

RESEARCH ARTICLE

The Assessment of Mixing Solid Waste from Palm Kernel Cake and *Indigofera Zollingeriana* as Chicken Feed towards the Free-Range Chicken Growth Rate

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ABSTRACT - This study is to determine the characteristics of the palm kernel cake (PKC) and *Indigofera zollingeriana* and its suitability as the ingredients for animal feed. This study focuses on the chicken feed formulation optimization with mixture of the solid waste and the *Indigofera zollingeriana*. This study also investigates the effect of the formulated chicken feed towards the growth of the chicken within the experimental duration. The formulated chicken feed with palm kernel cake and *Indigofera zollingeriana* have the nutrients needed for the chicken to grow healthily and this shows that the agro-industrial waste can substitute the corn as the main ingredient in chicken feed.

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1. INTRODUCTION

One of the largest and exporter of the palm oil industry globally is Malaysia [1]. There is a huge potential for producing sustainable products from agro-industrial byproducts. By utilizing agricultural byproducts, a variety of materials, and energy can be obtained [2]. If these agro-industrial byproducts are not properly disposed of, they could pollute the environment and have negative effects on the health of people and animals [3]. Countries that have different levels of development in economic sector have strengthened its food security by increasing the food availability in agricultural sector [4]. According to reports about the oil palm plantation's effects on the environment, it deforests rainforests, reduces biodiversity, increases greenhouse gas emissions, and contaminates waterways by discharging palm oil mill effluent (POME) [5]. Pollution and operating costs associated with waste management can be lowered [6].

Poultry farming is a significant industry in developing nations because it provides the majority of the animal protein needed by the rural population [7]. Because poultry offers high-quality protein and other nutrients and is frequently lower in fat than meat products compared to other animal sources, the American public generally views poultry meat as a healthful food. Poultry meat is also widely available and reasonably priced, which contributes to its high consumption rates around the world [8]. The majority of poultry production worldwide—up to 98% for meat and 92% for eggs—is derived from industrial farming, primarily from chicken and, to a lesser extent, from turkeys, ducks, geese, and other species [9].

The genus *Indigofera*, which has 700 species spread across Africa, Asia, Australia, and North America, is a member of the Fabaceae family of plants and shows great promise as a feed for animals [10]. This *indigofera* plant is resistant to salinity, dry seasons, acidic soils, and floods. In Indonesia, Malaysia, and other tropical nations, *indigofera* makes a good plant to grow as an additional food source for animals [11]. This *indigofera* plant grows quickly, requires little maintenance, tolerates poor soil conditions, and responds well to fertiliser [12]. This *indigofera* plant also can restrict the flow of organic matter and the loss of nutrients on the soil's surface because it is a ground cover plant [13]. The *indigofera* plant is a very potent and premium fodder, with good growth, high output, and nutritional value. The *indigofera* plant may be harvested in eight months; its herbage has a protein content of 29.56%, and its mean wet biomass total production is approximately 53 tons/ha/harvest [12]. To prepare for the upcoming industrial revolution, Malaysia must raise its livestock production to at least 50% of the local product market, and by exploiting this plant will help to realize the goals and mitigate the food security issue [1].

2. METHODOLOGY

2.1 Pellet Production

Receiving feed materials, grinding, proportioning, mixing, conditioning, pellet conversion, cooling, and packaging are some of the steps involved in making pelleted feeds [14]. Because it keeps ingredients from being separated, the pellet manufacturing process improves bulk density, handling qualities, and nutritional value in animal feeds [15]. A variety of materials can be used to make livestock feed, such as long materials like crop straw, grains like wheat and maize, and other materials like oil cake or meal, additives, etc. Different storage techniques are used for different raw materials. Then, the screening equipment is being utilized to eliminate long and large impurities like sacks, mud blocks, and stones. Iron impurities are primarily removed using the magnetic separator [16]. The variety of feed and the necessary fineness dictate the technological process of feed crushing. It can be separated into two categories based on the combination form of batching: first batching, followed by crushing, and first crushing, followed by batching technology. The most often used equipment in this process is the hammer mill. Every feed material used in this batching technology is manually weighed by employees before being added to the mixing machine [16].

