# APPARENT METABOLIZABLE ENERGY OF BASAL FEEDS IN ItikPINAS-ITIM *(Anas platyrhynchos)*

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## ABSTRACT

**An experiment was conducted using 18 growing (10-week-old) female Philippine mallard duck-IP Itim (PMD-IPI) breed to establish the apparent metabolizable energy (AME) and nitrogen-corrected apparent metabolizable energy (AMEn) of the commonly used basal feeds (BF), corn (Co), rice bran D1 (Rb), and soybean meal (Sm). The experiment was carried out by in vivo metabolizable energy (ME) assay that lasted for 102 hours with 54-hour excreta collection period. The experimental design was completely randomized with six replications and one duck per replication. The AME of Co, Rb, and Sm were 3.69, 3.49 kcal/g as fed and 3.10, and 4.07, 3.62, and 3.27 kcal/g DM. While the AMEn were 3.60, 3.35, and 2.55 kcal/g as fed and 3.96, 3.47, and 2.68 kcal/g DM. The AME and AMEn generated on the BF for PMD-IPI were higher than the values by PHILSAN, the primary reference standard of feedstuff nutrient composition matrix in the country required in feed formulation. The experiment results suggest that BF have higher energetic values for PMD-IPI and the breed demonstrates additional efficiency in metabolizing BF energy. Therefore, this will facilitate the formulation of least-cost diets and underpins precision feeding for the breed.**

Keywords: corn, rice bran, soybean meal, duck, feed formulation

## INTRODUCTION

The country's duck production is considered a specialized type of poultry production attributed to the developed niche markets for its egg products. For this reason, the native mallard duck was subjected to intensive selection and breeding and produced the Itik Pinas (IP) with two pure lines (i.e., IP Itim and IP Khaki), and one commercial hybrid (IP Kayumanggi). The IP is a superior breed of egg-type Philippine mallard duck developed for consistently high egg production and stable egg quality (Parungao, 2016; Pinca *et al*., 2019). To maximize the potential of these new duck breeds, the nutrition aspect should also be revisited and must be given attention to ensure the sustainability of IP production. Optimal performance of IPs can only be achieved by providing them with ideal nutrition and changes in profit per egg are attributed to feed input.

However, there is minimal information and understanding on duck nutrition in the

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country unlike abroad wherein a nutritional foundation has been established for Pekin and other breeds of ducks. Specifically, in the Philippines, the energy and nutrients of IP are yet to be understood and established to formulate a breed-specific diet in the context of precision nutrition. Pinca *et al.* (2019) revealed that the majority of IP raisers utilized commercially mixed-layer diets formulated based on an established nutrient recommendation for chickens. Such feeding practice might not maximize the IP's digestive capacity and potential and contribute to the high feed cost, high nutrient excretion, and unseen welfare and health of the species. In formulating poultry diets, energy is one of the top nutritional requirements to be considered as it represents the most expensive dietary component and is unlikely to change given the stiff competition for available energy sources for human food. Likewise, it is the most critical nutrient requirement because it serves as the reference point in setting most nutrient concentrations and controls nutrient intakes. The most common basis for balancing the energy fraction of duck diets is based on the energy content of feedstuffs expressed in apparent metabolizable energy obtained from bioassay data on chicken. However, the accuracy of utilizing metabolizable data of feedstuffs for duck feed formulation derived from chickens is questionable due to their differences in body compositions, digestion physiology, and growth rates.

In the case of the IPs, these breeds might elicit further to harness the energy potential of basal feeds due to their genetic origin as native poultry species. Native poultry species including ducks are well adapted to the local environment and can subsist in low-plane management and nutrition as well as in maximum utilization of feed nutrients. Borin *et al.* (2006) indicated that native breeds under traditional production systems have adapted to the available feedstuffs of poor quality characterized as bulky, fibrous, and resistant to digestive enzyme degradation. Pinca *et al.* (2019) revealed that IP-Kayumanggi has relatively higher mRNA expressions of monosaccharide transporter, SGLT1 in the intestinal segments compared to commercial-layer chicken thereby, suggesting their efficiency of absorbing the energy from the feed leads to a higher energy value of feedstuffs for IP. Therefore, this study aimed to determine the apparent metabolizable energy (AME) value of common basal feedstuffs such as corn, rice bran, and soybean meal specific for the IP-Itim breed of a mallard duck.

