298,805.38
30 days old	313,417.50	706,174.00	509,795.75
Average	261,096.63	547,504.50	
P-value			
Factor A			0.278[ns]
Factor B			0.151[ns]
Factor A x Factor B			0.574[ns]

Figures with different letter superscripts are significantly different

IV. CONCLUSION

Jackfruit by-product concentrate supplementation given "three times weekly" either for 15-day or 30-day old kids caused significant increase in voluntary DMI, CWG and ADG of suckling kids than "daily supplementation". It also promotes normal rumen pH and higher rumen bacterial population. The potential, therefore, of JBC supplement is comparable with the more commonly used energy-concentrate supplements, and its feeding is better at three times weekly rather than daily, with an added benefit of reducing the cost of supplementation.

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Emely J. Escala is an Instructor in the Department of Agriculture, College of Agriculture and Fisheries at Capiz State University in Pontevedra, Capiz, 5802 Philippines. She teaches ruminant production, animal nutrition, and animal climatology. During her undergraduate years she took up BS in Animal Science major in Animal Production in 2007. Her quest for continued learning and excellence in work pushed her to apply for a scholarship to finish her Master of Science major in Animal Science and minor in Food Science and Technology in 2013 at the Visayas State University, Baybay City, Leyte, Philippines under the National Science Consortium - Accelerated Science and Technology Human Resource Development Program of the Department of Science and Technology. She worked as Research Assistant in the Philippine Carabao Center (PCC) at Ubay Stock Farm in Lomangog, Ubay, Bohol, Philippines in 2013-2014 covering Central Visayas region before joining Capiz State University.

Lolito C. Bestil is Professor IV in the Department of Animal Science (DAS) at the Visayas State University, Baybay City, Leyte, Philippines. He graduated *cum laude* of his Bachelor's degree in 1980, and his Master's degree major in Ruminant Nutrition and minor in Experimental Statistics with High Class Honors at the University of Melbourne, Australia in 1985. He finished his Doctor of Philosophy in Animal Science major in Ruminant Nutrition and minor in Biochemistry and Agricultural Education in 2008. He worked as Training Specialist of the Regional Training Center for Rural Development in 1980-1982, as Director of the Philippine Carabao Center (PCC) for Eastern Visayas region in 2002-2005 focusing on dairy enterprise development and carabao upgrading receiving a commendation from the PCC-National Headquarters & Gene Pool, and as Department Head in 2010-2013. He served as Project Manager of the Beef Cattle Project (1985-1993) and the Small Ruminant Project (1997-2001) of VSU, and as Livestock and Poultry Specialist of FAO of the United Nations of an AECID-supported project for flood-affected farming communities in Eastern Visayas (2009-2010). He has published several scientific articles, acted as resource person on livestock project management, agricultural development planning, and training of trainers, and involved in capacity-building of farmers using "continuous improvement & innovation" (CI&I) process.