

Effect of Fermented Tamarind Seeds (FTS) Supplementation to Sows during Estrus to Lactation Period on Sow Reproduction Performances and Piglet Mortality at Weaning

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Abstract: Twenty four first weaned sows Duroc × Landrace × Veredeld Duits Landvarken (VDL), average live weight 135-190 kg (11% coefficient of variation (CV)) were allocated to four treatments (six animals/group/treatment) in a randomized block design to evaluate the effect of fermented tamarind seeds (FTS) supplementation during estrus to lactation period on the performance of sows and weaned piglets. There were four treatment diets offered: basal diet (T₀), T₀ + 5% FTS (T₁), T₀ + 7.5% FTS (T₂) and T₀ + 10% FTS (T₃). Supplementing sows with 5%-10% FTS increased daily feed intake at all stages and 10% FTS supplementation level performed the highest ($P < 0.05$) at all stages of pregnancy. Litter size increased 1-2 piglets/sow, piglets born alive increased 1.3-3 piglets/sow, piglet birth weight increased 10-160 g/piglet and weaned piglets increased 3.3-5.3 piglets/sow, while mortality was reduced of 18%-27% per sow. Inclusion of FTS at level of 10% in the diet of sows had the highest daily live weight gain of piglets during four suckling weeks ($P < 0.05$). However, there was no significant difference ($P < 0.05$) among treatments on daily live weight gain of piglets at week 1-2. This study revealed that supplementing sows with FTS during estrus to lactation period improved sows' and piglets' performances, and reduced piglets' mortality up to 29% at weaning.

Key words: Pigs, tamarind seeds, supplementation, prolonged flushing, liter size, mortality.

1. Introduction

Insufficient of feed nutrient during the first 10 d of pre-implementation period may cause low reproduction performances of sow or low piglet performances, due to the clearance in both fat and progesterone hormone that sows experienced physiologically, which resulting in low appetite of feed intake [1, 2]. It is well established in pig industries that providing sows with flush feeding or high quality feed, such as concentrates can improve sow's reproduction performances, as well as increase piglet performances [2, 3]. Previous studies reported

that animals fed concentrates 10-14 d prior to mating [4] or two weeks prior to farrowing [5] increased both litter size and birth weight. However, this strategy could not be applied in small farmer systems, such as in semiarid region of West Timor, Indonesia, where feed supply is limited and concentrates are unaffordable to farmers [6]. Alternatively, a prolonged flush feeding using local high quality feed which is sustainably available, easily provided and cheaply affordable to farmers may be more effective.

Tamarind seeds are non-woods prime forestry products with potential production about 3,000 ton per annum in semiarid region of Indonesia [7]. Approximately 99% of the seeds are wasted and cannot be easily utilized, yet it contains 16%-20%

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crude protein (CP) and potentially can be used as feed supplementation to pig [8]. Supplying pigs with feed supplement could be one of the ways to improve pig production, especially to pigs with poor nutrient supply. According to Chittavong et al. [9], feeds (rice bran and cassava root) supplementation (0.11 ± 0.10 kg/d) improved feed intake and daily body weight of local pig-keeping households (sows, growing and piglets) in Laos. In addition, Adeniji and Azeez [10] reported that fish meal (5%) supplementation in combination with cotton cake (0%-15%) performed higher body weight and nutrients (CP, crude fibre (CF) and fat) digestibility values than without fish meal of growing pigs. On the other hand, it was well reported that hard husk and tannins (mostly in the husk) are the main characteristics of tamarind seeds that inhibit nutrient digestion and absorption resulting in constipation and induces digestive tract disorders of pig [11, 12]. Tannin must be removed from tamarind seeds as there is no any threshold at which tannin are beneficial, but negative effect for pigs until now. Ginting and Aryantha [13] reported that feeding whole roasted tamarind seeds meal performed lower performance and caused constipation on growing pigs compared to pigs fed dehusked roasted seeds meal. There were many strategies that have been developed in order to alleviate the impact of tannins in tamarind seeds. The use of physical processing methods (roasting, soaking in the water, heating and cooking) could not be efficient to eliminate tannins [11, 14]. However, the use of microbial tannase (an enzyme produced by microbial that can catalyzes the tannin hydrolysis) has been considered as a promising strategy [15, 16]. This can be performed by using the fungus, starter culture, such as *Rhizopus oligosporus* that enhances fermentation [17]. Another starter culture, i.e., *Saccharomyces cerevisiae* [18-20] has been recommended both in breaking down the anti-nutritional factors [17, 21, 22] and improving the protein and amino acids profile, since it functioning as a single protein microbe [23]. Studies reported by Ly