## MATERIALS AND METHODS

### Ethics Statement

This experiment complied with the animal care protocol prescribed by the Institutional Animal Care Use Committee (IACUC) of the Mariano Marcos State University (MMSU) in the City of Batac, Ilocos Norte, Philippines. Furthermore, the study was also issued an Animal Research Permit with reference number AR-2022-077 by the Bureau of Animal Industry (BAI) of the Department of Agriculture, Regional Field Office 1 in San Fernando City, La Union, Philippines.

### Experimental Ducks and Design

Week-old (female) IP-Itim used were secured from Central Luzon State University (CLSU)- College of Agriculture Duck Research Facility in Munoz, Nueva Ecija, Philippines. The ducklings were reared at the MMSU Poultry and Livestock Project until they reached the desired age (10 weeks) required for the energy assay following the recommended rearing practices for mallard ducks.

The biological energy assay through the direct method was executed in a Completely Randomized Design (CRD) with three treatments represented by the test feedstuffs, corn (local), rice bran (D1), and soybean meal (US). Each treatment has six replications and one growing IP-Itim was allocated per replicate. The experimental ducks were relatively of the same body weights, age (10- weeks,) and sex (female). The experiment was conducted in a naturally ventilated room.

**Description of the Excreta Collection Method and Apparatus**

The study used the metabolic cage technique to collect the excreta with some modifications for improvement. The metabolic cage used in the study has a dimension of 1.5 x 0.75 x 1 ft made with galvanized welded wire mesh, gauge 16, and ¼ hole size. The top portion is open-type and serves as the cage door access. The frame of the cage was made up of an 8 mm plain bar. For the modification of the metabolic cage, instead of placing a basin under the cage to collect the excreta which is prone to experimental biases as described by several studies, the metabolic cage was suspended using an 8 mm plain bar in a 32-li. capacity clear plastic storage box. This modification ensured that all excreta were collected inside the clear plastic box. Moreover, a non-grease baking paper was lined inside the plastic box under the metabolic cage to ease the collection of excreta.

**Pre-experiment Adaptation of Experimental Ducks and Preparation of Test Diets**

One week before the start of the pre-experiment adaptation, the experimental ducks were dewormed using commercial anthelmintic. Before the start of the experiment, the ducks were physically checked, and dirt adhered to their body parts was removed. The three-day adaptation period was followed. The ducks were placed individually in the metabolic cage and kept in the experimental room which accustomed the ducks to the new environment. During this period, commercial feeds and water were given on an ad libitum basis. The corn (local) and soybean (US) were ground through a 0.5-mm screen before feeding. Samples of the feeds were collected and placed in an airtight specimen container and sent to UPLB-Animal Nutrition and Analytical Laboratory. The proximate analysis of the test feedstuffs is presented in Table 1.

Table 1. Proximate analysis of the test feedstuffs.

| Nutrient Content | Test Feedstuffs | | |
|---|---|---|---|
| | Corn (Local) | Rice bran (D1) | Soybean Meal (US) |
| Dry matter (%) | 88.84 | 90.05 | 89.94 |
| Gross Energy (cal/g) | 4191 | 4782 | 4426 |
| Crude Protein (%) | 8.90 | 12.83 | 46.48 |
| Crude Fiber (%) | 2.82 | 7.82 | 4.73 |
| Crude Fat (%) | 2.83 | 15.02 | 1.18 |
| Ash (%) | 1.31 | 7.6 | 7.34 |
| Nitrogen Free Extract (%) | 72.58 | 46.68 | 30.21 |

**Feeding and Excreta Collection Procedure**

The feeding methodology employed was based on Ragland *et al.* (1997) and Adeola *et al.* (1997) and modified slightly, particularly on the frequency of tube feeding and volume of test feed per feeding. A tube-feeding apparatus consisted of a 60-mL syringe for pet feeding, of which a 35-cm section of Nalgene tubing (8 mm inside diameter) was attached to facilitate delivery of the test feeds to the ducks' pseudo-crop. Forty-eight hours before feeding the test feeds, the feed was withdrawn from all experimental ducks. At eight and 32 hours after feed withdrawal, all ducks were tube-fed with 15 g of dextrose in 100 mL of distilled water (Vidad *et al.*, 2021) and allowed to purge their gastrointestinal tracts. At 48 and 54 hours after feed withdrawal, all ducks were tube-fed with 30 grams of their assigned test feedstuff in 80 mL of distilled water. Feed regurgitation was avoided by dividing the test feed mixture into three parts and tube feeding at intervals of one hour. Approximately 20 ml of distilled water was used to wash particles of feedstuff that adhere to the tube and syringe into the ducks' esophagi.

