Mineral Content, Energy, and Fiber Fraction Analysis of Fermented Liquid Feed With Tamarind Seeds in Different Water Ratio

Redempta Wea [1,*], Christian Abimanyu More Laka[1] , Theresia Nur Indah Koni[1] , Helda Helda[1] , and Bernadete Barek Koten [1]

[1] *Animal Husbandry Department, Kupang State Agricultural Polytechnic, Kupang, Indonesia 85011*
[*]*Corresponding author. Email:redemptawea@gmail.com*

ABSTRACT

This study aims to examine the mineral, gross energy, and fiber fraction content of liquid feed fermentation contains tamarind seeds with different water comparisons. The study used whole tamarind seeds and feed ingredients are corn, bran, meat and bone meal, and soybean meal. The parameters of the research are the content of mineral (Ca and P) and fiber fractions (ADF, NDF, cellulose, hemicellulose, and lignin). The study used a Completely Randomized Design (CRD) consisting of 5 treatments and 5 replications, as follows: R0: Basal ration without tamarind seeds and fermentation, R1: Basal ration of fermentation tamarind seeds without water), R2: Fermentation ration 1: 1 water ratio , R3: Fermentation ration 1: 3 water ratio, and R4: Fermentation ration 1: 5 water ratio. Data were analyzed using analysis of variance (ANOVA) and Duncan's further tests. The results showed that the use of water ratio in fermented liquid feed had no signivicantt effect ($P>0.05$) on Ca and gross energy but very significant effect ($P<0.01$) on the P and fiber fraction.

Keywords: *Tamarind seed, Water ratio, Fermented Liquid*

1. INTRODUCTION

The pig population is increasing along with the increasing need for animal protein. However, the feed used in pig farms always uses feed ingredients that compete with human needs. Therefore alternative feeds are used, for example by utilizing waste, namely tamarind seeds.

Tamarind seeds are suitable as pig feed because they contain 131.3 g / kg crude protein, 67.1 g / kg crude fibre, 48.2 g / kg crude fat [1], and contain 55.6% unsaturated fatty acids compared to 44.4% saturated fatty acids [2]. The crude fibre content found in tamarind seeds exceeds the standard amount of crude fibre in pig feed, especially pigs in the starter, grower, and finisher phases. This is because the standard of crude fibre in the starter, grower, and finisher phases is a maximum of 4%, 4.5%, and 6% respectively [3].

The solution used to reduce the crude fibre content in tamarind seeds without disturbing the content of other nutrients such as minerals, energy, and reducing the fibre fraction is using fermentation technology. However, in animal husbandry, tamarind seeds are often made into flour first, then fermented or fermented directly but separated from other feed ingredients before being mixed and given to pigs. This results in time inefficiency. In addition, the fibre fraction of the crude fibre in tamarind seeds (67.1 g / kg) is unknown [1]. This will also affect the use of tamarind seeds as pig feed ingredients. Besides that, the energy and mineral content, especially calcium and phosphorus in tamarind seeds need to be investigated because both are very important minerals for monogastric livestock. Thus, [4] stated that phosphorus is a critical and relatively expensive mineral needed in monogastric livestock rations. Furthermore, one-third of P is found in plant-based feed ingredients as inorganic P which is easily digested, and most of the P (about 2/3) is found in grains, grain waste and plant protein sources in the form of phytic acid and their salts.

The results of the study [5] show that intact tamarind seeds soaked for 48 hours and fermented for 72 hours using 20% palm sap can provide lactic acid bacteria which increase the nutritional value of tamarind seeds and also help in the digestive process. This results in pigs with good growth and meat quality. Based on this, tamarind beans can be fermented directly with other feed ingredients using liquid feed fermentation technology.

Fermentation of tamarind seeds with other feed ingredients is expected to stimulate the formation of lactic acid bacteria. Spontaneous fermentation or by using soluble carbohydrates will produce epiphytic lactic acid bacteria (LAB) which ferment water-soluble carbohydrates to lactic acid and a small portion into acetic acid which will lower the pH of the substrate and inhibit pathogenic microorganisms [6].

Pig liquid feed fermentation is usually carried out in a ratio of 1: 1.5 - 1: 4 [7]. However, the ratio of water when fermented using tamarind seeds and how it affects the mineral content of calcium, phosphorus, energy, and fibre fraction has not been studied.

