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Metabolizable energy and nitrogen retention of ration of super native chicken contains fermented catfish waste

Abun Abun [1,*], Rendi R.O. Putra [2], Kiki Haetami [3] and Rahmad Fani Ramadhan [1]

[1] *Department of Animal Nutrition and Feed Technology, Padjadjaran University, Sumedang-West Java, Indonesia.*

[2] *Alumni Department of Animal Nutrition and Feed Technology, Padjadjaran University, Sumedang-West Java, Indonesia.*

[3] *Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Sumedang-West Java, Indonesia.*

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Abstract

The study aimed to explore fermented catfish waste product (FCWP) by microbes *L. paracasei*, *B. subtilis*, and *S. cerevisiae* as a substitute for fishmeal with observations on metabolizable energy and nitrogen retention of the ration. The study used 24 14-week-old Super Native Chickens which were kept for 14 days. The experimental design used was a Complete Random Design with 6 treatments and 4 replicates. The treatments given were: R0 (basal ration, 15% protein and ME 2,750 kcal/kg); R1 (basal ration, containing 5% FCWP); R2 (basal ration, containing 10% FCWP); R3 (basal ration, containing 15% FCWP); R4 (basal ration, containing 20% FCWP); and RS (Ration, 18% protein and ME 2,750 kcal/kg). The results showed that the addition of FCWP by consortium microbes had a real effect ($P<0.05$) on metabolizable energy and nitrogen retention. The use of FCWP, as much as 10% in the ration formula, provides the highest metabolizable energy and nitrogen retention value in Super Native Chickens.

Keywords: Fermented catfish waste; Metabolizable energy; Nitrogen retention; Super Native Chickens

1. Introduction

One of the feed nutrients needed by the livestock body is energy. Energy itself is used by chickens for basic life purposes as well as production. Some of the energy consumed will be digested energy, and the rest will be discarded together in the excrete. The energy consumed by chickens will be used for the growth and production of body tissues [1]. Energy calculations are very important to determine whether the rations given to livestock are able to meet their needs or not. Metabolizable energy is a method to assess the energy content of a ration. The factor that affects metabolizable energy is feed digestibility. The digestibility of feed is low, so a lot of energy will be wasted through excretion [2]. The calculation carried out in measuring metabolizable energy is carried out using the method [3] where comparing the energy content contained in the ration with the energy content contained in the excrete, the value of metabolizable energy will be obtained after calculating the difference between the ration energy and the excrete energy.

In addition to the quality of energy that needs to be considered in compiling a poultry ration, the quality of the protein in the ration should not be forgotten. The quality of ration protein can be measured by nitrogen retention, namely nitrogen consumption, nitrogen excreted, and urine [4]. Protein in feed is very important for the survival of livestock. Protein itself has a role in composing meat about 16% [5]. In general, proteins are composed of 16% nitrogen and are sometimes found in other elements such as phosphorus and sulfur [5]. The calculation of feed protein retention can be estimated from nitrogen retention in animal feed, and the conversion of protein into nitrogen should be divided by the number 6.25 [6]. Factors that affect the value of nitrogen retention include genetics, age, and feed given, and not all proteins consumed by livestock can be retained. Other factors that affect the nitrogen retention value include feed

* Corresponding author: Abun Abun

consumption, protein consumption and the quality of the protein provided, the digestibility of crude fiber, the condition of livestock, and the balance of nutrients in the ration [7]. Nitrogen retention is closely related to livestock ration consumption. The value of nitrogen retention depends on the protein content in the ration; the nitrogen that is retained is in line with the protein content in the ration consumed by livestock [8]. The more nitrogen value in the body (absorbed), the less nitrogen is wasted together in the Excreta [9]. Feed with low protein content will move faster to leave the digestive tract when compared to feed with high protein content and will move more slowly to leave the digestive tract to get more time in the denaturation process of the protein that has been consumed [10]. This nitrogen retention value is closely related to ration consumption. Increased ration consumption will result in high nitrogen retention with a high protein content in the feed, as well as increased growth. The process of measuring nitrogen retention is by measuring the nitrogen consumed by livestock and nitrogen released through excretion so that the amount of nitrogen that can be digested by the livestock body can be known.