The duration for the excreta collection was based on King *et al.* (1997). Total excreta samples were collected 54 hours after the test diet administration from each duck. The metabolic cage was lifted from the clear storage box and placed temporarily in a separate empty storage box. The excreta were collected manually in the baking paper removed from the inside of the storage box. Before returning the metabolic cage to the original storage box, the clean baking paper was placed ready for the next collection. Collection of excreta was done every six hours starting from the time of tube feeding. The excreta collected were placed in a small clear zipper bag, weighed, labeled, and frozen immediately at -18 $^{o}$C. During the excreta collection period, all ducks were given 50 ml of water by tube about 32 hours after feeding to overcome any effects induced by low water intake. The summary of the digestibility trial protocol followed is described in Table 2.

After the completion of the 54-hour feeding period, the frozen excreta samples were allowed to come to equilibrium at room temperature. Each excreta sample was examined thoroughly, and small feathers and shank scales were removed manually with the use of surgical forceps. Afterward, the excreta samples were dried at 55$^{o}$C for 48 hours using a laboratory oven, weighed, and then ground through a 0.5-mm screen. Before placing the excreta samples in the small zipper bag, these were sieved again in a 0.5 mm strainer which further removed contaminants such as feathers and scales. The processed excreta were divided into two parts and placed in a small zipper bag and sent separately to UPLB-Animal Nutrition and Analytical Service Laboratory and Lipa Quality Control Incorporated for direct energy and proximate analyses, respectively.

**Data Gathered and Statistical Analysis**

The initial and final weights of the ducks were determined by weighing the ducks before the administration of test diets and after the five-day experiment period, respectively using a digital weighing balance (OHAUS Scout Pro, 0.001g). Lastly, the gain in weight was determined by subtracting the initial from the final weight. On the other hand, after the collection of fresh excreta, these were weighed immediately, similarly after drying.

The energy values of the test feedstuffs were calculated by the method cited by Adeola *et al.* (1997). The AME and corrected apparent metabolizable energy (AMEn), were calculated as follows: AME = (EI – EO)/FI; and AMEn= AME – (8.22 x ANR/FI) where EI is gross energy intake (kilocalories); EO is gross energy output in the excreta (kilocalories);

FI is feed intake (grams), and ANR is apparent nitrogen retention(grams) calculated as the difference between nitrogen intake and nitrogen output.

On the other hand, the data were analyzed using the Analysis of Variance (ANOVA), and significant means ($p < 0.05$) were subjected to LSD test for comparison of means. All the statistical analyses will be performed using Statistical Tool for Agricultural Research (STAR v. 3.0) software.

Table 2. Periodic feeding and excreta collection protocol of the energy balance assay.

| Day | Hours After Feed Withdrawal | Operation |
|---|---|---|
| 1 | 0 | Feed withdrawal was done. |
| 1 | 8 | Ducks were tube-fed with dextrose solution (15 g/100 g water). |
| 2 | 32 | Ducks were tube-fed with dextrose solution (15 g/100 g water). |
| 3 | 48 | The initial weight of the ducks was recorded.<br><br>Ducks were tube-fed with appropriate test feed (30 g/100 g water). The test feed mixture was divided into three parts and administered at an hourly interval.<br><br>The baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 3 | 54 | Excreta was collected and frozen.<br><br>Ducks were tube-fed with appropriate feedstuff (30 g/100 g water). The test feed mixture was divided into three parts and administered at hour intervals.<br><br>The new baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 3 | 60 | Excreta was collected and frozen. The new baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 4 | 72 | Excreta collected and frozen. The new baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 4 | 84 | Excreta collected and frozen. The new baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 5 | 96 | Excreta was collected and frozen. The new baking paper was placed inside the storage box underneath the suspended metabolic cage. |
| 5 | 102 | Excreta was collected and frozen, Ducks were weighed for final weight and removed from the metabolic cage. They were placed immediately in their usual rearing cage and offered immediately *ad libitum* feeds and medicated water. |

