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RESEARCH ARTICLE

The Utilisation and Feasibility Study of Solid Waste, Palm Kernel Cake, and *Trichantera Gigantea* (Ketum Ayam) as Animal Feed for Broiler

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ABSTRACT - This study aims to investigate the utilisation and feasibility of solid waste into animal feed. Every year, agro-based industries produce a large number of residues. Since the majority of untreated and underutilised agro-industrial wastes, this problem can be solved by utilising the waste from palm oil industry into animal feed. The waste that are used in this study is palm kernel cake (PKC). PKC is one of the region's most abundant, accounted 2.3 Million tonnes are being export and potentially to be used as low-cost agricultural products. Furthermore, it has the potential to mitigate the pollution levels and reduce the operational expenses associated with waste management. The solid waste characteristics in PKC proven that these by-products are high in nutrient that can be used for animal feed with the additional of *Trichantera Gigantea* (Ketum Ayam) and other ingredients to help the growth rate of chickens and also control the agro-industrial waste.

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1. INTRODUCTION

Rapid population expansion over the last two decades has fueled urbanization and industry, adding to the problem of solid waste management and generate large number of residues especially in agricultural-based industries [1]. These residues contribute to climate change by increasing greenhouse gas emissions if these residues are untreated [2] . Agro-industrial waste holds enormous potential for the reutilization as one of the renewable commodities and bioenergy. As reutilization of solid waste is adopted in the industry, the waste management cost and pollution can be reduced [3]. Palm oil industry was the most abundant agricultural wastes. Palm oil is used as food ingredient, feedstock for oleochemicals and biodiesel industries due to high oil yield [4]. Indonesia holds 59% of global palm oil production while, Malaysia at second place at 24% and Thailand 4% that has made this three countries emerges as top three countries in palm oil producers in the world [5]. The process of extracting palm oil results in the generation of significant amounts of biomass residues, such as empty fruit bunch, palm mesocarp fibres, palm kernel cake, and palm oil mill effluent (POME), particularly during the wet milling phase [6]. The PKC export in 2023 are 2,311,506 million tonnes which shown an increasing of 7.7% from 2022 which only 2,146,024 million tonnes as reported by Malaysia Palm Oil Board, MPOB [7]. The massive amount of this waste, can be utilized since palm oil residue are one of the region's most abundant and potentially low-cost agricultural byproducts that can be converted into animal feed especially poultry which Malaysia poultry meat consumption has increased tremendously year by year, as it becomes a staple food for Malaysians [8].

Animal feed is the most vital aspects to ensure the poultry industry is cost effective and positive results success. Nutritional values are the important parameter in formulating an effective animal feed [9]. Animal feed is a medium that can provide livestock with enough nutrient and energy to meet the production needs (eggs or meat)[9]. Due to the rising of global population, the demand for animal proteins keeps increasing especially in Malaysia which creates challenges to meet the poultry consumption and this were the current challenge that Malaysia face. Due to the pandemic and Russia-Ukraine war, food security issue has arisen globally, and Malaysia is also affected since Malaysia relies on imported soybean, corn and barley grains from Argentina, Brazil, Ukraine and also Russia [10]. The cost of animal feeds accounted for 60% to 70% of total production costs so there is a need of finding alternatives and one of them was utilised agro-industrial waste [11]. One of the examples in utilising agro-industrial waste are using fermented coconut pulp flour-contained feed into free-ranged chicken in Bali, Indonesia. The result showed a significant impact which are increasing weight gain and reduce feed consumption by using 10% of coconut pulp flour in the animal feed [11]. Another study that used *Trichantera Gigantea* in animal feed, shows that 10% to 15% inclusion of *Trichantera Gigantea* shown an economically viable in broiler production [12]. In order to mitigate the impact of rising food prices and reduce dependency on imported food ingredients, there is a need for finding an alternative ingredient that can be used in animal feed ingredients and reconsider agricultural-based industries development while strengthening national food security [13].