Super Native Chickens is a cross between a male local chicken and a female breed of chicken [11]. Super Native Chickens grows relatively faster compared to real kampung chicken; the fat content in the meat is small and has a meat taste similar to that of "kampung" chicken [12]. Super Native Chickens has a uniform weight with a fast growth rate, low mortality rate, and easy adaptation to the rearing environment [13]. However, in small-scale maintenance, Super Native Chickens 's productivity is quite low, grows slowly, and has incubation properties [14]. For this reason, efforts are needed to increase the use value of the feed provided by adding catfish waste from fermented products to the ration of Super Native Chickens .

Catfish waste production in West Java-Indonesia reached 76,842.41 tons recorded in 2018-2020 [15]. Large production will produce quite a lot of waste, and if not managed, it will cause pollution, such as a pungent odor due to the decomposition of fish protein. The catfish fillet industry will always produce waste because, in general, only the meat is taken while the head, stomach, and fins of the fish will be thrown away. In the catfish industry, it produces around 67% of waste [16]. The economic value of this fish waste is very low, but if it can be used, it will provide a significant value [17]. The results of the proximate analysis of the nutrient content of catfish waste contain 26.05% crude protein, 20.94% extract ether, 2.21% crude fiber, 1.5% calcium, 7.2% phosphorus, 1.29% lysine, 0.40% methionine, 0.26% cystine (Saraswanti Indo Genetech, 2022). In terms of nutritional content, catfish waste is quite far when compared to fishmeal. Fishmeal has a crude protein content of 41.6%, extract ether 7.82%, crude fiber 0.91%, calcium 5.5%, phosphorus 2.73%, lysine 4.45%, methionine 1.26%, cystine 0.63% (Laboratory of Non-Ruminant Poultry Nutrition and Animal Feed Nutrition, Faculty of Animal Husbandry, Padjadjaran University, 2022). This means that catfish waste needs to be reprocessed to increase the content of nutrients, including amino acids and fatty acids. One of the processors is fermentation.

Fermentation is a cost-effective and easy process as a form of feed processing. The advantages obtained in the fermentation process include preserving feed, reducing anti-nutrient substances in feed ingredients, being environmentally friendly, increasing the digestibility of feed ingredients, and being a solution in utilizing feed ingredients that have good quality with abundant availability [18]. During the fermentation process, protein compounds and peptides are degraded into amino acids that are easily absorbed by the body [19]. This fermentation process involves proteolytic enzymes in the body and enzymes produced by microbes [20]. Microbes *L. paracasei*, *B. subtilis*, and *S. cerevisiae* are proteolytic and lipopolitical bacteria that, in the fermentation process, can increase amino acids and fatty acids [21]. The fermentation yield of catfish waste with consortium microbe increased when compared to the nutrients of catfish waste without fermentation.

Effect of Feeding Shrimp Waste Bioprocessing Products by consortium microbe with a bioprocessing time of two days in free-range chickens showed a metabolizable energy of 2,613.90 kcal/kg [22]. Bioprocessing shrimp waste through gradual fermentation by *B. licheniformis* followed by *Lactobacillus sp* and *S. cerevisiae* produced the best nutrient concentrate with a metabolizable energy value of 2,614 kcal/kg and a protein digestibility value of 72.91% [23].

Research on the provision of fish waste silage has been carried out previously by [24], who tested fish waste silage with a level of 15% in the ration to have a good influence on ration consumption, body weight gain, and weight of broiler chicken carcasses. According to [25], the level of feeding shrimp waste flour in broiler chicken rations of 100 grams/kg (10%) achieves the best nutritional digestibility and energy availability of 5,467 MJ g/kg, dry material base. In addition, [3] have also conducted a study on the effect of shrimp skin fermentation with *B.licheniformis, Lactobacillus sp.,* and *S. cerevisiae* as much as 10% in low-protein feed, resulting in the performance and efficiency of Sentul chicken feed.

2. Research materials and methods

2.1. Research Materials

The Super Native Chickens used was obtained from Super Native Chickens farmers (PT. Sinar Tani Garut-Indonesia). The chickens used are 14 weeks old. The Number needed in this study is 24 heads.

