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ANÁLISIS DE LA PRESIÓN HÍDRICA POR MEDIO DE LA DENSIDAD DE KERNEL EN EL VALLE DE AZAPA, CHILE

CUENCAS TRANSFRONTERIZAS Y ÁREAS DE MONTAÑA. ENFOQUES Y PERSPECTIVAS DESDE EL CAMPO DEL SABER GEOGRÁFICO

EVALUACIÓN DEL BIENESTAR EN PUEBLOS ORIGINARIOS: DESARROLLO DE UNA ESCALA PARA LA COMUNIDAD ANDINA LICKAN-ANTAY

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1- The Benefit of the Use Agriculture and Food Industry Wastes as Pig Feed and Its Impact on Production Performance and Economic Value of Pigs at Various Rearing Phases in Manokwari District

Trisiwi Wahyu Widayati 1, Anwar Malongi2, Bernadeta Wahyu Irianti Rahayu3, Dwi Djoko Rahardjo4, Budi Santoso5

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Author(s)	**Trisiwi Wahyu Widayati 1, Anwar Malongi2, Bernadeta Wahyu Irianti Rahayu3, Dwi Djoko Rahardjo4, Budi Santoso5**
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The Benefit of the Use Agriculture and Food Industry Wastes as Pig Feed and Its Impact on Production Performance and Economic Value of Pigs at Various Rearing Phases in Manokwari District

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ABSTRACT

The objective of the study was to find out the economic potential of the use of pig feed ration based on agriculture and food industry wastes and the performance of the pig production in starter, grower and finisher phases. It used 12 starter pigs, 4 grower pigs and 4 finisher pigs. The pigs were of local breed of Papua. They were given feed treatments in all of the phases at the ratios of commercial feed to the feed made of the agricultural and food industry wastes of 100% commercial feed: 0% wastes, 75% commercial feed: 25% wastes, 50% commercial feed: 50% wastes, and 25% commercial feed: 75% wastes. All of the feeds were formulated using iso energy and iso protein methods in accordance with the need for the feed at each of the growing phases of the pigs. The results of the study showed that there was not any significant impact on the performance in terms of average daily gain and vital statistic of body length and body circumference of the pigs at all of the phases. However, there was a significant difference among the feed costs among the treatments. The waste feed was able to significantly reduce the feed up to 62.49%. Based on the results of the study, it could be recommended that the pig ration made of the agricultural and food industry wastes might be given as the replacement of the commercial feed. The waste-based ration might be used in rearing pigs up to 28 weeks of age to obtain positive profit.

Key words: economic potential, production, pigs, phases, feed, agricultural and food industry wastes.

INTRODUCTION

The paradigm of agricultural and animal husbandry development refers to zero waste concepts, meaning that wastes should be processed in any possible way into useful products. The awareness of the economic value of the wastes begins to increase in some countries such as America, Australia, Sweden and New Zealand and some European countries. Venkat (2011) suggests that the economic value of the vegetable and fruit wastes in America is US$ 197.68 billions annually. Some countries have high demand for animal husbandry products, such as Japan, South Korea and they increase added value of agricultural waste by processing the waste into animal feed (Thi *et al.,* 2018*).*

Agricultural and food industry activities produce organic wastes and follow-up materials that are well-known as food wastes. It is because the management of the agricultural production, the post-harvest management, the storage, the processing, the distribution and the consumption of the agricultural products have not bee efficient (Venkat, 2011 and Gustavsson *et al.,* 2011). Such wastes are not well-managed in developing countries because of the lack of sufficient supporting infrastructure and integrated environmental management with industrial area and it result in a big amount of useless feed materials (Liu, 2013 and Thi *et al*., 2015).

Pig farm has huge potential to develop in Papua and West Papua provinces because there are supporting vast land, natural resources, and the culture of the people of Papua. Cultural value when pigs are used as dowry, while social values when pigs are used as a means of payment of fine in case of conflict in the community. Based on the data of the Directorate General of Animal Husbandry (2018), the populations of pigs at the two provinces in the two provinces are 871,808 and 82,500, respectively. Pigs become favorite livestock because they have high economic, social and cultural values. The price of a pig of finisher age ranges from IDR 5,000,000 (US4 355) to IDR 8,000,000 (US$ 567). The highest price of the pig prevails when the pig is required in custom ceremony.

