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Preference of Broiler Chicken for Cassava-*Moringa* Based Diet

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ABSTRACT

The poultry industry is under pressure from the rising cost of imported feed ingredients. In order for the industry to be profitable and sustainable, it has to reduce the cost of production by using locally available feedstuff. A study was carried out to evaluate feed preference of broiler chicken for cassava root chip, for three diets made by mixing different proportion in percentage of cassava root chip and ground *Moringa* leaf (90:10, 80:20, 70:30) and compare it to the preference for commercial starter diet. These diets were offered as free choice to five 20-days old chicken, one at a time over a period of five days. The three feed preference criteria assessed were (i) the visiting frequency to each diet station, (ii) time spent feed at each diet station, and (iii) amount of different treatment diet consumed. The hypothesis is that the preferred food will be visited more often; the chicken will spend longer time feeding on it and therefore consume it more. We found that broiler chicken consumed cassava root chip the least (2 g), visited it less often (9 visits) and spent less time (3.5 minutes) feeding on it. In contrast, feed consumption (6.12 g) and time spent (17 minutes) was highest for mixed diet containing 80% cassava and 20% *Moringa* leaf meal. Visiting frequency was highest for commercial starter diet (29 visits) and second highest (24 visits) for mixed diet of 80% cassava: 20% *Moringa* and 70% cassava: 30% *Moringa*. It is concluded that broiler chicken preferred the diet containing 80% cassava root chip and 20% *Moringa* leaf meal among all diets on offer.

Keywords: Broiler chicken, cassava root chip, feed preference, *Moringa* leaf meal

INTRODUCTION

Poultry meat (1.59 million metric tonnes in 2019) and egg (9 billion per year) is a very important component of livestock industry in Malaysia (Department Veterinary Services, 2020). It is cheaper than other protein sources such as beef, lamb or pork, and consumed by most people due to the absence of racial and religious prohibition. Per-capita consumption of poultry meat in Malaysia is currently about 50 kilograms, which is the highest in Asia and third highest in the world (Ferlito, 2020; Hirschmann, 2021).

The cost of feed accounts for about 70% of the cost of poultry production, so to make the industry cost-effective, competitive and sustainable, we should address this cost of feed issue first (Thirumalaisamy *et al*., 2016; Abdurofi *et al*., 2017). The magnitude of the issue can be seen from 2017 statistics during which Malaysia produces about 80,000 metric tonnes (MT) of grain corn compared to 3.7 million MT demanded by the livestock industry. To meet this demand Malaysia has to import all the grain corn required, mainly from Brazil and Argentina, worth RM 3 billion. Grain corn import rose from 3.7 million MT in 2017 to 4.1 million MT in 2020. This situation is clearly unsustainable and undesirable, hence the government is looking for ways to increase local production by learning from our neighbour Indonesia who are almost self-sufficient in grain corn production (Nazmi *et al*., 2021).

The preferred strategy should be to depend less on imported feed ingredients such as corn (energy source) and soybean meal (protein source) and promote the production and use of locally produced feedstuff. Cassava has been identified and suggested as partial replacement for corn especially in areas where it is readily available (Morgan & Choct, 2016) while *Moringa oleifera* has been tested in a feeding trial with poultry in South Africa (Sebola *et al*., 2015).

An important criterion to the use of alternative feedstuff is whether its taste, colors and textures will influence the acceptability and hence food intake of the ration. If it is not preferred by the chicken, then it may reduce food intake and hence affect the production level, which is detrimental to the industry. Hence, the usefulness of locally alternative feedstuff is dependent on whether chicken would readily consume it or not. For example, cassava root chip is a locally produced feedstuff, which mean it should be relatively cheap compared to corn. However, due to it lacking many nutrients particularly protein, amino acid and mineral (Garcia & Dale, 1999; Chauynarong *et al.*, 2009; Bhuiyan & Iji, 2015), it must be supplemented with a good source of protein. One such source is *Moringa* leaf meal whose crude protein content have been reported to range from 23-43% (Wu *et al*., 2013; Bin & Chen, 2020). The problem is there has been no investigation on the modern poultry breed's preference for cassava or whether preference for it can be enhanced through addition of *Moringa* leaf meal.