et al. [8] revealed that tannins of tamarind seeds kernel meal have been reduced to 93% after processed by dried frying and fermented using 0.3% *Saccharomyces cerevisiae* over 12 h. Consequently, nutrient contents, such as CP, amino acids and fatty acids were increased 3%, 2.3% and 20%, respectively. The adequacy of both amino acids and fatty acids contents of fermented tamarind seeds (FTS) meal would have advantages to pigs as feed supplementation, which in turn will improve both sow and piglet performances [24].

The present study aimed at evaluating the effect of supplying sows with different levels of FTS meal as a prolonged flush feeding during the whole reproduction cycle (throughout estrus to lactation period) on sow reproduction and at weaning piglet performances.

2. Materials and Methods

2.1 Animal, Experimental Design and Feeding Management

The experiment was carried out at a semi-intensive Pigs Breeding Center, in Kupang District, East Nusa Tenggara (NTT) Province, Indonesia, for six months. Twenty-four first weaned sows (an offspring of Duroc \times Landrace \times VDL) of multi purposes "high grow strain", with an initial live weight of 135-190 kg (11% coefficient of variation (CV)) were used in this study. Based on their body weight, pigs were randomly selected from a total group of 100 pigs, subdivided into four groups (six animals per group) and submitted to one of the following treatments: T₀ (basal feeds), T₁ (T₀ + 5% FTS), T₂ (T₀ + 7.5% FTS), and T₃ (T₀ + 10% FTS). The animals were housed in individual pens (0.60 m \times 2.50 m) within a covered pig's house facility during the study. Feed was offered thrice per day (8:00, 12:00 and 16:00) and *ad libitum*, throughout the course of experiment. The amount of feed was fixed on 3% of animal body weight. For each animal group, water was separately distributed *ad libitum* in the bucket. Supplementation of FTS was

daily given to animals. FTS were daily offered to the animals, prior to the morning basal feeding, at two weeks before the estrus, four months during gestation and one month throughout lactation period.

2.2 Tamarind Seeds Processing and Fermentation

The whole processing of tamarind seeds and fermentation were performed following the procedures proposed by Ly et al. [8]. Raw sun-dried tamarind seeds were fired in a wok at ± 60 °C temperature fired stove for 15 min. Then, fried seeds were taken out when the colour of the seeds turned into dark brown and fissures around the husk followed by peanut aroma appear. The fried seeds were immediately cooled in an open air for 15 min and dehusked by using a low speed peeling machine (Honda GX 160/local assembling) to separate husk from the seed's kernel. The clean seeds kernel was then ground with a medium speed grind machine (Honda GX 160/local assembling) to obtain 0.6-1 mm of seeds kernel meal (SKM). The obtained SKM were subsequently analyzed for proximate in the Laboratory of Faculty of Animal Husbandry of Nusa Cendana University (Table 1). For the fermentation, a homogeneous *Saccharomyces cerevisiae* solution was made of 15 g brewers dried yeast (6.7×10^{10} CFU/g *S. cerevisiae*) with 3,000 mL distilled water. The solution was then mixed with 5 kg SKM in the bucket to perform a moist mixture SKM-*S. cerevisiae* (SKMS) as daily requirements for 24 sows. The fermented materials (SKMS) were then taken out from the bucket after 12 h incubation and dried by spreading on a 2 m \times 2 m plastic sheet laid down

on woods made floor for 1 h before being included into the basal diet. Ten percent of fermented materials were sampled and taken to the laboratory for subsequent analysis.