2. MATERIALS AND METHOD

The research used feed ingredients in the form of whole tamarind seeds from South Central Timor (TTS), bran, corn, soybean meal, and meat and bone meal which were mixed into liquid feed with different water ratios.

The research procedure was as follows: First, the preparation of tools and materials, especially feed ingredients (bran, corn, soybean meal, and meat and bone meal) was carried out. After that, the tamarind seeds are collected and sorted against foreign objects (stones, tamarind shells, nails, etc.); Sorting of tamarind seeds is done via floating test (good tamarind seeds sink). The weighing of tamarind seeds and other feed ingredients is carried out according to the treatment. After weighing, the tamarind seeds are mixed with other feed ingredients than mixed with water according to the ratio in the treatment. After the addition of water, liquid feed fermentation is carried out (fermentation time is according to the results of the research by Wea *et al*., which is 72 hours [8]). Furthermore, the liquid feed is weighed after fermentation. After the fermentation results are harvested, then the fermented liquid feed is dried using an oven 60°C ± 48 hours; and weighing and sample preparation for analysis.

2.1. Parameters and Research Design

The parameters used in this study were the mineral content of calcium, phosphorus, and energy [9], including fibre fraction consisting of acid detergent fiber (ADF), neutral detergent fiber (NDF), cellulose, hemicellulose, and lignin [10].

This research was conducted using a completely randomized design (CRD) consisting of five treatments with a fermentation time of 72 hours [11] and with a water ratio of 1: 1.5 - 1: 4 [7]. The treatment groups were as follows: R0: basal ration without tamarind seeds, R1: basal ration of fermented tamarin seeds (without water), R2: fermented ration with a water ratio of 1: 1, R3: fermented ration with a water ratio of 1: 3, and R4: Fermented ration with a water ratio of 1: 5. This research was conducted in 5 replications.

2.2. Data Analysis

The research data were tabulated and analyzed using analysis of variance (ANOVA) and Duncan's advanced test [12].

3. RESULTS AND DISCUSSION

3.1. Results

The fermentation process went well. This is characterized by no growth of fungus. The success of this fermentation is supported by environmental conditions (temperature, pH, and humidity), the decomposed medium / substrate, and microorganisms [13]. Other supporting factors are the availability of nutrients which include elements of C, N, P and K, fermentation temperature of 23-27°C with a tolerance in the range 18-

Table 1. Mineral content (%), gross energy (…….) and fraction of fermented liquid feed made from tamarind seeds (%)

Variable	Treatments				
	R0	R1	R2	R3	R4
Mineral:					
Ca	0,62	2,25	1,99	1,66	1,47
P	0.75^{b}	0.80^{a}	0.73^{b}	0.45^{c}	0.44^{c}
Gross Energy	3246.80	3309.60	3381.20	3265.20	3200,40
Fiber Fraction:					
ADF	21.32^{c}	19.12^{d}	20.42^{c}	23.82^{b}	27.65^{a}
NDF	37.15^{c}	36.12^{c}	34.58^{c}	43.87^{b}	48.65^{a}
Selulose	6.96^{c}	8.61^{b}	7.53^{bc}	7.09^{bc}	11.91^{a}
Hemiselulose	15.82^{cd}	17.00^{bc}	14.16^{d}	18.55^{b}	21.01^{a}
Lignin	8.35^{b}	6.18^{b}	7.99^{b}	10.36^{a}	10.18^{a}

Explanation: a, b, c, d Different superscripts on the same line showed significant differences ($P < 0.05$); R0: Basal ration without tamarind seeds; R1: Basal ration of fermented tamarind seeds (without water); R2: Fermented ration with a water ratio of 1: 1; R3: Fermented ration with a water ratio of 1: 3; R4: Fermented ration with a water ratio of 1: 5.

35°C, availability of air but not in the form of active aeration, absence of shock or vibration and direct sunlight exposure during the fermentation process [14].

Analysis of variance showed that liquid feed fermentation with different water ratios had no significant effect (P> 0.05) on Ca content and energy but had a very significant effect (P <0.01) on P content and fibre fraction (ADF, NDF, cellulose, hemicellulose, and lignin). In addition, it appears that increased amount of water in the fermentation will decrease the P content, but generally causes an increase in the fibre fraction content (Table 1).