The main aim of this study is to determine the food preference of broiler chicken for diets containing different ratios of cassava root chips and *Moringa* leaf meal diet. Food preferences were evaluated according to the following criteria: (i) frequency of visit to each diet station (ii) duration of feeding bout at each diet station, and (iii) consumption of each diet. In addition, the nutrient content of cassava root and *Moringa* meal was also determined. Commercial starter feed was used as the benchmark for preference.

MATERIALS AND METHODS

Chicken Breed

Broiler chicken breed used for this study was Cobb. This is the main broiler breed in Malaysia, accounting for 98.77% of the total parent stock. As and when required, one chicken at a time was bought from QL Livestock Farm in Bau and brought home. It was kept in a modified cage (refer to experimental design below), fed with a commercial starter diet and they were used for the preference trial when they are about 20 days old. At this age, the digestive tract of the chicken is already well developed and matured enough to handle new dietary manipulation (Santos *et al*., 2019). At the start of the preference trial, each chicken was weighed using a Pesola MS500 spring balance and weighed again at the end of the preference trial.

Experimental Design

A standard dog cage (76 cm x 54 cm) was used to house the chicken prior to and during the experiment. It was placed at the back of the house under a roof to protect the chicken from direct sunshine and rain. The base of the cage and lower sidewall was covered with recycled carboard boxes to reduce draught and prevent chill. A 25-watt light bulb was suspended 33 cm above the base area and turned on at night to keep the chicken warm. The cage was furnished with five feeding bowls into which the different types of diet were placed (the location of each bowl represents a station, explained below), and one water bowl. These bowls were made from recycled mineral water bottle, which was cut about 5 cm from the bottom.

Experimental Diet

The feedstuff used in this trial were commercial broiler feed (Starter pellet 201, Gold Coin), cassava root meal and *Moringa* leaf meal. *Moringa* was supplied by Betterlin Health Products Sdn. Bhd. The experimental diets were: (A) commercial food pellet 100%, (B) cassava root chips 100%, (C) 90% cassava root chips + 10% *Moringa* leaf powder, (D) 80% cassava root chips +20% moringa leaf powder, and (E) 70% cassava root chips + 30% with *Moringa* leaf meal. During the preference trial, each chicken was offered free choice 10 g of each diet, giving a total of 50 g of total feed offered to each chicken per day.

Experimental Procedure

During the preference trial, any left-over food from the previous day was removed. Then 10 grams of each diet was weighed and put into its designated bowl. At 8 am all the diet was offered simultaneously to the chicken and its feeding behavior was recorded until 9 am. At 9 am the food left in the bowl was weighed and put back in the cage at the same position. The position of the bowl in the cage was rotated daily during five days observation period to ensure that its position does not influence the preference for the diet in the bowl. Due to limitation in space, the trial was done with one chicken at a time, each

chicken entered the trial for 5 days to allow for diet rotation mentioned above.

Nutritional Analysis of Feed Sample

Nutritional analysis of feed samples used in this experiment was carried out at the Animal Nutrition Laboratory, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS). All the feed samples were kept dry in force draught oven which was maintained at 80 °C. Analysis was done in triplicate and the average values are expressed on dry matter basis. Briefly, ash was determined by incinerating the samples at 500 °C for 5 hours, while organic matter (OM) was determined by difference, ie. OM = 100 – % Ash. The ash was then dissolved in dilute HCl for mineral analysis. Crude fibre was determined by using the fibre bag method (Gerhadt Analytical System, nd). The sample inside the fibre bag was subjected to consecutive digestions by weak H_2SO_4 followed by weak NaOH, and the residue remaining after washing was dried, weighed, ashed and then the ash was weighed. Crude protein was determined by the Kjedahl method (Thiex *et al.*, 2002). Crude fat was determined by extraction using diethyl ether (AOAC 945.16, 2005). Phosphorous was determined on the ash solution using a UV-Visible spectrophotometer (Thermo Scientific, model GENESYS 50) and readings taken at 420 nm wavelength (Dragičević *et al*., 2011). Calcium and magnesium determination were done on a diluted solution of sample ash using atomic absorption spectrophotometer (Analytik Jenna, model novAA800) according to method described by Siong *et al*. (1989).