Additionally, pig farming in West Papua still faces the obstacle of the high cost of animal feed and there has not been any commercial feed continuously available. Therefore, it is necessary to find alternative feeds. One of the alternative feeds is that made of agricultural and food industry wastes around Manokwari. There are some agricultural wastes easy to find in Manokwari district such as fish waste, paddy milling by-product, vegetable waste with the production rate of 1000; 11,586.60; and 546.00 kg/day in addition to the existing food industry wastes such as tofu production waste, soybean peels, mung bean peels, banana peels, taro peels, rice bran with the production rate of 2400, 55, 83.4, 127.50, 11.4 11586.60 kg/day (Santoso *et al*., 2009 and Widayati *et al*., 2018; Mallongi,et.al 2019). The nutrients resulting from the wastes are quite high with the crude protein content of about 4.6 to 31.21%. Considering the basic principle of the ratio of energy to protein for pigs, it is expected that the agricultural and food industry wastes could be alternative sources of pig feed.

MATERIALS AND METHODS

Location of Study

The experiment was carried out from June 2017 to August 2019 at the Animal Research Laboratory of Universitas Papua in Manokwari, Indonesia (134°04’ longitude and 00°48’ latitude) with a mean altitude of 110 m. The average temperature is 37°C with daily variations of 37-39^{o}C.

Animal, Ration and Experimental Design

The four treatments were Ti1: 100% commercial ration, Ti2: the combination of 75% commercial ration and 25% agricultural and food industry by-products, Ti3: the combination of 50% commercial ration and 50% agricultural and food industry by-products, P4: the combination 25% commercial ration and 75% agricultural and food industry by-products (i: 1,

2, 3 with 1: starter phase, 2: grower phase, 3: finisher phase). All rations were formulated on dry matter basis with isoprotein and isoenergy concepts. The chemical compositions of each of the feed materials were summarized in Table 1.

Table 1. The chemical composition of rations

Ingredients	CP (%)[1]	EE (%)[1]	CF (%)[1]	ME (kcal/kg)[2]
Fish waste	45.85	7.89	1.59	2776
Soybean curd waste	20.56	12.73	16.42	3660
Taro skin	4.66	0.54	10.77	2871
Vegetables waste	17.55	2.20	24.01	2495
Rice bran	11.19	7.77	13.47	3230
Restaurant waste	13.72	6.63	0.81	3315
Commercial pig ration (CP 551)	19.50	4.00	6.00	3315
Commercial pig ration (CP 552)	19.00	5.00	7.00	3200
Commercial pig ration (Malindo 9304)	16.00	7.00	6.00	3200

The variables measured in the study were feed consumption, daily body weight, revenue of feed price, profit of pig sale, vital statistics (body length and hearth girth). The formulation of pig ration in each period is presented in Table 2.

Table 2. Animal, Ration and Experimental Design

Period	**Starter**				**Grower**				**Finisher**			
Ingredients (g)	**T11**	**T12**	**T13**	**T14**	**T21**	**T22**	**T23**	**T24**	**T31**	**T32**	**T33**	**T34**
Fish waste		18.57	12.37	6.17		10.8	7.2	3.7		7.56	4.76	1.97
Soybean curd waste		15.7	10.47	5.23		28.1	18.8	9.5		24.56	16.77	9.01
Taro skin		8.82	5.9	2.94		16	9.5	4.9		22.04	1.,36	6.71
Vegetable waste		16.04	10.69	5.37		14	3.9	5		2	1.9	1.8
Restaurant waste		15.87	10.57	5.29								
Rice bran						6	10.5	1.9		18.84	12.21	5,.1
Commercial ration (CP 551)	100	25	50	75								
Commercial ration (CP 552)					100	25	50	75				
Commercial ration (Malindo 9304)									100	25	50	75
Total	100	100	100	100	100	100,0	100,0	100,0	100		64.11	76.8
Initial body weight (kg)	12.54 ± 1.84				22.63 ± 2.53 kg				56,9 ± 5,27 kg			
Iso Nitrogen (%)	**20,9 %;**					**18%**					16%	
Iso Energy (Kkal/kg)	3265					3265					3200	
Experimental Design	Completely Randomized Design					Latin Square Design					Latin Square Design	