Duncan's test showed that there was a significant difference in phosporus content (P <005) between the feed without tamarind seeds and without fermentation (R0), with fermented tamarind seed feed without the use of water (R1) and with a water ratio of 1: 3 and a ratio of 1: 5, but there was no significant difference (P> 0.05) between R0 with feed using 1: 1 ratio of liquid feed water. Beside that, there was no significant difference (P> 0.05) between liquid feed with a water ratio of 1: 3 and a water ratio of 1: 5.

The Duncan test showed that there was a significant difference (P<0.05) in the ADF content between feed without the use of tamarind seeds and without fermentation (R0), with feed using fermented tamarind beans (R1) and fermented feed using a water ratio of 1: 3 (R3) and 1: 5 (R4), but but there was not a significant difference (P> 0.05) between R0 and feed fermented feed with a water ratio of 1: 1 (R2). Likewise, in relation to the NDF content, it was observed that there was not a significant difference (P>0.05) between the treatment without using tamarind seeds and fermentation (R0) with treatment using fermented tamarind seeds without using water (R1) and with fermented tamarind liquid feed with water ratio of 1: 1 (R2), but there was a significant difference (P<0.05) between the three of them with fermented tamarind seed feed with a water ratio of 1: 3 (R3) and 1: 5 (R4).

The Duncan test on cellulose content showed that there was not a significant difference (P>0.05) between the treatment without using tamarind seeds and without fermentation (R0) with liquid feed with a water ratio of 1: 1 (R2) and 1: 3 (R3) but significantly different (P<0.05) with the treatment of fermented tamarind seed feed without the use of water (R1) and with liquid feed with a water ratio of 1: 5 (R4). Likewise, there was no significant difference (P>0.05) in the hemicellulose content between control feed without tamarind seeds and fermentation (R0) with feed containing fermented tamarind beans without the use of water (R1) and between control feed with fermented liquid feed with water ratio 1: 1 (R2). In addition, there was no significant difference (P>0.05) between feed containing fermented tamarind seeds without the use of water (R1) and fermented feed using a water ratio of 1: 3 (R3). A significant difference (P<0.05) was observed between all treatments with fermented liquid feed with a water ratio of 1: 5 (R4).

There was no significant difference (P> 0.05) in lignin content between control feed without tamarind seeds and without fermentation (R0) with feed containing unfermented tamarind seeds (R1) and with feed containing fermented tamarind seeds with a water ratio of 1: 1 (R2), but significantly different (P<0.05) with feed containing fermented tamarind seeds with a water ratio of 1: 3 (R3) and 1: 5 (R4). Likewise, there was no significant difference (P>0.05) between liquid feed containing fermented tamarind seeds with a water ratio of 1: 3 (10.36%) and feed with a water ratio of 1: 5 (10,18).

3.2. Discussions

The ratio of water in liquid feed made from tamarind seeds up to 1: 5 did not have any effect on calcium and energy content. This illustrates that although the ratio of used water was increasing and able to inflate cell contents, the ability of microorganisms to break down calcium and substrate energy remains the same, both in group without tamatind seeds and fermentation (R0), as well as in tamarind seed feed without fermentation (R1) and in feed containing whole tamarind seeds with a water ratio of 1: 1 (R2), 1: 3 (R3) to 1: 5. (R4).

Based on Table 1, it was also known that the higher the use of water in liquid feed caused a decrease in the phosphorus content. This occurred due to the use of water could dissolve the nutrients in the feed, including the mineral phosphorus. In addition, to live and grow, microorganisms need nutrients that they get from feed ingredients. Increasing the concentration of microbes without increasing the number of substrates causes limitations in meeting the nutritional needs for microbial growth [4].

It is further stated that the growth of microbial cells will take place indefinitely, but because the growth takes place by consuming nutrients as well as removing the metabolic products that are formed, after a certain time the growth rate will decrease and eventually the growth stops altogether.

Crude fibre including NDF and ADF are substances that form plant cell walls as well as lignin, cellulose, hemicellulose, and pentosans [15]. The ADF content of feed containing tamarind seeds was observed to increase, starting from feed without using water to feed using water with a ratio of 1: 5. This showed that the more water was used, the ADF content increased. The increase in the ADF content was due to the water causing the process of imbibition of water in the cells of feed materials, especially tamarind seeds, resulting in softening and peeling of the seeds which causes the dissolution of nutrients including crude fibre. This stimulates the activity of microorganisms, especially lactic acid bacteria (LAB) to grow.