Consortium mikrobes inoculum is made by fermenting catfish waste with pure culture to multiply consortium microbes so that each microbe is familiar with the catfish waste substrate. The manufacture of consortium microbes microbial inoculum was carried out at the Laboratory of Non-Ruminant Poultry Nutrition and Animal Feed Nutrition, Faculty of Animal Husbandry, Padjadjaran University.

Fermented catfish waste product (FCWP) is obtained after fermentation of catfish waste with consortium microbes for 5 days at a dose of 10%. After that, it is harvested, then the products from the fermentation are dried and then ground into fermented catfish waste product (FCWP). The preparation of FCWP will be carried out at the Laboratory of Non-Ruminant Poultry Nutrition and Animal Feed Nutrition, Faculty of Animal Husbandry, Padjadjaran University.

The ration used is prepared based on the nutrient needs of Super Native Chickens during the finisher period, namely crude protein 18-19%; extract ether 4-7%; crude fiber 3-5%; calcium 1-1.2%; phosphorus 0.35%; lysine 0.6%; methionine 0.8%; and ME 2,750 kcal/kg [26]. The ration consists of two types, namely 15% crude protein content and 18% crude protein. The ration formulation is shown in Table 1, and the nutrient content of the treatment ration is shown in Table 2.

Table 1 Ration formula

Rations	**R0**	**R1**	**R2**	**R3**	**R4**	**RS**
	………………………………………………%…………………………………………………					
Fish Meal	10,00	8,00	4,50	2,00	0,00	13,00
FCWP*	0,00	5,00	10,00	15,00	20,00	0,00
Soybean Meal	8,00	6,00	5,00	3,50	1,50	14,00
Yellow Corn	57,00	58,00	58,00	58,00	58,00	53,00
Fine Bran	23,00	21,00	20,50	19,50	18,00	18,00
$CaCO_3$	0,75	0,75	1,00	1,50	2,00	0,75
Bone Meal	0,75	0,75	0,50	0,00	0,00	0,75
Premix	0,50	0,50	0,50	0,50	0,50	0,50
Total	100,00	100,00	100,00	100,00	100,00	100,00

Description FCWP, fermented catfish waste product; R0, Basal rations without FCWP; R1, rations contain 5% FCWP; R2, ration contains 10% FCWP; R3, rations contain 15% FCWP; R4, ration contains 20% FCWP; RS, rtandard rations without FCWP

Table 2 Nutrient content of therapeutic rations

Rations	**Nutrien**								
	CP	**EE**	**CF**	**Ca**	**P**	**Lys**	**Meth**	**Sys**	**ME**
	………………………………………………%…………………………………………………								**kcal/kg**
R0	15,07	5,19	4,20	1,09	0,53	1,10	0,49	0,30	2.750
R1	15,09	5,27	3,92	1,25	0,90	1,04	0,47	0,29	2.763
R2	15,00	5,39	3,83	1,37	1,18	0,94	0,44	0,29	2.748
R3	15,06	5,50	3,67	1,59	1,45	0,88	0,42	0,29	2.742

R4	15,09	5,59	3,43	1,95	1,82	0,81	0,41	0,29	2.746
RS	18,07	5,61	3,96	1,26	0,62	1,37	0,54	0,33	2.751

2.1.1. Sampling Procedure

Sampling was carried out by transferring 24 chickens aged 14 weeks to a metabolizable cage labeled according to the treatment given. The method of extracting the Excreta follows Sibbald and Morse [27], with the method of mastering first and then collecting the Excreta. 14-week-old Super Native Chickens is fasted for 24 hours to empty the previous feed from the chicken's digestive tract. Furthermore, chickens are given feed according to the treatment of 100 grams. Drinking water is given ad libitum. Excrete collection is carried out for 24 hours. Excretes are sprayed with a 5% borax acid solution every 3 hours to avoid nitrogen evaporation. Excreta is collected using a round container of aluminum foil. The excrete is cleaned of attached hairs and accommodated in it, then weighed. Excreta samples were analyzed for gross energy and nitrogen content at the Ruminant Livestock and Food Chemistry Laboratory of Padjadjaran University.

