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Digestibility of different carbohydrate sources in the diet of native chicken (*Gallus gallus domesticus*)

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ABSTRACT

The price of conventional sources of energy such as corn and wheat is high due to insufficient supply and tough competition between humans and animals. This study was done to determine the digestibility of various carbohydrate sources in the diet of native chicken (*Gallus gallus domesticus*) with regard to dry matter content, apparent metabolizable energy and crude protein. The study result would help poultry raisers to determine alternative, inexpensive energy sources of feed that are available in the local community. There were six dietary treatments used in this study namely: t_0-commercial feeds (CF), t_1-peeled cassava (PC), t_2-peeled sweetpotato (PSP), t_3- unpeeled cassava (UC), t_4-unpeeled sweetpotato (USP) and t_5-grated coconut (GC). The treatments were arranged in Complete Randomized Design (CRD) with four replicates. Native chickens undergone a 10-day digestibility trial. During the digestibility trial, homogenous feces from test diets were collected, weighed and dried as well as the endogenous feces which were collected after no feeding period. Feed sample and collected feces from each treatment were subjected to chemical analysis. The result of this study revealed that PC got the highest percent dry matter digestibility followed by GC. On the other hand, CF statistically got the lowest %dry matter digestibility (DMD) among other treatments. In terms of crude protein digestibility (CPD), PC diet obtained the highest crude protein digestibility while GC obtained the lowest percentage. When it comes to Apparent Metabolizable Energy (AME), native chicken fed with GC diets attained the highest digestibility which is significantly higher than commercial feeds and other diets. The results on the digestibility percentage of dry matter, crude protein and apparent metabolizable energy is determined through the One-way Analysis of Variance (ANOVA). Peeled cassava and grated coconut can be used as energy source of feed for native chicken.

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INTRODUCTION

Native chicken production is an integral part of farming for most backyard farmers in the Philippines since it is the primary source of meat and eggs. It is the second most popular meat in the country next to pork. Philippine native chicken (*Gallus gallus domesticus*) is thought to be developed from the domesticated red jungle fowl. It has a plumage color of brown and black which varies from the white commercial layers and broilers. Native chicken production is an integral part of farming to most backyard farmers in the Philippines since it is the primary source of meat and eggs. Native chickens have consistently made up over 60% of the country's total chicken population (Madibana et al., 2020). Philippine native chicken, a fowl usually found in the backyards of many Filipino households, is one of the primary sources of meat and eggs (Dusaran and Pabulayan, 2015). Rural farmers have earned additional income by raising native chickens throughout the years. Several studies claimed that native chicken meat is better than broiler meat in sensory characteristics like flavor, color, off-flavor, and overall acceptability. Native chicken meat is mainly preferred in cooking over broiler, especially in broth and soups. Recently, there has been more attention given to the improvement, utilization, and conservation of the Philippine native chicken.

Indigenous or native chickens are thermotolerant, and disease-resistant, good palatability in meat and egg and have high fertility and hatchability. However, it is low in productivity and has slow growth rates. The meat of these native chicken strains are renowned for its tastiness, roughness and leanness. However, due to a number of issues including sub-optimal nutrition and occurrence of diseases, the productivity is relatively low. In order to increase the production, a transition to semi-intensive system would be a viable approach, wherein highly-nutritious diets are given.

Feeds and feeding constitute 70-75% of the production cost and inflict quality and productivity based on the feeding system and feed quality (Abdulsalam, Yahaya, and Yakasa, 2021). A few obstacles that prevent the birds from growing to their full potential are the scarcity and high cost of chicken feed, the need for veterinary care, and the unfavorable environmental factors related to heat stress. Since feed still accounts for a significant portion of the cost of raising chickens, the industry faces significant challenges due to the limited availability of feedstuff, particularly essential feed ingredients like maize and oil seed cakes. Additionally, it reduces feed intake, disrupts the metabolism of carbohydrates, and reduces the efficiency of protein synthesis. Oxidative stress and fat deposition rise, lipid utilization falls, and glucose or insulin homeostasis is disrupted. Furthermore, the primary issue with chicken production in hot and humid climates is climate change, a topic that has gained international attention (Kpomasse et al., 2021). The price of conventional sources of energy such as corn and wheat is high due to insufficient supply and tough competition between humans and animals (Omede et al., 2018).