2.3 Data Collection and Measurements

Feed intakes were collected in three stages of pregnancy: the first month pregnancy, the second month pregnancy and the second week of the fourth month pregnancy by subtracting the daily refusal weight from the weight of the feed offered in the previous day. Litter size at birth was obtained by counting the number of piglets per birth of each sow. Piglet's birth weight was calculated by weighing the piglet immediately after birth using a scale with an accuracy of ± 10 g (Double wolf; capacity 10 kg). Stillborn and born alive piglets were calculated as the proportion between piglets stillborn and born alive of each sow. Pre-weaning death piglets correspond to the number of dead piglets during the four weeks of suckling period. Weaned piglets correspond to the number of piglets that survive until weaned period. Piglet's mortality was calculated using formula of Khanh et al. [24] as the percentage of total death piglets between birth and weaning on total born alive piglets (litter size) of each sow.

2.4 Statistical Analysis

The data were analyzed by one way analysis of variance (ANOVA) with treatment as the sole source of variation in the model. Least squares means and standard errors are presented. The ANOVA was performed using the IBM SPSS Statistics for windows,

Table 1 Chemical composition and gross energy (GE) of the basal diet, treatment feeds and FTS*.

Diet	DM (%)	OM (%)	CP (%)	Fat (%)	CF (%)	GE (MJ/kg)
T ₀	91.0	93.7	15.7	4.6	6.7	16.8
T ₁	88.6	95.2	16.1	4.8	7.1	17.7
T ₂	89.7	93.9	16.6	4.9	7.3	17.9
T ₃	89.0	95.0	17.0	5.1	7.6	18.1
FTS	71.2	97.0	19.2	4.2	9.5	19.1

* Analysis result of Laboratory of Faculty of Animal Husbandry of Nusa Cendana University, 2014. DM: dry matter, OM: organic matter.

version 22.0 software package (IBM corp., Armonk, N.Y.). Tukey honestly significant difference test was also performed and level of significant was set at $P < 0.05$.

3. Results

3.1 Feed Intakes

As illustrated in Table 2, there is no significant effect ($P > 0.05$) of treatment on sow feed intake at different pregnancy stages, even though the highest feed intake was recorded for animals submitted to T_3 treatment in the last stage of pregnancy. For all treatments, the highest feed intake was observed in this stage and the lowest in the early stage ($P > 0.05$).

3.2 Sow Performance

There was no significant difference ($P = 0.317$, Table 3) in litter size among treatments. However, there were differences between treatments recorded for birth weight ($P = 0.007$), born alive ($P = 0.000$), mortality ($P = 0.012$) and weaned ($P = 0.000$). Post

hoc tests revealed that supplementation of FTS at level of 7.5% (T_2) and 10% (T_3) per day during pregnancy caused an increase in the values of birth weight, born alive, died pre-weaning, mortality and weaned of animals, compared with sows received 5% FTS or those not fed with FTS. Furthermore, there was no difference among sows groups supplemented with FTS at level of 7.5% and 10% of FTS.

3.3 Piglet Performance

As depicted in Table 4, sows treated with 7.5% (T_2) and 10% (T_3) of FTS per day had higher values of piglet birth weight than those received T_0 or T_1 ($P = 0.007$). No significant differences ($P > 0.05$) were observed between T_2 and T_3 groups. Likewise, treatment of sows with T_3 had a significant effect ($P < 0.05$) on average daily gain (ADG) of piglets from week 1 to week 2 and amongst the whole suckling period (from week 1 to week 4). However, ADG of piglets from week 3 to week 4 remained constant (0.3 kg/piglet/day) for the different diet treatments

Table 2 Effect of the treatments on sow feed intake (kg/day/sow) at different stages of pregnancy.

Feed intake	Treatment				ANOVA <i>P</i> values
	T_0	T_1	T_2	T_3	
Early stage	3,521.71 ± 112.46	3,676.51 ± 98.08	3,762.51 ± 101.37	3,827.88 ± 93.56	0.200
Middle stage	3,735.91 ± 84.79	3,821.98 ± 83.29	3,880.19 ± 85.52	3,934.70 ± 101.83	0.454
Last stage	3,795.76 ± 80.43	3,954.54 ± 100.41	4,001.88 ± 99.81	4,023.05 ± 99.20	0.349

Table 3 Least squares means ± standard deviation (SD) for litter size, birth weight, born alive, mortality and weaned piglets for sows treated with 0%, 5%, 7.5% and 10% of FTS per day.