Experimental Procedure

The experiment 1 (starter phase) lasted for 35 days, consisting of 10 days for ration adaptation and 4 weeks for feed intake data collection. The experiments 2 and 3 lasted for 8 weeks, consisting of 7 days for adaptation and 7 days for data collection in each period. The rations were given twice a day (at 08:00 and 16:00 h) *ad libitum*. Fresh water was available *ad libitum*. Individual ration refusals, if any, were collected, weighed daily and samples were collected for analysis. Before the experiments were started, the pigs were given B-Sanplex. The animals were weighed weakly during the experiments.

Table 3. Performance production and economic value of pig starter fed agricultural and food industry wastes-based ration

Variables	T11	T12	T13	T14	SE	Sig.
Feed consumption (g/day/head)	1001.63	1042.25	1004.41	1053.57	12.17	0.35
Average daily gain (g/day/head)	456.61	465	445.18	443.81	7.71	0.79
Price (Rp/kg)	11.000	8517.12	6034.185	3551.16		
Feed cost (Rp/day/kg)	11017.88^{d}	8876.97^{c}	6060.76^{b}	3741.39^{a}	836.25	0.00
Revenue (Rp/kg live weight)	28537.95	29062.5	27823.66	27738.09	481.75	0.79
Profit (Rp/kg live weight)	17520.07^{c}	20185.53^{b} ^{c}	21762.90^{a} ^{b}	23996.69 ^{a}	810.05	0.06

The mean value with different superscripts on the same line shows significantly different (P<0,01)

Statistical Analysis

Data were subjected to analysis of variance for a completely randomized design and Latin Square Design using SPSS version 21. Comparison of means was carried out using the Duncan's multiple range tests, when the effect of treatment was significant (P<0.05).

RESULT AND DISCUSSION

Growth represents the change in the form and the dimension of a livestock expressed in length, volume or mass. The growth can be measured using the increase in the height, the length, the circumference and the weight of livestock (Mutua *et al.,* 2011; Sandu, et.al.,2019).

The results of the statistic test showed that there was not any significant difference in the impact of the different treatments on the performance of the starter pigs in terms of consumption, body weight, and hearth girth as compared to animal feed. On the contrary, there was statistically significant difference in the impact of the treatments on the feed cost. The use of the agriculture and food industry wastes-based feed was able to reduce the ration cost of the starter phase T14 (35.86%), the ration cost of T13 (25.80%), and the ration cost of T12 (9.45%) as compared to the commercial ration T11.

The results of the use of the agriculture and food industry wastes-based feed for the pigs in the grower phase were summarized in Table 4.

Table 4. Performance production and economic value of pig grower fed agricultural and food industry wastes-based ration

Variables	T21*	T22**	T23**	T24**	SE	Sig.
Feed consumption (g/day/head)	1941.68	1808.82	1694.78	1726.68	1792.99	0.11
Average daily gain (g/day/head)	785.72	723.22	671.43	732.14	728.13	0.74
Price (Rp/kg)	11000	8618.16	6247.89	3887.62		
Feed cost (Rp/day/kg)	14271.41	12929.11	11720.31	11978.49	12724.83	0.00
Revenue (Rp/kg live weight)	49107.19	45200.94	41964.38	45758.9	45507.85	0.74
Profit (Rp/kg live weight)	34835.78	32271.82	30244.07	33780.41	32783.02	0.86

They showed that the highest weight gain of the pigs in the grower phase took place in the treatment T21 (100% complete feed CP 552). However, there was statistically not any significant difference in the body weight among the treatments. It showed that the ability of the pigs in the grower phase in digesting and using the feed and in converting it into meat and other organs was relatively as good as those fed with combined rations of 25%, 50%, 75% food industry wastes as compared to the control (100% commercial ration). The body weight gain found in the study was higher than that found in the study by Carter *et al.* (2017) that used green forage-based feed for pigs of 15-20 days of age and gave the ADG of 160 g/day.