## RESULTS AND DISCUSSION

### Weight the Experimental Ducks

Before the start of the experiment, the weight of the ducks was fairly uniform across treatments. Similarly, they exhibited the same body weights at the end of the assay period. Thus, weight losses were similar across treatments (Table 3). The recorded percent weight loss relative to the initial weight of the experimental birds was lower than the findings of King *et al.* (1997) for Pekin ducks subjected to energy bioassay using corn, dehulled oats, and wheat as test feedstuffs at 17.7, 12.9, and 14.4 percent, respectively. Likewise, in the studies of Adeola *et al.* (1997) at 12.6 and 11.3 percent for corn and sorghum, correspondingly and King *et al.* (2000) at 11.1, 11.2, and 11.3 percent for corn, low tannin sorghum, and high tannin sorghum, respectively on the same breed of ducks.

Table 3. The weight (g) and weight loss (g and %) of the experimental ducks used in the energy assay of three basal feedstuffs.

| Treatment | Initial Weight (g) | Final Weight (g) | Weight Loss (g) | Weight Loss (%) |
|---|---|---|---|---|
| Corn (Local) | 890.50±72 | 818.67±61 | 71.83±12.54 | 7.78±1.12 |
| Rice bran (D1) | 890.50±74 | 813.83±72 | 76.67±08.00 | 8.64±1.00 |
| Soybean Meal (US) | 891.00±62 | 813.50±54 | 77.50±10.00 | 8.68±0.68 |
| *p-value* | 0.9912 | 0.9813 | 0.3820 | 0.2148 |
| CV | 7.80 | 7.68 | 13.48 | 11.36 |

### Energy and Nitrogen Balances of the Experimental Ducks

The nitrogen and energy balances of the experimental ducks are given in Table 4. The nitrogen output of the experimental ducks differs significantly ($P < 0.001$) and ducks tube-fed with soybean meal voided the highest nitrogen in their excreta at 0.50 grams while ducks tube-fed with corn and rice bran insignificantly excreted a volume of nitrogen. Similarly, ducks tube-fed with soybean meal significantly ($P < 0.001$) retained the highest nitrogen (3.97 g) followed by ducks tube-fed with rice bran and corn at 1.05 g and 0.69 g, respectively. In terms of energy excreted via the feces, ducks tube-fed with soybean meal and rice bran significantly ($P < 0.001$) excreted a higher energy density at 106.34 kcal and 103.22 kcal, respectively, whereas ducks tube-fed with corn excreted 58.95 kcal. Moreover, ducks tube-fed with the three test feedstuffs excreted approximately 20%, 30%, and 40% of the energy intake accordingly.

The percent nitrogen retention relative to the nitrogen intake of the experimental ducks for the test feedstuffs was 81.33%, 85.17%, and 88.33% for corn, rice bran, and soybean meal, respectively. These recorded values were higher than the N retention value for ducks presented by Applegate and Angel (2008) at 65.7%. The recorded N retention value of the experiment for corn is higher than the report of Hoai *et al.* (2011) at 79% for growing cherry valley ducks with a different assay procedure. For rice bran, the 85.17 % N retention recorded is higher than the findings of the latter author at 71%. On the other hand, a similar tendency was observed in soybean meal, the finding of Adeola *et al.* (2007) is lower at 48.34% for Pekin ducks compared to the 88.33% recorded in the study with the same assay procedure. Moreover, the report of Hoai *et al.* (2011) is also lower (79%) than the value generated in the study, however, the latter researchers used a different assay method for growing Cherry Valley ducks.