2.2. Observed Variables

The variables observed in this study were apparent metabolizable energy values, metabolizable energy corrected by retained nitrogen, and nitrogen retention.

2.2.1. Apparent metabolizable energy (AME)

Apparent Metabolizable Energy (AME) takes the equation [3].

$$\text{AME (kcal/kg)} = \frac{[(\text{Ger x Nrc})-(GEe\ x\ jNe)]}{Nrc}$$

2.2.2. Metabolizable energy corrected by retained nitrogen (AMEn)

The Metabolizable energy corrected by retained nitrogen (AMEn) is calculated using equations [3]. The formula used is as follows:

$$\text{AMEn (kcal/kg)}= \frac{\{(GEr\ X\ Nrc\ )-(Ne\ X\ GEe\ )-(Nrc\ x\ Nr)-(Ne\ x\ Ne\ )\}}{Nrc}\ \text{x } 8{,}22$$

2.2.3. Information

MEn = Metabolizable energy corrected by retained nitrogen (kcal/kg)

GEr = Gross energy ration (kcal/kg)

GEe = Gross energy excretes (kcal/kg)

Nrc = Number of rations consumed (kg)

Ne = Number of excretes (kg)

Nr = Nitrogen rations (%)

Ne = Nitrogen excretes (%)

8,22 = Constant value of energy and nitrogen of retained

3. Nitrogen Retention (NR)

Nitrogen retention calculations are based on [3].

$$\text{NR (\%)} = \{ \frac{(\ Nitrogen\ comsumntion)-(nitrogen\ excretes)}{(\ nitrogen\ comsumtion)} \}\ \text{x } 100\%$$

2.3. Experimental Design and Statistical Analysis

The research was conducted using an experimental method using a Complete Random Design with six treatments. Each action was repeated 4 times so that 24 experimental units were obtained. If the results of the variant analysis obtained are significantly different (P<0.05), then to test the difference in the average treatment, the Duncan Multiple Region Test is carried out.

3. Results and discussion

3.1. Apparent metabolizable energy (AME) Contain Catfish Waste Fermentation Products

The data from the study on the application of catfish waste fermentation products in rations to pseudo-metabolizable energy (EM) in Super Native Chickens is presented in Table 3.

Table 3 The apparent metabolizable energy (AME) Value of Super Native Chickens

Deuteronomy	Treatment					
	R0	R1	R2	R3	R4	RS
	……………………………………………kcal/kg……………………………………………					
1	2,728	2,666	2,931	2,739	2,634	2,739
2	2,821	2,691	2,979	2,809	2,683	2,763
3	2,746	2,598	2,994	2,832	2,740	2,852
4	2,709	2,696	2,885	2,743	2,605	2,793
Sum	11,005	10,652	11,792	11,124	10,664	11,149
Average	$2,751^{b}$ ± 48.97	$2,663^{a}$ ± 45.22	$2,948^{c}$ ± 49.7	$2,781^{b}$ ± 46,91	$2,666^{a}$ ± 58.94	$2,787^{b}$ ± 48.9

Description: R0, Basal rations without FCWP; R1, Rations contain 5% FCWP; R2, Ration contains 10% FCWP; R3, Rations contain 15% FCWP; R4, Ration contains 20% FCWP; RS, Standard rations without FCWP; Different letters in the mean row of significance indicate a noticeable difference (P < 0.05).