Energy is require in varying amounts for all metabolic purposes, so a deficiency of energy affects most aspects of the productive performance of poultry. If the available energy concentration of the diet is changed, birds maintain constant energy intake by changing their feed intake. Therefore, energy is require for chickens to support scavenging activities and productive performance. Locally available resources are helpful as energy feeds when they are abundant and low in price. Dietary carbohydrates such as corn, wheat, barley and sorghum are vital energy sources for poultry species. Poultry can easily digest a significant amount of carbohydrates in cereal grains as starch. Different amounts of certain carbohydrates can be found in protein supplements and cereal grains.

The digestibility of nutrients in feed ingredients is essential for sustainable economic and food production. Therefore, evaluating alternative, inexpensive, nutritious, and readily-available feed ingredients is needed (Madibana et al., 2020). For this reason, the researcher conceptualized the idea of evaluating the digestibility of various sources of carbohydrates in the diet of native chicken.

OBJECTIVES OF THE STUDY

Generally, this study aims to determine the digestibility of different carbohydrate sources in the diet of native chicken.

Specifically, this study was performed to determine and compare the digestibility of different carbohydrate sources in the diet of native chicken in terms of Dry Matter content, Crude Protein, and Percent Apparent Metabolizable Energy.

MATERIALS AND METHODS

This study was laid in a Complete Randomized Design (CRD), with six (6) treatments replicated four (4) times. A total of twenty-four (24) experimental units were utilized in the study. The drawing of lots was executed for randomization to eliminate experimental error. One bird was randomly assigned per replicate cage. Each cage had a maximum floor space of 1 square foot per grower bird, following the space requirement for poultry. Plastic fecal receptors were placed under the floor for the collection of fecal droppings.

Experimental Set-up

The study was conducted at Brgy. Tigbon, Calatrava Negros Occidental from March 5-15, 2022. The poultry house was made of bamboo and wood. The area was divided into two parts, with 12 cages in each of it. The study used 24 heads of grower native chicken as experimental organisms. Native chickens were acclimatized before the feeding trial. Each chicken was placed into their cages through drawing of lots for randomization. Chicken in treatment zero (0) was fed with commercial feeds (CF), which is the control. Treatment one (1) diet is peeled cassava (PC), treatment two (2) is peeled sweetpotato (PSP), treatment three (3) is unpeeled cassava (UC), treatment (4) is unpeeled sweetpotato (USP), and treatment five (5) is grated coconut (GC).

Feed Preparation

Peeled cassava (Figure 1) was prepared by peeling, chopping and sundrying. Unpeeled cassava which can be seen in Figure 2 did not undergone peeling, however it was chopped and sundried. The peeled sweetpotato (Figure 3) undergone the same process as peeled cassava, while unpeeled sweetpotato (Figure 4) was processed similarly as the unpeeled cassava. After sundrying, the treatments were smashed into small particles for easy digestion of chicken. On the other hand, grated coconut which can be seen in Figure 5 was processed through grating, milk extraction and sundrying. All treatments were sundried to over 10% moisture content.

Figure 1. Peeled cassava

Figure 2. Unpeeled cassava

Figure 3. Peeled sweet potato

Figure 4. Unpeeled sweet potato

Figure 5. Grated coconut

Digestibility Trial

The adjustment period was done for five (5) days. Within this period, the native chickens were fed with the old diet, which was the cracked corn, and then the test diets, whose ratios were changed gradually (100:0, 75:25, 50:50, and 25:75). This was to prevent digestive upset during the transition period which would probably affect digestion. After five days, elimination of feed was undertaken. The animals were given only plain water to help eliminate the feeds provided on the previous days. On the seventh day, treatments consisting of 100 grams per bird (DM basis) were forced-fed to the experimental animals. The test diets were given in exact amounts simultaneously (8 o'clock in the morning) to ensure uniformity of the computation. Right after feeding, fecal receptors were installed under each cage to collect their excreta for 12 to 24 hours. On the eighth day, fecal droppings were collected from each treatment and each replicate. The feces were guarded against fly and maggot infestation, as well as to prevent contaminants like downs or scales, for these might pollute the integrity of the samples. Each sample was labeled and weighed, subtracting the weight of their respective plastic receptors before homogenizing according to their assigned treatments. All animals were returned to the 'no feeding' set up on this day, given only plain water in preparation for collecting of the endogenous fecal samples. Feces from no feeding were collected on the ninth day. These feces were used to compute the endogenous nutrients digested during the process. The same management of the feces from Day 8 was applied on this day. The samples were dried under the sunlight and using an oven drier. Samples containing 100g of dried feed diet were kept in an airlock plastic container. Dried homogenous and endogenous feces were also collected and kept in an airlock plastics as samples for laboratory analysis. The diets and excreta were analyzed for crude protein and apparent metabolizable energy using standard procedures of Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory, Bacolod City.