The most dominant microbes in the fermentation process were those from the LAB group which were able to carry out fermentation in aerobic and anaerobic conditions [16]. The presence of LAB stimulates the production of enzymes that work using soluble carbohydrates in feed to form organic acids which also cause a decrease of pH. During the fermentation process, LAB will ferment the feed ingredients to produce lactic acid which will reduce the pH of substrate and affect protein and other nutrient compounds [17], which will also cause an increase in the amount of crude fibre.

The NDF content in feed using tamarind seeds, both unfermented and fermented with a water ratio of 1: 1, although the amount is less, is thought to still be in the form of a complex bond. This was stated because even though the tamarind seeds swell, the epidermis has not peeled off. Based on this, it was assumed that the tannin content in tamarind seed coat was still in the form of complex bonds so it cannot be broken down by microorganisms in the fermentation. Likewise, even though the NDF content in liquid feed with a water ratio of 1: 3 and 1: 5 was high, it was in a free bond form so it was easily broken down by microorganisms. This was in agreement with Narsih et al. [18] that processing, one of which immersion, can result in biological changes consisting of the breakdown of various components into simpler compounds

Cellulose found in plants forms plant cell walls and has a structure as a carbohydrate polymer or polysaccharide composed of anhydro glucopyranose with the formula $C_6H_{10}O_5$ [19]. The highest average cellulose was found in treatment R4 (11.91%). This occurred due to the R4 treatment applied the highest amount of water. This amount of water soaked the feed, causing a swelled feed material cells. This made it easier for water to enter the cells which will resulted in the separation of the feed nutrient complex bonds into simple bonds. This will facilitate the activity of microorganisms to utilize nutrient substrates for life. According to Lumova et al. [20], at the time of immersion, a spontaneous fermentation process occurs which causes LAB to develop. Water dissolved carbohydrates derived from feed ingredients including tamarind seeds will produce organic acids, one of which is lactic acid and a small portion of acetic acid which will lower the pH of the substrate and which will inhibit the development of harmful pathogenic microorganisms [6].

Like cellulose, hemicellulose is also a polysaccharide in plant cell walls which is alkaline soluble. Hemicellulose consists of D-glucose, D-galactose, D-mannose, D-xylose, and L-arabinose units which are formed together in various combinations and glycosylic bonds [2]. Water in the liquid feed fermentation process causes the feed ingredients used to become softer. This is in accordance [22], that is at the time of immersion in the fermentation process, water penetrates into the contents of the seeds which causes swelling and peeling of the contents of the seeds or feed ingredients [23].

Lignin is a combination of several compounds that are strongly connected to each other, containing carbon, hydrogen and oxygen, but with a higher proportion of carbon than carbohydrates. Lignin is often classified as a carbohydrate because of its relationship with cellulose and hemicellulose in forming cell walls, but lignin is not a carbohydrate [15]. In addition, lignin is very resistant to chemical degradation, including enzymatic degradation [15]. This indicates that the use of water in liquid pig feed causes an increase in lignin content. The increase in lignin content is thought to be due to the use of water in the fermentation process. The water in the fermentation process also serves to immerse the feed ingredients. The soaking process during fermentation causes water absorption into the feed material which causes the swelling and softening of the feed material cells. This situation also causes fermentation microorganisms to be able to easily use the nutrients in the feed for their life processes and break complex bonds into simple bonds. This is in accordance [24], that fermentation is a process that occurs through enzyme reactions produced by microorganisms to convert both physically and chemically complex organic materials such as proteins, carbohydrates and fats into simpler molecules.

In this research, it could be observed that the fiber fraction content increased with increasing water ratio up to 1: 5. Although the fiber fraction is available in a simpler form, it cannot be concluded that the ratio of water used is optimal. Thus, it is concluded because in principle the desired fibre fraction is low in lignin content because lignin is part of the fibre fraction that is difficult to digest. The increase in fibre fraction content that occurs in this study is thought to have not reached optimal results. Thus, it was concluded because it was suspected that the fermentation time of 72 hours in this study was not the optimal time to produce a decrease in fibre fraction.

4. CONCLUSIONS

The ratio of water in the fermentation of liquid feed made from tamarind seeds up to 1: 5 did not affect the Ca content and energy, but caused a decrease in P and an increase in the fiber fraction (ADF, NDF, Cellulose, Hemicellulose, and lignin).

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