Sow performance variables	Treatment				ANOVA <i>P</i> values
	T_0	T_1	T_2	T_3	
Litter size (piglets)	11.83 ± 0.65	12.16 ± 0.47	13.00 ± 0.44	13.00 ± 0.51	0.317
Birth weight (kg)	1.84 ± 0.02 ^a	1.85 ± 0.72 ^a	1.99 ± 0.01 ^{ab}	2.02 ± 0.07 ^b	0.007
Born alive (piglets)	9.33 ± 0.55 ^a	10.66 ± 0.33 ^{ab}	12.00 ± 0.44 ^b	12.33 ± 0.33 ^b	0.000
Amount of weaned piglets	6.00 ± 0.51 ^a	9.33 ± 0.49 ^b	10.33 ± 0.49 ^b	11.33 ± 0.33 ^b	0.000
Mortality (%)	35.98 ± 3.46 ^a	17.18 ± 1.52 ^b	11.08 ± 1.71 ^b	8.03 ± 2.00 ^b	0.012
Weaned (%)	46.01 ± 3.46 ^a	87.36 ± 3.18 ^b	88.00 ± 1.89 ^b	91.96 ± 2.00 ^b	0.000

^{a, b} Values within a row with different superscripts differ ($P < 0.05$); $n = 6$ sows/group.

Table 4 Effect of FTS diet treatments (0%, 5%, 7.5% and 10%) on litter size, birth weight and ADG of piglets at week 1-2, week 3-4 and during suckling (week 1-4).

Piglet performance variables	Treatments				ANOVA <i>P</i> values
	T ₀	T ₁	T ₂	T ₃	
Birth weight (kg)	1.84 ± 0.02 ^a	1.85 ± 0.72 ^a	1.99 ± 0.01 ^{ab}	2.02 ± 0.07 ^b	0.007
ADG week 1-2 (kg)	0.25 ± 0.11 ^a	0.26 ± 0.00 ^{ab}	0.29 ± 0.00 ^b	0.28 ± 0.00 ^b	0.003
ADG week 3-4 (kg)	0.30 ± 0.18	0.31 ± 0.00	0.30 ± 0.00	0.30 ± 0.00	0.922
ADG during suckling period week 1-4 (kg)	0.27 ± 0.00 ^a	0.28 ± 0.00 ^{ab}	0.29 ± 0.00 ^b	0.29 ± 0.00 ^b	0.001

^{a, b} Values within a row with different superscripts are significantly different (*P* < 0.05); *n* = 6 sows/group.

Table 5 Lysine, palmitic, stearic, oleic and linoleic content of basal, treatment feeds and FTS*.

Amino & fatty acids	T ₀	T ₁	T ₂	T ₃	FTS
Lysine (mg/100 g CP)	0.60	0.65	0.67	0.69	0.94
Palmitic acid (mg/100 g fat)	12.60	12.90	13.10	13.20	6.09
Stearic acid (mg/100 g fat)	2.40	2.60	2.70	2.80	4.40
Oleic acid (mg/100 g fat)	22.30	22.90	23.10	23.40	10.50
Linoleic acid (mg/100 g fat)	26.90	28.00	28.50	29.10	21.20

* Separated from whole group of amino and fatty acids, not statistics analysis as the laboratory analyzed once.

4. Discussion

The finding of the present study was that supplementation of FTS to the diet of sows during estrus to lactation period improved piglets' performances at weaning period although by not significantly (*P* > 0.05) increasing feed intakes at all pregnant stages. This experiment is the first to study the potential use of FTS meal in the context of providing a prolonged flush feeding on sow reproduction and piglet performances in East Nusa Tenggara Province, Indonesia. Inclusion of 7.5% and 10% of FTS in the diet of sow increased both sow and piglet performances. Supplementation of FTS in the diet of sow not significantly (*P* > 0.05) increased feed intake and liter size, but significantly (*P* < 0.05) increased birth weight, born alive, amount and percentage of weaned piglets, and reducing piglet mortality at weaning. In ruminant, Wang et al. [25] found there was no difference between treatments when wethers were fed with tamarind kernel powder. Furthermore, other researchers also reported that no significant difference was found in dry matter intake of dairy cows offered tamarind seed husk [26].