Data gathering procedure

The specimens for experimental diets and the feces of native chickens were subjected to laboratory analysis. Dry matter, crude protein and metabolizable energy are obtained through the following formula:

Dry Matter Digestibility:

%DMD = (SWa-SWb) ÷ (SWa – Weight of endogenous) x 100

Where:

SW = weight of the sample, DM basis.

Crude Protein Digestibility:

%CPD = (DWa x %CPa) – (DWb – %CPb) ÷ (DWa x %CPa) x 100

Where:

DWa = dry weight of the sample feed
DWb = dry weight of the sample feces
%CPa = percent crude protein of feed given
%CPb = percent crude protein of feces collected

Apparent Metabolizable Energy (AME) Digestibility:

%AMED = (DWa x AMEa) – (DWb – AMEb) ÷ (DWa x AMEa) x 100

Where:

AMEa = apparent metabolizable energy of the feed
AMEb = apparent metabolizable energy in the feces

Statistical Analysis

Data of the study were consolidated, tabulated, and analyzed using One-way Analysis of Variance (ANOVA) in a Complete Randomized Design (CRD) through the use of Statistical Tool for Agricultural Research (STAR) version 2.0.

RESULTS AND DISCUSSION

Dry Matter Digestibility

A feedstuff"s dry matter content is significant since it shows the true proportions of different nutrients that the animal eating the meal can get. The feed is represented by fed or feed as it is given to the animal, taking into account the moisture level. Although feeding is an a true depiction of the stream that is being provided, it is not a reliable. Regarding the non-water feed components' nutritional makeup, especially when the amount of moisture is high. Determining the dry matter digestibility of chickens is crucial in assessing the amount of nutrients they receive.

Table 1 below presents the means in the percent dry matter digestibility of the different carbohydrate sources in the native chicken's diet.

Table 1. Dry Matter Digestibility of Different Carbohydrate Sources in the Diet of Native Chicken

Treatments	**%DMD**
CF	87.69[c]
PC	92.84[a]
PSP	89.11[b]
UC	89.31[b]
USP	87.88[b]
GC	89.55[b]

Means of the same letter did not differ significantly

Data in Table 1 shows that in terms of %DMD, T1-peeled cassava got the highest digestibility with 92.84%, followed by T5-grated coconut with 89.55%, T3-unpeeled cassava with 89.31%, T2-peeled sweetpotato with 89.11%, T4-unpeeled sweetpotato with 87.88% and commercial feeds (T0) got the lowest dry matter digestibility with 87.69%.

The result shows that peeled cassava as the highest %DMD significantly differ from commercial feeds, which is the control. This correlates to the study of Morgan and Choct, 2016, that cassava can be a substitute energy source to wheat and corn because of its high carbohydrate content. Additionally, cassava is high in resistant starch as well as fiber, subjected to microbial fermentation and enhances the animal's intestinal health (Jha and Berrocoso, 2015). Cassava has comparatively higher digestible starch than corn starch. Studies reported that cassava starch contains 83% amylopectin and amylose content of 17%. The significantly higher amylopectin content of cassava means that it may have higher digestible starch than other identified starch sources fed to poultry (Morgan and Choct, 2016).

Crude Protein Digestibility

The body will break down and use the excess protein for energy or excrete it as uric acid; opportunistic pathogens may use the excess protein in the lower gastrointestinal tract as food, increasing the risk of disease; and the rate of nutrient digestion and absorption will be slowed down. Because lowering the dietary protein level will result in a decrease in the amount of essential or nonessential amino acids (AA), lowering the CP content of diets may impair immune system performance and growth performance.

Table 2 shows the means in the percent crude protein digestibility of different carbohydrate sources in the native chicken diet.