The data summarized in Table 5 showed that the best feed consumption took place in the ration treatment T21 (control). It might be because the control commercial ration of was in the form of pellet. Hancock *et al.* (2001) suggested that the pellet ration for pigs could help more to support the performance of the pigs as compared to the feed of different forms.

Table 5. Performance production and economic value of pig finisher fed agricultural and food industry wastes-based ration

Variables	T31	T32	T33	T34	SE	Sig.
Feed consumption (g/day/head)	3061.54	3435.75	3231.61	3201.72	90.68	0.35
Average daily gain (g/day/head)	825	821.43	735.71	500	88.46	0.69
Price (Rp/kg)	11000	8632.95	6289.50	3944.74		
Feed cost (Rp/day/kg)	33676.89^{a}	29660.64^{a}	20325.19^{b}	12629.93^{c}	2239.66	0.00**
Revenue (Rp/kg live weight)	51562.5	51339.29	45982.14	31250	5528.61	0.07
Profit (Rp/kg live weight)	17885.61	21678.65	25656.95	18620.07	5191.04	0.56

The mean value with different superscripts on the same line shows significantly different (P<0,01)

The use of P2, P3, and P4 wastes-based ration was able to reduce the feed cost 19.82%, 35.73%, and 48.96%, respectively. The cost of the commercial ration in Manokwari IDR 11,000/kg, while the ration has not been continuously available. Considering the huge potential of market wastes and food industry wastes, it is necessary to process the agriculture and food industry wastes in Manokwari to increase the continuous availability of the feed.

The results of the experiment of the use of the ration for the finisher pigs summarized in Table 5 showed that the mean highest consumption in the treatment T32 (75% commercial feed and 25% waste) was 3435.75 g/day/pig. Subsequently, it was clearly observed that the agriculture and food industry wastes-based feed gave higher consumption value as alternative animal feed than the consumption value of the treatment of 100% commercial feed. According to Figueroa (2019), the highest consumption value resulted from good palatability of thee feed.

The results of the statistic test showed that there was not any significant difference in the impact of the various treatments on the performance of the finisher pigs in terms of body weight (Table 5), body length (Figure 1c) and hearth girth (Figure 2c). Therefore, if the agriculture and food industry wastes were well-managed considering the nutrient aspects and the form of the feed, they could be the alternative replacement of the commercial feed. The results of the study showed that the three treatments of the finisher pigs using the T32, T33 and T34 wastes-based feed could reduce the feed cost 11.93%, 39.65% and 62.49%, respectively. The results of the statistic test of the feed cost showed that there was significant difference in the feed cost among the treatment. However, there was not any significant impact of the treatments on the revenue and the profit among the treatments.

Based on Table 6 the rearing of the pigs in the starter and grower phases for all of the treatments gave positive value.

Table 6. Profit of each pigs rearing phases (Rp/kg live weight in ten thousand)

Starter Phase	Age (weeks)			
Treatment	9	10	11	12
T11	1.43	1.69	1.79	2.09
T12	1.65	1.98	2.25	2.20
T13	1.97	1.53	2.62	2.59
T14	1.96	1.66	3.43	2.55
Grower Phase	Age (weeks)			
Treatment	13	15	17	19
T21	2.57	2.36	2.30	3.87
T22	1.96	1.29	2.81	5.79
T23	2.28	2.46	2.54	5.27
T24	3.93	2.57	1.93	7.19
Finisher Phase	Age (weeks)			
Treatment	23	25	27	29
T3.1	3.32	1.43	3.76	-1.34
T3.2	1.99	3.76	3.61	-0.69
T3.2	1.96	4.39	4.55	-0.64
T.3 4	1.89	1.42	4.90	-0.76