Based on Table 3, the largest metabolizable energy value was produced by rations with R2 treatment (rations with 10% FCWP), followed by RS, R3, R0, R4, and R1. R1 and R4 were not significantly different (P>0.05). The treatment of R3, R0, and RS was not significantly different (P>0.05) but was significantly different (P<0.05) from the treatment of R1 and R4. This shows that the use of FCWP can increase AME in Super Native Chickens. This increase in AME value is due to the presence of *L. paracasei, B. subtilis, S. cerevisiae* in the ration. The fermented products provided contain consortium microbes, which can have a positive impact due to the activity of microorganisms that can increase the absorption of nutrients in the poultry digestive tract; this is because consortium microbes is able to remodel complex protein and fat compounds into simpler amino acids and fatty acids according to what was conveyed [23], *S. cerevisiae* is a yeast that produces amylase enzymes, lipase, proteases and other enzymes that can decompose nutrients in the digestive organs. Likewise, research conducted by [28] that fermentation of fish waste with *B. subtilis* bacteria is able to increase the content of nutrients in it, including amino acids. In addition, processing feed can improve the quality of feed by causing a high digestibility value and affecting the increase in metabolizable energy value [29]. Low digestibility values cause a lot of energy to be wasted through excretory, and vice versa; if the digestibility is high, then less energy is wasted through excretory, in line with [30] that the less energy is excreted, the more energy in the ration is absorbed or digested by the body, so that the efficiency of energy use in the ration is high.

The metabolizable energy of feed can be increased or improved by processing the feed first [31]. One way is to ferment. Fermentation is the processing of products with the help of microorganisms to produce new products with the enzymes produced by microorganisms to remodel complex compounds to be simpler [32]. *L. Paracasei* is a gram-positive bacterium that is capable of producing prolidase enzymes, depeptidases, esterases, and aminopeptidases and is able to produce lactic acid so that it can suppress the development of gram-negative bacteria such as *E.coli* [33]. Based on [34], *B. subtilis* bacteria are able to produce protease enzymes, carboxy peptidases, and lipases to catalyze fatty acid hydrolysis. Meanwhile, *S. cerevisiae* is a unicellular microbe and a very potential amylase producer that is able to remodel starch [35]. The enzymes produced *by S.cerevisiae* include proteases, amylases, glucosidases, and other enzymes that are able to facilitate the absorption of nutrients in digestion [36].

Fermentation of organic matter can release amino acid compounds and also saccharides in the form of dissolved compounds so that they can be easily digested and absorbed in the poultry digestive tract optimally [37]. In addition, fermented feed will also increase the content such as vitamins, riboflavin, provitamin A, and vitamin B12, which have an influence on poultry growth [37]. The administration of 10% in the R2 treatment with 15% ration protein is optimal for metabolizable energy in Super Native Chickens .

3.2. Metabolizable energy corrected by retained nitrogen (AMEn) Rations Containing Catfish Waste Fermentation Products

Data from the study on the application of fermented catfish waste in rations to metabolizable energy corrected by retained nitrogen in Super Native Chickens is presented in Table 4.

Table 4 Metabolizable energy corrected by retained nitrogen (AMEn) Value of Super Native Chicken

Deuteronomy	**Treatment**					
	R0	**R1**	**R2**	**R3**	**R4**	**RS**
	……………………..…………kcal/kg…………………………………					
1	2,577	2,526	2,776	2,595	2,488	2,588
2	2,664	2,550	2,821	2,660	2,537	2,612
3	2,593	2,467	2,835	2,683	2,588	2,698
4	2,561	2,556	2,735	2,598	2,462	2,642
Sum	10,397	10,100	11,169	10,536	10,077	10,541
Average	$2{,}599^{b}$ ± 45.56	$2{,}525^{a}$ ± 40.9	$2{,}792^{c}$ ± 45.58	$2{,}634^{b}$ ± 44.14	$2{,}519^{a}$ ± 55.58	$2{,}635^{b}$ ± 47.64

Description: R0, Basal rations without FCWP; R1, Rations contain 5% FCWP; R2, Ration contains 10% FCWP; R3, Rations contain 15% FCWP; R4, Ration contains 20% FCWP; RS, Standard rations without FCWP; Different letters in the mean row of significance indicate a noticeable difference (P < 0.05).

Based on Table 4, the largest AMEn value was produced by rations with R2 treatment (rations containing 10% FCWP), followed by RS, R3, R0, R1, and R4. R1 and R4 were not significantly different (P>0.05). The treatment of R3, R0, and RS was not significantly different (P>0.05) but was significantly different (P<0.05) compared to the treatment of R1 and R4. AMEn is a metabolizable energy value corrected by the nitrogen value, which is the result of reducing the calorific value of one gram of nitrogen (8.22) multiplied by the non-nitrogen retention value [3]. The calculation of AMEn is very important because the calculation of feed metabolizable energy without nitrogen correction is considered to be less representative of the energy value of a feed. According to the opinion [38], the importance of calculating AMEn is because the calculation of metabolizable energy alone cannot predict the energy value of a feed because the nitrogen stored in the body tissues when catabolized will eventually be expressed as energy lost as urine. Therefore, by calculating AMEn, it is hoped that energy will no longer be affected by nitrogen.