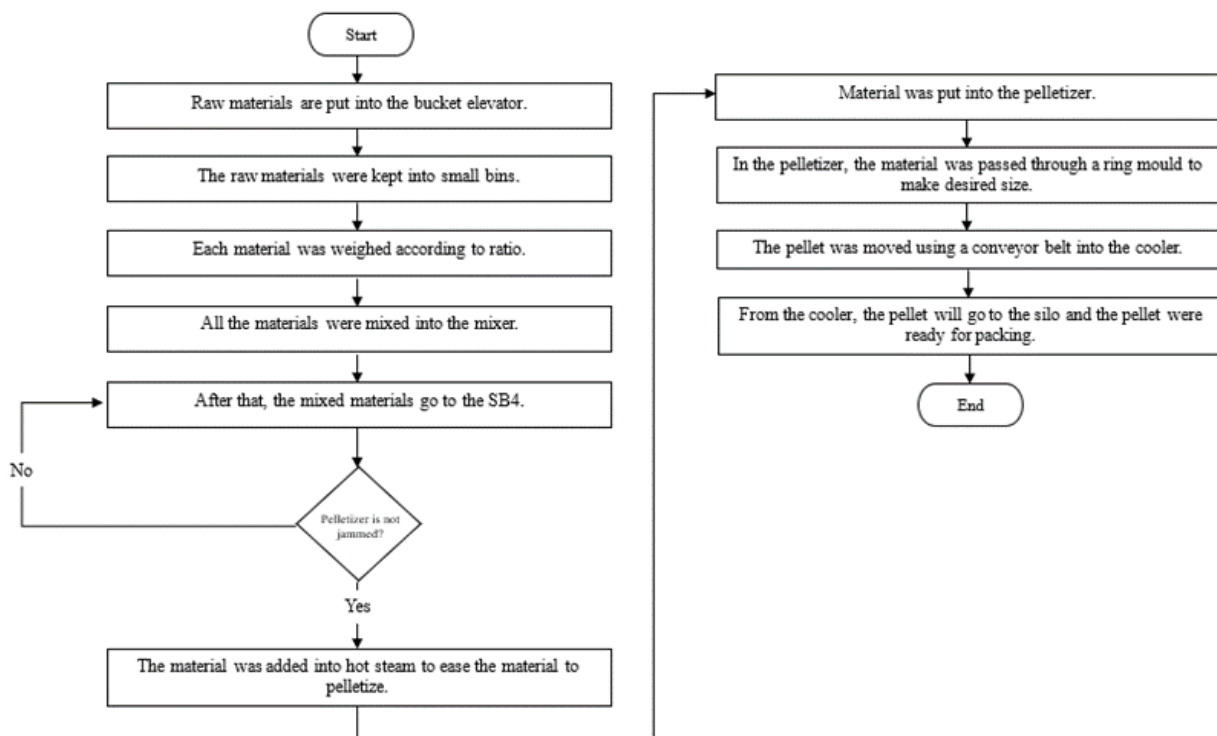


Figure 1. Process of pellet manufacturing

Batch mixing and continuous mixing are the two feed mixing techniques. Combining all the ingredients in the formula's prescribed proportions and mixing them in a "batch mixer" that runs on a regular basis is known as batch mixing. Batch mixing is currently widely used because it is a convenient way to replace feed formula and results in less intermixing between batches. However, automatic program control is mostly utilized due to the complexity of the start and stop operation [16].

The ring die feed pellet mill is typically fitted with a conditioner on top because feed material conditioning, or tempering, is required in medium- to large-scale feed processing factories. The quality of feed pellets is directly impacted by the conditioning outcome. Conditioning is the process of adding water to feed powder to give it a specific moisture content. Following conditioning, the feed pellets are pushed out through the ring die holes, cut, and released by being equally distributed between the roller and the ring die [16].

Like the pelletizing process, the feed is heated to a high temperature (80-90°C, may rise to 95°C due to friction) and steam humidity (15-16% moisture content) during the squeezing process, which produces a lot of heat and allows the feed pellets to reach temperatures between 75 and 85 degrees Celsius and a moisture content of 16 to 18%. It is essential to use a feed pellet cooler to lower the temperature to below 8 degrees Celsius and reduce the moisture content of the feed pellets to below 14% because they are easily broken and deformed under these conditions, and they would also bond and mildew in storage. For market sale, produced feed pellets are packaged and weighed [16].

2.2 Animal Feed Composition

There are three types of animal feed for the chickens in this study. The first category consists of traditional animal feed, which is maize and is sold in the market. The second category consists of animal feed that has been PKC-formulated.

The PKC-formulated feed that contains additional *Indigofera zollingeriana* plant to enhance nutritional value falls into the third category. The cost and nutritional value of the feed must be considered when creating an efficient diet for poultry [17]. The three different diets that the chicken will be fed are displayed in Table 1. Diet 3 was required to compare the nutritional content of the combination between PKC and *Indigofera zollingeriana* with Diet 2, and Diet 1 served as a control diet. *Indigofera zollingeriana* has a notable high tolerance for acidic soils and is adapted to a comparatively broad variety of climatic conditions and soil types. With high crude protein concentrations (265 g/kg DM average), low fibre concentrations (367 g neutral detergent fiber/kg DM), and high in vitro DM digestibility (72.6%), the quality of the forage is high [18].