Table 4. Nitrogen and energy balances of fed experimental ducks[1].

| | **Corn (Local)** | **Rice bran (D1)** | **Soybean Meal (US)** | **SEM** |
|---|---|---|---|---|
| Nitrogen intake, g | 0.85 | 1.23 | 4.46 | - |
| Energy intake, kcal | 280.65 | 312.89 | 292.15 | - |
| Nitrogen output, g | $0.16^{a} \pm 0.03$ | $0.18^{a} \pm 0.01$ | $0.50^{b} \pm 0.02$ | 0.0122 |
| Energy output, kcal | $58.95^{b} \pm 9.16$ | $103.22^{a} \pm 4.51$ | $106.34^{a} \pm 2.71$ | 3.52 |
| ANR[2], g | $0.69^{c} \pm 0.03$ | $1.05^{b} \pm 0.01$ | $3.97^{a} \pm 0.02$ | 0.0119 |
| ANR[2], % | $81.33^{c} \pm 3.14$ | $85.17^{b} \pm 1.17$ | $88.33^{a} \pm 0.41$ | 1.13 |

[a-c] Means in each row with no common superscript differ significantly (P 0.01)
[1] Mean of six ducks
[2] ANR – Apparent nitrogen retention

Table 5. Metabolizable energy (kcal/g,) of basal feedstuffs for growing Philippine Mallard Duck (IP-Itim).

| **Test Feedstuff** | **As Fed Basis** | | **Dry Matter Basis** | |
|---|---|---|---|---|
| | **AME[a]** | **AMEn[b]** | **AME[a]** | **AMEn[b]** |
| Corn (Local) | $3.69 \pm 0.16^{a}$ | $3.60 \pm 0.15^{a}$ | $4.07 \pm 0.19^{a}$ | $3.96 \pm 0.19^{a}$ |
| Rice bran (D1) | $3.49 \pm 0.08^{b}$ | $3.35 \pm 0.08^{b}$ | $3.62 \pm 0.07^{b}$ | $3.47 \pm 0.07^{b}$ |
| Soybean Meal (US) | $3.10 \pm 0.04^{c}$ | $2.55 \pm 0.04^{c}$ | $3.27 \pm 0.04^{c}$ | $2.68 \pm 0.04^{c}$ |
| S.E.M[c] | 0.0594 | 0.0584 | 0.0704 | 0.0704 |
| P values | <0.01 | <0.01 | <0.01 | <0.01 |
| CV | 3.00 | 3.20 | 3.34 | 3.62 |

[an] AME: apparent metabolizable energy
[b] AMEn: apparent metabolizable energy corrected for nitrogen
[c] S.E.M: standard error of means (6 replicates with one duck per replicate)
Means in the same column with different superscripts were significantly different (p-0.001)

The dissimilar values obtained by the experiment with literature might be due to the assay procedure followed. Nitrogen excretion in the fasting state has been observed not to be constant even in identical experimental conditions (Yaghobfar and Zahedifar, 2003; Adeola, 2005). Moreover, Lippens *et al.* (2002) explained that hormonal changes induced by feed restriction increase nitrogen efficiency. This might also explain the high N retention of IP-Itim in the study as they were subjected to short-term stress, particularly during the five-day assay period. However, this is not in agreement with the report by El-far (2014) wherein Pekin ducks subjected to six-day feed restriction suffered a significant decrease in serum duck growth hormone 1 and chicken insulin-like growth factor 1. These two hormones are associated with increased N retention. Finally, the differences would be further associated with genetics, age, body weight, sex, and environmental temperatures (Yaghobfar and Zahedifer, 2003; Akinde *et al.*, 2010).