Data Collection

Data that were collected during the experiment to assess food preference include; (i) number of visits by each broiler chicken to a diet station, (ii) duration of each feeding visit by each broiler chicken to a diet station, (iii) total amount of time each chicken spent at each diet (=sum of duration of each visit) and (iv) total amount of each diet consumed during the first hour of feeding.

Data Analysis

The data was analysed using Kruskal-Wallis test, and if there is significant difference it was tested further using Dunn's post hoc test.

RESULTS

Weight Gain

During the experiment, all the chicken showed increment in their body weight over the 5 days of observation period (Table 1). Although all chicken had access to the same diet, chicken #1 and #3 gained the most weight while chicken #4 gained the least weight.

Table 1. Live weight of broiler chickens used in the trial

Replicates	Initial Weight (g)	Final Weight (g)	Gain (g/day)
Chicken #1	316.8	449.6	132.8
Chicken #2	380.1	427.8	47.7
Chicken #3	328.8	459.0	130.2
Chicken #4	459.9	465.0	5.1
Chicken #5	476.0	549.0	73.0
Mean	392.3	470.1	77.8

Nutritional Analysis of Feedstuff

The nutrient content of *Moringa* leaf and twig meal, Cassava root chip and commercial starter diet is presented in Table 2. Cassava root chip have a low crude protein content (3.21%), low ash (3.75%) and therefore lower concentration of phosphorus, calcium and magnesium. It is also low in crude fibre content, meaning it will be highly digestible and therefore suitable as source of energy for chicken. *Moringa* leaf meal has the best nutrient content, with high crude protein content of 26.49% and relatively low crude fibre content of 9.34%. It is equal to or better than the commercial starter diet in terms of ash content, crude fat, crude protein and calcium content. In contrast, the *Moringa* twig sample has a much lower crude protein content (9.32%) and higher crude fibre content (41.47%) than the leaf sample. The big difference in crude fiber content between *Moringa* leaf and twig sample (9.34% vs. 41.47%) is expected. The twig sample is composed of woody material with high content of cellulose, hemicellulose and lignin, which provide structural strength to the plant.

Time Spent at and Number of Visits to Each Station by Broiler

In this preference trial, it was hypothesised that the chicken would spend more time at a diet that it prefers and also visit or feed on that preferred diet more frequently. Table 3 shows the chicken spent the most time feeding on diet D (mean 1024 seconds) and least at diet B (mean 208 seconds). Kruskal-Wallis test shows that the time spent feeding on each diet is significantly different ($H = 13.056$, $p = 0.011$), with the time spent feeding on cassava (diet B) being significantly less than on moringa-based diets D and E (Dunn's post hoc test, $p = 0.009$).

The data on visiting frequency suggests that the chickens visited commercial pellet (diet A) and diet containing 20% moringa (diet D) more than the other treatment diets and visited diet B (cassava root chips) the least (Table 4). However, Kruskal-Wallis test showed that the medians are not significantly different from each other.

Table 2. The nutrient composition of Moringa leaf and twig meal and Cassava root chip (all values on dry matter basis)

	Moringa leaf	Moringa twig	Cassava root chip	Commercial feed *
Organic matter, %	92.02	88.18	96.25	NA
Ash, %	7.98	11.82	3.75	8
Crude fibre, %	9.34	41.47	1.76	5
Crude fat, %	35.81	38.71	12.84	5
Crude protein, %	26.49	9.32	3.21	21
Phosphorous, mg/g	3.83	3.02	1.06	4
Calcium, mg/g	19.69	7.52	0.73	8
Magnesium, mg/g	4.95	2.33	0.80	NA

Notes: *The nutrient content for Commercial feed is as per printed on the bag. NA = not available.