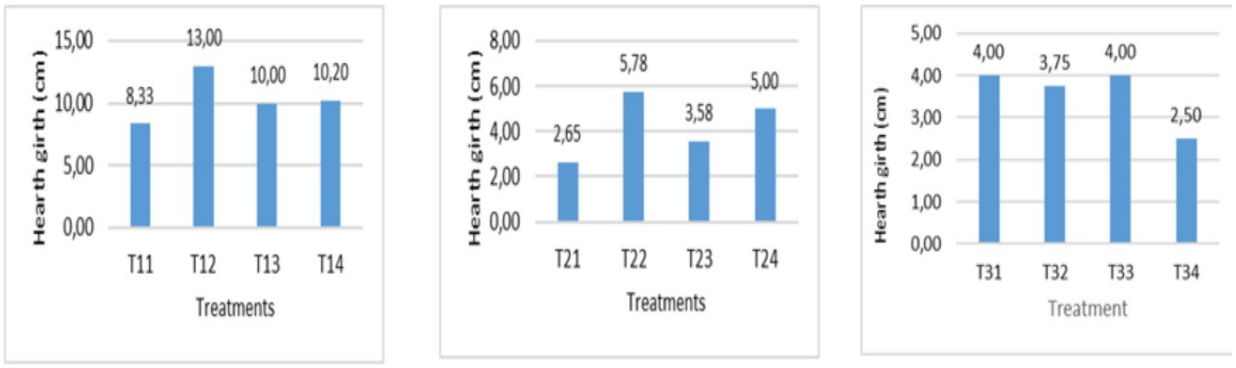

Figure 1. Hearth girth pig starter (1) (P>0.05), grower (2) (P>0.05) and finisher (3) (P>0.05) after fed ration based on agricultural and food industry wastes

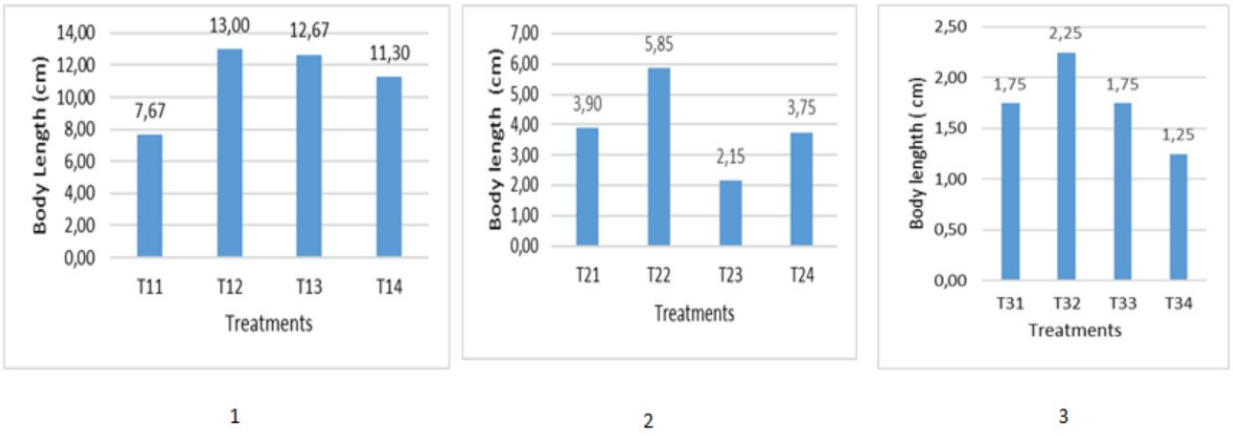

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Figure 2. Body length pig starter (1) (P>0.05), grower (2) (P>0.05) and finisher (3) (P>0.5) after fed ration based on agricultural and food industry wastes

However, the positive value of the finisher phase could only be obtained at the rearing age of 27 weeks. After the age all of the ration treatments resulted in loss and the biggest loss took place in the rearing with alternative ration T31.

Profit was the function of the increase in body weight and ration cost. According to Kusec *et al.,* (2008), the ideal age to slaughter pigs was 167 days with the body weight of 112 kg. The rearing of the pigs in the study was organized up to the age of 29 weeks. Therefore, the rearing age of the pigs gave the highest profit.

Conclusion

The agriculture and food industry wastes-based ration could be used as the alternative replacement of the commercial feed without any decrease in the performance of the pigs. The waste-based ration might be used in rearing pigs up to 28 weeks of age to obtain positive profit.

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