**Apparent Metabolizable Energy of the Test Feedstuffs**

The apparent and nitrogen-corrected metabolizable energy (AME and AMEn) values of the test feedstuffs expressed in as-fed and on dry matter bases are given in Table 5. A significant difference ($P < 0.001$) was observed in the calculated AME and AMEn values of the test feedstuffs as fed and on dry matter bases. Corn has the highest AME value at 3.69 Kcal/g followed by rice bran at 3.49 kcal/g and soybean meal yields the lowest at 3.10 kcal/g on as-fed basis. Similarly, on a dry matter basis, the AME value of the test feedstuffs increased at 4.07, 3.62, and 3.27 kcal/g, accordingly. As expected, the AME value of the test feedstuff decreased when these were subjected to N retention correction. In the same way, the AMEn value of the test feedstuffs differs significantly ($P < 0.001$). This agrees with the elucidation of Abdollahi *et al.* (2021) that AME values to zero N retention for modern broilers penalize the energy value of protein feeds and are of a higher extent for ingredients with higher protein content. The significantly lower values of soybean meal in the experiment are validated by the claim of the latter researchers. Corn recorded the highest AMEn at 3.60 kcal/g followed by rice bran and soybean at 3.35 and 2.55 kcal/g, respectively on as-fed basis. While, on a dry matter basis, the values were 3.96, 3.47, and 3.27 kcal/g accordingly. The N correction penalty or energy reduction for corn recorded in the study is within the range presented by Lopez and Leeson (2008) at three to five percent however for soybean meal it is higher than seven to 12% as presented by the latter authors using the substitution method for growing broiler chickens. The relatively higher AME and AMEn values of corn might be attributed to its highly digestible characteristic which is associated with its high starch content. The lower values of rice bran and soybean meal are associated with their high concentration of non-starch polysaccharides which interfere with the digestion process. The higher energy values of corn to that of soybean meal are parallel ($p < 0.001$) to the report of Barzegar *et al.* (2020) and Longo *et al.* (2004) for laying hens and broiler chicks using the reference diet substitution method. On the other hand, a similar result was obtained with the report of Vidad *et al.* (2021) wherein corn has higher ($p < 0.001$) AME and AMEn values than rice bran D2 for Philippine mallard duck with an identical assay procedure. Likewise, the finding of Hoai *et al.* (2011) for the comparative AME and AMEn of corn, rice bran, and soybean meal. Corn has a higher ($p < 0.001$) AME value than rice bran and soybean meal, however, the latter two feedstuffs have identical AME values. The same trend was observed for the AMEn of the three feedstuffs. Their experiment was carried out on meat-type growing ducks using different feeding techniques. On the other hand, the recorded AME value of the test feedstuffs is higher than the values presented by the Philippine Recommends for Feed Formulation and the Philippine Society of Animal Nutritionists (PHILSAN) for poultry. It is noteworthy to mention that these two references are the main sources of feed nutrient composition required in the formulation of poultry diets in the country. The published AME values of corn, rice bran, and soybean meal by the latter references were 3400, 2400, and 2500 kcal/kg on the as-fed basis, respectively.

The main energy-yielding components of the individual feedstuffs are starch, lipid, and to some extent the soluble and non-soluble non-starch polysaccharides (NSP) components. The higher ME values of the test feedstuffs for IP-Itim might be attributed to the capacity of the breed to digest and metabolize the starch component of the test feedstuffs. The starch fraction of the test feedstuff dry matter is the most important source of energy in poultry diets (Svihus, 2014). It is a series of glucose molecules joined by one to four and one to six α-glycosidic bonds and these are rapidly digested with the intermediary action pancreatic α amylase releasing its absorbable unit monosaccharide, glucose. In terms of molecular confirmation of glucose absorption efficiency of Philippine mallard ducks, Pinca *et al.* (2019) revealed in their recent experiment that IP-Kayumaggi, another breed of mallard duck in the country has a higher relative mRNA expression of sodium-glucose transporter (SGLT1) in the three intestinal segments compared to that in commercial layer chicken. SGLT1 levels in IP were greatest in the ileum and jejunum parts of the small intestine. SGLT 1 is responsible for transporting glucose and galactose across the intestinal brush border hence, the absorption of glucose.

The lipid component of feedstuffs can also be a viable source of energy for metabolism. Fats and oils have the highest caloric value of the known feed nutrients (Ravindran *et al.*, 2016). The high oil content of rice bran might explain the high AME and AMEn recorded for IP-itim in the experiment compared with the presented literature for chickens. The experiment of Martin and Farrell (1998) found that ducklings digested the lipids in rice bran better than broilers of equivalent age. Jamroz *et al.* (2002) concluded in their study that lipase activity in the intestinal wall was different in poultry species at the age of 28 days, the highest values were found in ducks and geese than in chickens. Ravindran *et al.* (2016) further stated that ducks at early stages may have a greater capacity to produce enough volume of bile and lipase than chickens. The genotype has a direct link to intestinal lipase activity. Lipase activities in intestinal chyme of Beijing fatty chickens were higher than Arbor Acher broilers at each day of age (day 1 to 56) and significantly higher at 21 and 56 days old ($P<0.05$). Similarly, the crude fat digestibility of Beijing fatty chickens was also higher, and significant differences were recorded at 56 days old ($P<0.05$) (Yan *et al.*, 2009). Beijing fatty chicken is considered a native chicken of China. A similar observation was reported by Liu *et al.* (2021) on intestinal lipase activity in Landrace and Jinhua pig, an indigenous breed in China. Wherein, the latter breed exhibited higher lipase activity in their small intestine. This gave the idea that native animals have higher intestinal lipase activity and the IP-Itim used in the experiment is considered a true-to-type native mallard duck in the country.