Table 2. Crude Protein Digestibility of Different Carbohydrate Sources in the Diet of Native Chicken

Treatments	%CPD
CF	36.83[ab]
PC	39.56[a]

PSP	21.67[d]
UC	28.16[c]
USP	31.56[bc]
GC	17.66[d]

Means of the same letter did not differ significantly

As presented in Table 2, the data in %CPD revealed that T1 (peeled cassava) obtained the highest crude protein digestibility of 39.56%, followed by T0 (commercial feeds) with 36.83%. In comparison, T5 (grated coconut) got the lowest percentage of crude protein digestibility of 17.66%.

The result in the percent crude protein digestibility of different carbohydrate sources shows a great significant difference among treatments. This correlates with Bhuiyan and Iji (2015), that cassava chips have higher crude protein content. According to the study by Omede et al. (2017), crude protein of cassava root comprises of 50% whole proteins, and free amino acids are present in the remaining proportion.

Apparent Metabolizable Energy Digestibility

The widely recognized method for characterizing the energy that chickens can use is called AME. The feed industry currently uses formulas or reference tables with AME or AMEn values of components that have been determined using older birds for developing commercial poultry diets (Khalil et al., 2021).

Table 3. Apparent Metabolizable Digestibility of Different Carbohydrate Sources in the Diet of Native Chicken

Treatments	%AMED	AMED, J
CF	92.04[f]	80,913.72 [f]
PC	95.63[c]	177,965.93 [c]
PSP	96.40[b]	217,089.78 [b]
UC	93.65[e]	152,916.72 [e]
USP	94.59[d]	158,981.09 [d]
GC	98.17[a]	532,613.07 [a]
CV%	0.8626	

Means of the same letter did not differ significantly

As shown in Table 3, T5 (grated coconut) obtained the highest apparent metabolizable energy digestibility of 98.17%, followed by T2 (peeled sweetpotato) with 96.40%. T1 (peeled cassava), T4 (unpeeled sweetpotato), and T3 (unpeeled cassava) got 95.63%, 94.59%, and 93.65% respectively, while T0 (commercial feeds) obtained the lowest %AMED with 92.04%.

The result in the percent apparent metabolizable energy digestibility of different carbohydrate sources shows a significant difference among treatments. The coconut's total carbohydrate content are about 61% of polysaccharides, comprising 42% mannose and 58% glucose (Sundu et al., 2020). Studies reported that mannose-based polysaccharides enhances feed digestibility and body weight gain of chicken. Innovating waste materials like coconut dregs into potential feedstuff could lessen the production cost and minimize pollution without affecting the performance of chicken (Viliganilao, 2019). Coconut dregs contain 5.7% protein and 36.7% crude fiber (Hafsah et al., 2020).

An increased energy level in the diet will cause the bird to eat less feed, so the diet's amino acid, vitamin, and mineral content must increase correspondingly. In order to give an adequate nutritional intake based on requirements and the actual feed consumption, nutrient density in the ration should be modified in proportion to energy (Korver, D., 2023).

CONCLUSION AND RECOMMENDATION

Based on the result of the study, it is concluded that peeled cassava is the most digestible carbohydrate source of feed in terms of dry matter and percent crude protein. This is essential to improve the growth rate and feed efficiency of native chicken. Furthermore, grated coconut is the most digestible energy source in terms of apparent metabolizable energy. Previous studies stated that chickens fed with coconut-containing diets optimized body weight and feed conversion ratio.

Because of its abundance and high digestible starch content, cassava has become crucial. Cassava could be a potential substitute for maize to up to 50% in the poultry diets when processed properly through drying, boiling and fermentation. On the other hand, coconut has good nutritive values to be used as feed for chicken, especially native chicken. As a potential feedstuff, it could reduce the production cost and minimize pollution without affecting the performance of chicken.

It is therefore concluded that both peeled cassava and grated coconut can be used as substitute for high-cost commercial feeds.

It is recommended to use peeled cassava and grated coconut in the diet of native chicken. Additionally, a further research on actual feeding trials of other locally available carbohydrate sources is recommended.