3.3. Nitrogen Retention of Super Native Chickens Rationed Contains Catfish Waste from Fermented Products

The data from the study on the addition of FCWP doses in rations to nitrogen retention of Super Native Chickens are presented in Table 5.

Based on Table 5, the nitrogen retention value given the treatment of FCWP dosage difference in the ratio of Super Native Chickens when compared to R2, R3, R4, R0, and RS, with R1, the result was significant (P < 0.05). But in the rations of R2, R3, and R4, compared to R0 and non-significant RS (P > 0.05).

Nitrogen retention is a method to show the amount of nitrogen that can be absorbed by the livestock body by measuring nitrogen consumed with feed and nitrogen released in the form of excretion [39]. The addition of FCWP in the ratio at the level of 10% to 20%, seen from the nitrogen retention parameter, gave the same results as the lower control of R0 and the upper control of RS. This means that the addition of FCWP at the level of 10% to 20% in the ration can still be used by Super Native Chickens to achieve optimal nitrogen retention.

Table 5 Nitrogen Retention Value of Super Native Chickens Given Ration Containing FCWP

Deuteronomy	Treatment					
	R0	**R1**	**R2**	**R3**	**R4**	**RS**
	……………………………………………………%……………………………………………………					
1	70.317	63.700	68.665	65.104	65.653	68.100
2	73.157	63.661	69.735	67.244	65.759	67.950
3	71.812	59.392	70.362	67.463	68.080	69.356
4	69.269	63.341	66.149	65.246	64.229	67.788
Sum	284.555	250.094	274.911	265.056	263.720	273.194
Average	71.13^{b} ± 1.703	62.523^{a} ± 2.094	68.728^{b} ± 1.857	66.264^{b} ± 1.262	65.930^{b} ± 1.594	68.299^{b} ± 0.716

Description: R0, Basal rations without FCWP; R1, Rations contain 5% FCWP; R2, Ration contains 10% FCWP; R3, Rations contain 15% FCWP; R4, Ration contains 20% FCWP; RS, Standard rations without FCWP; Different letters in the mean row of significance indicate a noticeable difference ($P < 0.05$).

The influence that is not different is real because the Super Native Chickens in the finisher period is only able to utilize the protein contained in the ration as much as 15% for its life needs. In other words, 15% crude protein is enough for its life needs. In line with [40] rationing for 12-week-old Super Native Chickens, namely with a crude protein range of 14.4% - 17.5% with a metabolizable energy of 2,400-2600 kcal/kg. In addition, with the provision of FCWP, the Super Native Chickens consumes lactic acid bacteria. According to [41], LAB can cause the pH condition in the poultry digestive tract to decrease so that it can suppress the growth of pathogenic bacteria. [42] stated that this decrease in pH can also cause proteolysis activity so that protein absorption increases. That is why a ration with 18% protein has the same result as a ration with a protein content of 15% when viewed from the nitrogen retention parameters.

According to [43], the value of nitrogen retention is greatly influenced by ration consumption, protein consumption, and protein quality. Nitrogen consumption with nitrogen retention is directly proportional, and the nitrogen retained in the body indicates the efficiency of protein use in Super Native Chickens . The higher the nitrogen retention value, the more nitrogen is left in growing livestock, so the less protein will be wasted in the excrete.

4. Conclusion

Based on the results of observations and discussions that have been carried out, it can be concluded that the use of femernation catfish waste has an effect on apparent metabolizable energy (AME), metabolizable energy corrected by retained nitrogen (AMEn), and nitrogen retention (RN) in Super Native Chickens. The use of fermented catfish waste in rations at the level of 10% produces the highest metabolizable energy of 2,948 kcal/kg with nitrogen retention of 68.72%.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest is to be disclosed

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