The fermentation of non-starch polysaccharides (NSP) predisposes the synthesis of short-chain fatty acids that serve as a supplementary source of energy for animals. NSP can contribute approximately 3.5% of metabolizable energy (ME) to ducks, geese, and chickens. The higher AME and AMEn values of rice bran and soybean meal for IP-Itim compared with chickens based on literature might be explained by the efficiency of the species in digesting NSP. While Jamroz *et al.* (2002) revealed that ducks are more efficient than broiler chickens in digesting NSP from barley. The recorded net energy captured from NSP sugar residues of barley and gut formation of SCFA is 3.2 Kj/g in ducks compared to 2.8 Kj/g in chickens.

## CONCLUSION

The AME values of the corn, rice bran, and soybean meal in as-fed and dry matter bases were 3.70, 3.50, and 3.10, and 4.07, 3.62, and 3.27 kcal/g, respectively. Correcting the AME to zero nitrogen penalizes the value. The AMEn values of the basal feedstuffs were 3.60, 3.35, and 2.55 kcal/g and 3.96, 3.47 and 2.68 kcal/g, accordingly. The AME and AMEn values obtained by the experiment on the basal feedstuffs for growing Philippine mallard duck – IP-Itim were higher than the values obtained from the literature for broilers, layers chickens, and other breeds of ducks though, in different assay procedures. Furthermore, it is also higher than the published AME values of the said feedstuffs presented by the Philippine Society of Animal Nutritionists (PHILSAN). The result of the experiment insinuates that IP-Itim is efficient in harnessing the energy fraction of corn, a commonly used energy feed in poultry diets, rice bran an abundant feed with limited utilization due to high fiber content, and soybean meal, a primary plant protein source feedstuff with appreciable energy content. Moreover, the ME values generated in this experiment can provide an initial foundation and database for the preparation and adjustment of feed formulation leading to a reduction of feed cost and underpinning the concept of precision feeding and nutrition for Philippine mallard duck – IP breeds.

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## REFERENCES

Abdollahi MR, Wiltafsky-Martin M and Ravindran V. 2021. Application of apparent metabolizable energy versus nitrogen-corrected apparent metabolizable energy in poultry feed formulations: a continuing conundrum. *Animals (Basel)* 11(8):2174

Adeola O, Nyachoti CM and Ragland D. 2007. Energy and nutrient utilization responses of ducks to enzyme supplementation of soybean meal and wheat. *Can J Anim Sci* 87(2):199-205.

Adeola O, Ragland D and King D. 1997. Feeding and excreta collection techniques in metabolizable energy assays for ducks. *Poult Sci* 76(5):728-732.

Adeola O. 2005. Metabolizable energy and amino acid digestibility of high-oil maize, low-phytate maize, and low-phytate soybean meal for White Pekin ducks. *Br Poult Sci* 46(5):607-14.

Akinde OA, Kluth H and Rodehutscord M. 2010. Studies on the inevitable losses of nitrogen in Pekin ducks. *Arch Geflügelk* 74(4):233- 239.

Applegate TJ and Angel R. 2008. Variation in nutrient utilization by poultry and ingredient composition. Retrieved on September 26, 2022 from https://s3.wp.wsu.edu/uploads/sites/346/2014/11/Variation-in-Nutrient-utilization-by-Poultry-Ingredient-Composition-final.pdf

Barzegar S, Wu SB, Choct M and Swick RA. 2020. Factors affecting energy metabolism and evaluating net energy of poultry feed. *Poult Sci* 99(1):487-498.

Borin K, Lindberg JE and Ogle RB.2006. Digestibility and digestive organ development in indigenous and improved chickens and ducks fed diets with increasing inclusion levels of cassava leaf meal. *J Anim Physiol Anim Nutr (Berl)* 90(5-6):230-237.