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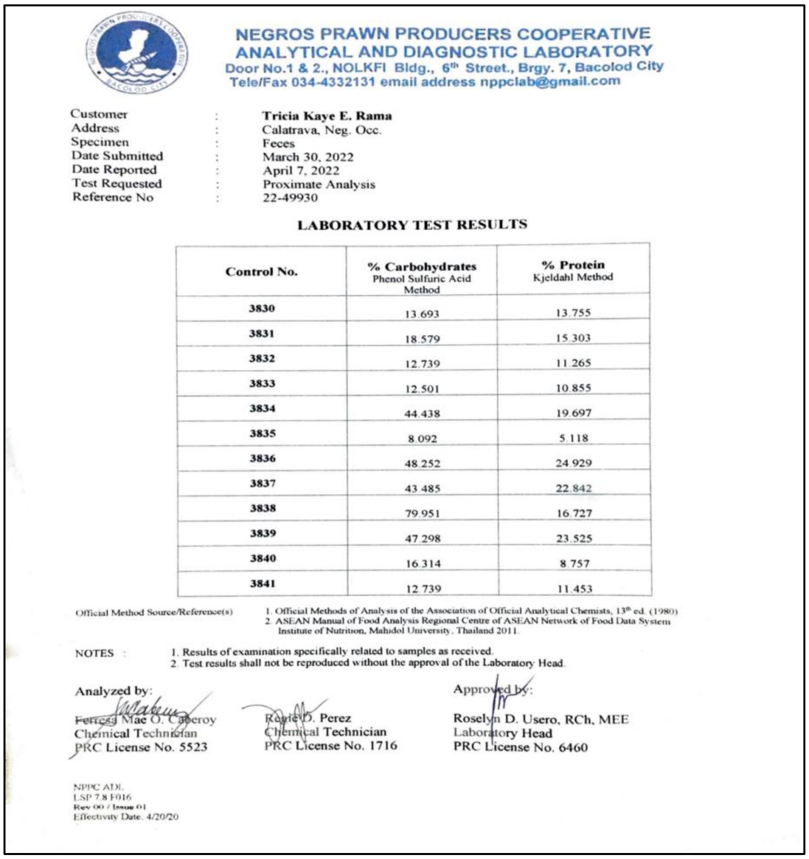
APPENDIX

Laboratory Analysis Result of the Test Diets, Fecal Samples, and Endogenous Samples given by Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory, Bacolod City, Philippines.



NEGROS PRAWN PRODUCERS COOPERATIVE
ANALYTICAL AND DIAGNOSTIC LABORATORY
Door No.1 & 2., NOLKFI Bldg., 6th Street., Brgy. 7, Bacolod City
Tele/Fax 034-4332131 email address nppclab@gmail.com

Customer : **Tricia Kaye E. Rama**
Address : Calatrava, Neg. Occ.
Specimen : Feces
Date Submitted : March 30, 2022
Date Reported : April 7, 2022
Test Requested : Proximate Analysis
Reference No : 22-49930

LABORATORY TEST RESULTS

Control No.	% Carbohydrates Phenol Sulfuric Acid Method	% Protein Kjeldahl Method
3830	13.693	13.755
3831	18.579	15.303
3832	12.739	11.265
3833	12.501	10.855
3834	44.438	19.697
3835	8.092	5.118
3836	48.252	24.929
3837	43.485	22.842
3838	79.951	16.727
3839	47.298	23.525
3840	16.314	8.757
3841	12.739	11.453

Official Method Source/Reference(s)
1. Official Methods of Analysis of the Association of Official Analytical Chemists, 13th ed. (1980)
2. ASEAN Manual of Food Analysis Regional Centre of ASEAN Network of Food Data System Institute of Nutrition, Mahidol University, Thailand 2011.

NOTES :
1. Results of examination specifically related to samples as received.
2. Test results shall not be reproduced without the approval of the Laboratory Head.

Analyzed by:
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NPPC ADL
LSP 7.8 F016
Rev 00 / Issue 01
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Table 4. Composition of the Test Diets (g DM/bird/day)

Treatments	DM	DM Requirement 100 g DM/bird/day
CF	88.0%	113.64
PC	69.58%	143.72
PSP	78.24%	127.81
UC	74.59%	134.07
USP	72.47%	137.99
GC	78.31%	127.70

Table 5. Test Diets Fed in DM Basis (g DM/bird/day)

Treatments	Adjustment Period			Test Period
	Day 3 25%	Day 4 50%	Day 5 75%	Day 7 100%
CF	28.41	56.82	85.23	113.64
PC	35.93	71.86	107.79	143.72
PSP	31.95	63.91	95.86	127.81
UC	33.52	67.04	100.55	134.07
USP	34.50	69.00	103.49	137.99
GC	31.93	63.85	95.78	127.70