Table 3. Time spent (seconds) at each treatment diet by each broiler chicken during the first hour of observation. A = commercial pellet, B = cassava root chip, C = 90 Cassava:10 moringa leaf, D = 80 cassava:20 moringa leaf, E = 70 cassava:30 moringa leaf

	Treatment Diet				
	A	B	C	D	E
Chicken #1	894	295	485	498	600
Chicken #2	265	310	363	681	726
Chicken #3	446	164	979	1064	998
Chicken #4	540	3	903	1308	1370
Chicken #5	1306	269	845	1569	1212
Mean	690.2^{ac}	208.2^{a}	715^{ac}	1024^{bc}	981.2^{bc}
Standard Error	184.9	57.3	122.2	196.7	144.1

Notes: Treatment means with different superscript letters are significantly different at p=0.05 (Dunn's post hoc test)

Table 4. Visiting frequency to each feed station by each chicken broiler. A = commercial pellet, B = cassava root chip, C = 90 Cassava:10 moringa leaf, D = 80 cassava:20 moringa leaf, E = 70 cassava:30 moringa leaf

	Treatment Diet				
	A	B	C	D	E
Chicken #1	10	4	3	3	5
Chicken #2	5	3	2	2	4
Chicken #3	5	2	7	9	9
Chicken #4	5	0	2	5	4
Chicken #5	4	0	3	5	2
Median	5	2	3	5	4

Table 5. Consumption (g) of treatment diet by broiler chicken within the first hour of observation. A = commercial pellet, B = cassava root chip, C = 90 Cassava:10 moringa leaf, D = 80 cassava:20 moringa leaf, E = 70 cassava:30 moringa leaf.

	Treatment Diet				
	A	B	C	D	E
Chicken #1	4.5	5	5	9.9	6
Chicken #2	5	2.5	1.5	3	3.1
Chicken #3	5	1.4	3.8	4.4	3.9
Chicken #4	9.9	0.1	4.7	5	7
Chicken #5	6	1.3	5.2	8.3	5.5
Mean	6.08	2.06	4.04	6.12	5.1
Standard error	0.985	0.827	0.678	1.285	0.708

Food Consumption

In this preference trial, it was hypothesised that the chicken will consume more of the diet that it preferred. Table 5, which shows the treatment means for amount of food consumed within the first hour of observation, suggests that consumption of cassava root chips is lower than the control or the cassava-moringa diet. However, Kruskal-Wallis tests ($H = 8.805$, $p = 0.06$) indicated that the treatment means were not significantly different from each other.

DISCUSSION

Dietary Preference

Choice feeding experiment has been used to assess the willingness of animals to consume experimental diets in a "free choice" situation thus determining their preference for, or the palatability of different feeds (Meier *et al*., 2012). In this study, each chicken was offered five different diets simultaneously in separate feeding trays inside a cage. Renaud and Peterson (1989) suggested that this is a better approach in order to reduce feeding biases and interactions that may occur if more than one chicken were present together. Commercial starter diet was used as a benchmark in this preference trial because this is the recommended diet used in commercial farms throughout Malaysia and one that the chickens were fed with before they enter the trial. The data used for preference trial is amount of food consumed within the first hour. This is to avoid observer fatigue and chicken feeding on food that is not their preferred just because their preferred food is finished.

The main finding of this preference trial is that mixing *Moringa* leaf meal with cassava root chips resulted in positive influence on all three preference indicators (food consumption, total time spent feeding on the diet, visiting frequency) used in this trial, with time spent feeding on cassava chip being significantly less than on the other diets. Diet containing 20% *Moringa* was equal to or better than the commercial diet in terms of interest and consumption by the chicken. Each visit to the feeding station, each peck and consumption adds to the variety of information that is gained via visual, olfactory and tactile stimuli which is processed by the chicken to decide whether to like or dislike the food. The rapidity of the foraging decision expressed by chickens (within 1 hour) suggested that both visual and olfactory cues were involved in their initial choices (Chagneau *et al*., 2006). As the chicken started to peck and eat the food, the taste buds in their

oral cavity provided further information on the taste of the food, which may either motivate the chicken to continue eating leading to what we see as food preference or elicit an aversive reaction leading to rejection of the food (Gentle, 1971; Roura *et al*., 2013; Neves *et al*., 2014). Although chicken have fewer taste cells, they have more taste buds per oral area compared to mammal (Roura *et al*., 2013). This sense of taste is the result of chemical compounds present in the food.