El-Far A. 2014. Effects of quantitative feed restriction on serum triacylglycerol, cholesterol and growth related hormones in white pekin. *Global J Biotechnol Biochem* 9(3):94-98.

Hoai HT, Kinh LV, Viet TQ, Sy PV, Hop NV, Oanh DK and Yen NT. 2011. Determination of the metabolizable energy content of common feedstuffs in meat-type growing ducks. *Anim Feed Sci Technol* 170(1-2):126-129.

Jamroz D, Wiliczkiewicz A, Orda J, Wertelecki T and Skorupińska J. 2002. Aspects of development of digestive activity of intestine in young chickens, ducks and geese. *J Anim Physiol Anim Nutr* 86(11-12):353-366.

King D, Fan MZ, Ejeta G, Asem EK and Adeola O. 2000. The effects of tannins on nutrient utilization in the White Pekin duck. *Br Poult Sci* 41(5):630-639.

King D, Ragland D and Adeola O. 1997. Apparent and true metabolizable energy values of feedstuffs for ducks. *Poult Sci* 76(10):1418-1423.

Lippens M, Huyghebaert G and De Groote G. 2002. The efficiency of nitrogen retention during compensatory growth of food-restricted broilers. *Br Poult Sci* 43(5 Suppl):669-676.

Liu X, Lyu W, Liu L, Lv K, Zheng F, Wang Y, Chen J, Dai B, Yang H and Xiao Y. 2021. Comparison of digestive enzyme activities and expression of small intestinal transporter genes in Jinhua and Landrace pigs. *Front Physiol* 2021: 12: 669238.

Longo FA, Menten JFM, Pedroso AA, Figueiredo AN, Racanicci AMC, Gaiotto JB and Sorbara JOB. 2004. Determination of the energetic value of corn, soybean meal, and micronized full-fat soybean for newly hatched chicks. *Braz J Poult Sci* 6(3):147-151.

Lopez G and Leeson S. 2008. Assessment of the nitrogen correction factor in evaluating metabolizable energy of corn and soybean meal in diets for broilers. *Poult Sci* 87(2):298-306.

Martin EA and Farrell DJ. 1998. Strategies to improve the nutritive value of rice bran in poultry diets. II. Changes in oil digestibility, metabolizable energy, and attempts to increase the digestibility of the oil fraction in the diets of chickens and ducklings. *Br Poult Sci* 39(4):555-559.

Parungao AR. 2016. *Itik Pinas to boost the balut industry through increased duck egg production*. Retrieved on 15 December 2022 from https://www.pcaarrd.dost.gov.ph/index.php/quick-information-dispatch-qid-articles/itik-pinas-to-boost-the-balut-industry-through-increased-duck-egg-production.

Pinca AM, Bautista HNF, Adiova CB and Sangel PP. 2019. Comparative expression analysis of small intestine nutrient transporters sodium/glucose cotransporter 1 (SGLT1) and peptide transporter 1 (PepT1) between Itik Pinas (*Anas platyrhynchos L.*) and commercial layer chicken (*Gallus gallus domesticus*). *Philipp J Sci* 148(3):433-439.

Ragland, D., King, D., & Adeola, O. 1997. Determination of metabolizable energy contents of feed ingredients for ducks. *Poult Sci* 76(9):1287-1291.

Ravindran V, Tancharoenrat P, Zaefarian F and Ravindran G. 2016. Fats in poultry nutrition: Digestive physiology and factors influencing their utilisation. *Anim Feed Sci Technol*

213:1-21.
Svihus, B. 2014. Starch digestion capacity of poultry. *Poult Sci* 93(9):2394-2399.
Vidad S, Duran DH, San Andres JV and Barroga AJ. 2021. Apparent metabolizable energy of corn and rice bran for philippine mallard duck. *Hasanuddin J Anim Sci* 3(2):78-84.
Yaghobfar A and Zahedifar M. 2003. Endogenous losses of energy and amino acids in birds and their effect on true metabolizable energy values and availability of amino acids in maize. *Br Poult Sci* 44(5):719-725.
Yan S, Zhang T, Liu Q and Liu Z. 2009. Comparative research of lipase activity and crude fat digestibility of AA broilers and Beijing fatty chickens. *Chin J Anim Nutr* 21(3):393-397.