Table 1. Animal feed composition

Ingredients	Diet 1	Diet 2	Diet 3
Corn	✓	✓	✓
Palm Kernel Cake	✗	✓	✓
Rice Bran	✗	✓	✓
Limestone	✗	✓	✓
<i>Indigofera zollingeriana</i>	✗	✗	✓

*Diet 1 = Conventional Feed, Diet 2 = Formulated Feed, Diet 3= Formulated Feed + *Indigofera*

2.3 Conduct of Experiment

Each type of feed was fed to 15 chickens aged 1 week with the average weight 40 ± 0.5 g. The chicken was divided into 3 groups and individually weighed. All chicken is housed in separated section in chicken coop based on type of diets that will be given and the chicken had free access to fresh water. For the first 2 weeks the chicken feed is added once every 2 days. The following week, the chicken feed is added when needed. All chicks will have access to water since water are important to maintain their body temperature. The chickens are weighing and measured the size of chicken for their initial measurement. The chicken is put into two separated compartment which depends on their diets. Then, the chicken's condition was monitored weekly and their weight and size were recorded.

3. EXPERIMENTAL RESULTS

For the growth rate, the weight for all chickens were obtained and then the weight difference in each month is plotted and shown in the Figure 2. The free-range chicken growth between 6 to 7 months but in this study the chickens are monitored for 5 months which is faster due to the additional formulated chicken feed. Continuous advancements in feeding methods and management systems may lead to an even higher rate of growth in the future. Maximising profits requires first optimising feed for the financial return [19].



Figure 2. Weight of chicken from first month to fifth months

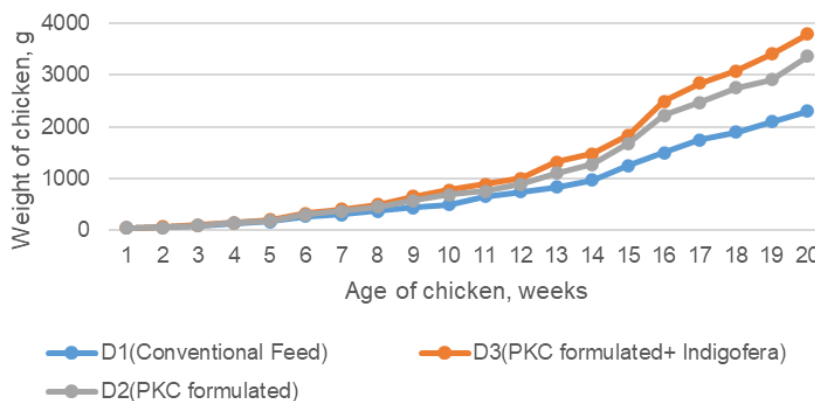


Figure 3. The growth performance curve for the free-range chickens

Based on Figure 3, it shows the growth rate curve for 3 types of diet for chickens during the study period. All chicken has shown a good growth rate. Even so, this study is to determine the effectiveness of formulated PKC feed in the chicken feed compared to corn feed. To do that, the chicken fed with D1 need to be compared with the chickens fed with D2 and D3. [20] reported that the weight of chicken on week 8 is 784.5 g/bird compared to the data collected which is 500 g. The significant difference of the weight is due to the environment that [20] have provided in his study. [20] reported in week 12 weight is 1532.5 g/bird more than the data collected which is 1000 g.

The weight changes of chickens in response to the formulated chicken feed were measured by taking the weight of individual chickens at the start of the project. This is followed by individual weighing per week for 5 months. The readings were recorded and plotted in graph for comparison in Figure 3. For the result of the weight gain, at the start of the study before feeding the chickens, the average of initial weight in D1, D2 and D3 chickens similar which are 40 g each. Then, after 5 months of feeding the average of final BW in D3 chicken, which is 3800 g, are shown a salient improvement compared to D1 and D2 which is 2300 g and 3370 g. This is due to additional ingredient added in the PKC-formulated chicken feed.

4. CONCLUSION

Several conclusions can be drawn from the research. The feed should have nutrients that meet the animal feed's nutrient requirements. The palm oil industry byproduct characteristics in PKC for manufacturing formulated chicken feed are high in nutrient that can fulfil the animal feed requirement. The formulated chicken feed by using PKC from agro-industrial waste and *Indigofera zollingeriana* have been proven that affect the growth rate of chickens to substitute corn. The growth rate of chicken towards the formulation of chicken feed which is shown by the health of chickens and its growth performances. By utilizing the palm oil industry byproduct, the waste can be reduced and help the waste management in the agricultural sector.

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AUTHOR CONTRIBUTION

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Abdul Sukor Abd Razak, Suryati Sulaiman, Mohd Rashid Ab Hamid, Noraini Samat: Supervision

Muhammad Amirul Syafiq Nasarudin: Data Collection, Writing- Reviewing

Nurul Farah Anisa Hairolnizam, Farah Amalina: Data Curation, Writing-Reviewing

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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