Nutritional Value

The chemical compounds in the food that are useful to the chicken for maintaining their body function and production are termed nutrients. The raw feed ingredients (cassava root chip and moringa leaf meal) used in this preference trial have vastly different nutritional characteristics (Table 2). Cassava root is composed of mainly starch with little fibre, protein, fat and minerals, and therefore an excellent candidate as a source of energy for broiler chicken. The nutritional values reported here is similar to those of Garcia & Dale (1999), Chauynarong *et al*. (2009) and Bhuiyan & Iji (2015). In contrast, *Moringa* leaf meal has high crude protein, fat, calcium and phosphorus content, thus suitable as supplement to mitigate the lack of these nutrients in cassava. The crude protein content of *Moringa* leaf sample provided by Betterlin Health Sdn. Bhd. is 26.49%, which is similar to the value (26%) reported by Makkar and Becker (1997) and within the range of concentration (25.4-27.1%) reported by Mahfuz and Piao (2019). Mahfuz and Piao (2019) also reported the values for calcium (20 mg/g) which is similar to ours (19.7 mg/g) but much lower phosphorus (0.2 mg/g) and magnesium (0.3 mg/g) from what we reported here.

When formulating a diet based on cassava root and *Moringa* leaf meal, the most pertinent question is how much of each component should be used. The proportion is guided by the chicken's nutrient requirement and their relative cost and can only be answered through feeding and growth trial where feed conversion efficiency is part of the assessment. The current preference trial has shown that broiler chicken liked the cassava root-moringa leaf meal mixture, and the mixture containing 20% *Moringa* leaf meal is as preferable as the commercial concentrate.

From the nutritional point of view, the proportion of cassava root chip and *Moringa* leaf meal in the mixture is guided by the desired content of crude fibre and protein in the mixed diet. The crude fibre content of broiler diet is normally capped at 5%, although the crude fiber content of diet has been tested up to 8% without much adverse effect on older chicken (Salami & Odunsi, 2018a; Salami & Odunsi, 2018b). The crude fibre content of diet C, D and E is calculated at 1.76, 3.28 and 4.03%, which is still well within the limit for broiler feed.

Because of the low crude protein content of cassava root chip, the addition of *Moringa* leaf meal is expected to contribute significantly to the protein and amino acid requirement of chicken, thereby promoting better growth rate and feed conversion efficiency. However, in the nutrition of non-ruminant livestock such as poultry and pig, the amino acid contents play an important role. Diet C (10%), D (20%) and E (30%) yielded a calculated crude protein content of 5.54, 7.87 and 10.19%. These values are lower than the requirement for broilers, which is 22% for starter and 18% for finisher diet (National Research Council, 1994). The effect of lowered crude protein and amino acid concentration in the mixture can only be assessed in a feeding and growth trial, which takes longer time to conduct.

In one of the rare studies involving cassava and moringa, broilers fed isonitrogenous and isocaloric diets containing 20-30% of cassava root chip and 5-10% of *Moringa* leaf meal, have significantly lower weight gain and poorer feed conversion ratio (Olugbemi *et al*., 2010). A review of the literature on the effect of feeding broilers with diet containing *Moringa* leaf meal (Mahfuz & Piao, 2019) showed varied responses, ranging from negative to positive. These authors generally recommend a 5% supplement level, which would not contribute much to the cost saving issue currently faced by the farmers.

CONCLUSION

This study investigated the broiler preference to a simple diet containing just cassava root and *Moringa* leaf meal with commercial starter as the benchmark diet. As expected, broiler chicken exhibited a preference for commercial starter diet because this was what they were raised on prior to the experiment. Cassava root was not

preferred despite it being the least fibrous of all the diet. Perhaps this is due to it being deficient in protein, fat and minerals or due to its unappetising sensory characteristics. Supplement of cassava root meal diet with 20% *Moringa* leaf meal resulted in significant improvement in food preference to a level similar to commercial pellet.

It is recommended that further studies should test a wider range of supplemental level, for example 5, 10, 15, 20, 25, 30, 35 and 40% moringa leaf in the mixture. Since it has been shown that incorporating *Moringa* leaf meal improve food preference, future studies on *Moringa* leaf meal provided by Betterlin Health Sdn. Bhd. should focus on food intake, digestibility, feed conversion efficiency as well as on growth and carcass characteristic of broilers. It should start with day-old chicks until sale weight so that the effect of moringa supplementation on different stages of feeding and growth can be assessed. The study should also be carried out with layer and breeder chicken to see the effect on egg production and quality.

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