In general, inclusion of 10% FTS in the diet of sows

consumed more feed intake in the last stage of pregnancy. High feed intakes of sows during early and middle stages could be related to the need of high protein during early and middle stages of pregnancy to supply enough nutrients to the embryo. Previous study reported that increasing feed intake during the first month of gestation increased sow body weight recovery and litter size [27]. Numerically, both feed intake at all stages and liter size (1-2 piglets) increased, but statistically none significant (*P* > 0.05) in the present study.

This present study showed that supplementation of FTS at level 5%, 7.5% and 10% increased 1-3 born alive and 3-5.5 (89%-98%) weaned piglets. However, it is unknown how FTS influenced litter size, born alive and weaned piglets, due to that no biochemical analysis was performed in this study. Increasing litter size, however, is assumed due to the increasing of fertile ova production during pregnancy [1], and mainly caused by increasing of CP, amino acids and unsaturated fatty acids in provided feeds. Increasing of nutrient contents in feed also lead to the improvement of birth weight [28], increasing born alive and reducing stillborn piglets, which are thought to be

related with increasing piglets immunity by additional unsaturated fatty acids containing omega 6 [29] (Table 5). Fatty acids in the provided diet are believed to improve colostrum quality in creating immunity system of piglets [30, 31]. Palmitic acid, as precursor for all unsaturated fatty acid, has been reported to increase from 0.3% to 0.6% [28, 32]. In addition, stearic acid as source of steroid hormone [33, 34] increased about 0.2%-0.4%. In present study, linoleic as the source of omega 6 [35] increased from 1.1% to 2.2% in the inclusion of FTS in the diet (Table 5). Studies reported by Ramanau et al. [36] revealed that, as compared with control group, supplementation sow with carnitine during pregnancy and lactation was traduced by an increase of piglets born alive and weights at birth and on 21 d piglets' age.

Inclusion of FTS in the diet of sows was traduced by a significant decrease ($P < 0.05$) of piglet mortality rate (Table 3). The lowest mortality (8%) was observed at 10% FTS inclusion and the highest with T_0 group (36%). T_2 and T_3 in this study were lower in piglets mortality than the results reported by Ramanau et al. [5] and Khanh et al. [24] of bedded farrowing system, however, it was relatively similar with finding of Sărăndan et al. [37] in healthy and affected methylmalonic academia (MMA) disease sows. Study by Johns et al. [38] found that piglet mortality rate in the study region was high (80%-90%). The 8.03 ± 2.00 - 17.18 ± 1.52 (Table 3) mortality in the present study can be ascribed to three following factors: (1) poor housing biosecurity protection [39] easing high disease spreading; (2) ineffective piglets' vaccination and lack of veterinary curative services weakening piglet immunity; (3) poor handling new born piglets facilitating high death case by cold and overlaid by sows [39]. The latter is the most dominant factor and lowest immunity of piglets fed T_0 resulted in highest mortality in this group [40].

Supplementing sows with FTS prior to estrus up to lactation period seem to be positively and linearly

correlated with ADG of piglets. Piglets with high birth weight have higher average ADG ($P = 0.001$) during four weeks suckling period. These findings agree with the results reported by Hughes and Varley [1] that ADG of piglets will be higher toward weaning time particularly at week 4. High increasing ADG of piglet perhaps due to the increase of sow's feed and nutrient intakes (Tables 2 and 5). An adequate nutrient in both quantity and quality feeds consumed by the sow until lactation period could perform high birth weight and ADG of piglets at weaning [41, 42]. Kyriazakis and Whittemore [2] claimed that improving diet quality, such as amino acids and fatty acids improves milk production of sow, which in turn enhances growth of piglets. Evidence suggests that improving healthy gut environment, well growth own gut microflora and body immunity could be the supporting conditions for the high performance of piglets [43].

5. Conclusions

Supplementing sows with FTS from two weeks prior estrus up to lactation period enhances sow and piglet performances. This finding provides a new strategy of utilizing FTS as part of nutritional management of sows-piglets production reared in the semiarid area with limited feeds availability but potential in tamarind seeds.

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