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2. METHODOLOGY

2.1 Feed Production

An experimental process was designed at Universiti Malaysia Pahang Al-Sultan Abdullah as shown in Figure 1. The raw materials were collected and weighed according to the composition that was formulated before the production began. The bucket elevator was used to transport all of the materials to the silo storage. Each material was weighed and fed into the mixer according to the desired ratio where batching process were introduced to improve the ingredients precision and improve the production management [14]. The materials are combined in the mixer to ensure the quality of feed and uniformity. The mixture was then transferred to a ring die pelletizer, where steam was supplied at 80 °C and mixed uniformly to soften the mixture. The mixture will be discharged by transfer in between of the roller and ring die, where the pellets will be pressed out through the ring die holes [15]. The pellet was moved to the cooler before transporting into a packaging silo. The cooler serves as an exhaust fan, releasing heat while also removing dirt from the pellet before beginning the packaging process.

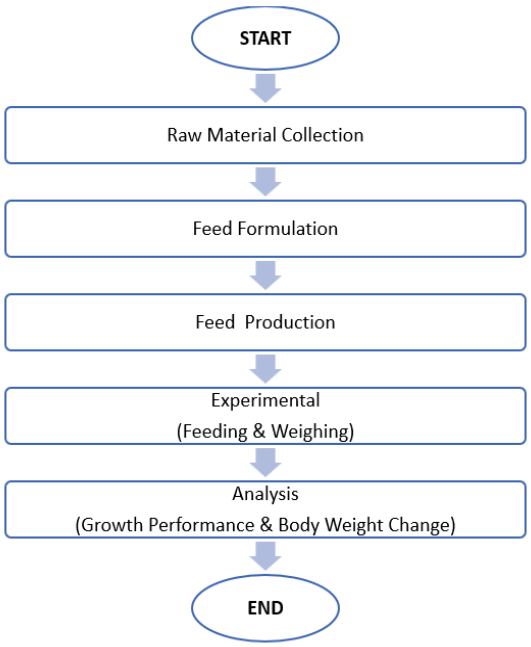

Figure 1. Experimental process

2.2 Experimental

Each type of feed was fed to 15 chickens aged 3 days old with the average weight 40 ± 0.5g. The chicken was divided into 3 groups and individually weighed. Table 1 shown the composition of animal feed. The first groups, Diet 1 (D1) are a conventional animal feed which is corn. The second groups, Diet 2 (D2) are the formulated animal feed, and the third groups, Diet 3 (D3) are the formulated chicken feed with *Trichantera Gigantea.* All chicken is housed in separate section in a chicken coop based on type of diets and the chicken had free access to fresh water.

Table 1. Composition of animal feed

Diet 1 (D1) Conventional Feed	Diet 2 (D2) Formulated Feed	Diet 3 (D3) Formulated Feed + *Trichantera Gigantea*
Corn	PKC	PKC
	Rice Bran	Rice Bran
	Soybean Meal	Soybean Meal
	Corn	Corn
	Limestone	Limestone

2.3 Analysis

For the first week, animal feed was added once every 2 days. The following week, the animal feed was added when needed because the chicken kept growing and animal feed needed to be refilled regularly. All chicken has access to fresh water to maintain their body temperature and light was on to heat the surrounding. The weight and condition of the chicken were monitored every week and chicken weight, and size were recorded until reaching maturity date. The parameter to assess the growth performance is body weight change (BWC). The initial body weight (BW) of the chicken

was taken before the feeding process. Body weight gain of every chicken was recorded at 5 days interim and was continued for 42 days by using weighing scale. The body weigh change was evaluated by calculating the difference between the final body weight and initial body weight of every chickens.

$$Body\ Weight\ Change\ (kg) = Final\ Body\ Weight\ (kg) - Initial\ Body\ Weight\ (kg) \quad (1)$$

3. RESULTS

3.1 Growth Performance & Body Weight Change (BWC)

Among all the chicken breeds used for meat production, poultry chickens have the highest body weight and the fastest growth rate [16]. A faster growth rate suggests that the chicken may reach market weight sooner. Continuous refinement of the feeding method and management system may eventually result in an even quicker growth rate and greater profitability in the poultry industry [17]. To compare the body weight of the chicken after reach the matured age which are 42 days, the body weight of the chicken was calculated for 5 days interval. The growth performance curve used the difference weight of the chicken to indicate growth of the chicken. Figure 2 shows the weight of poultry chicken from Day 2 until reaching Day 42.

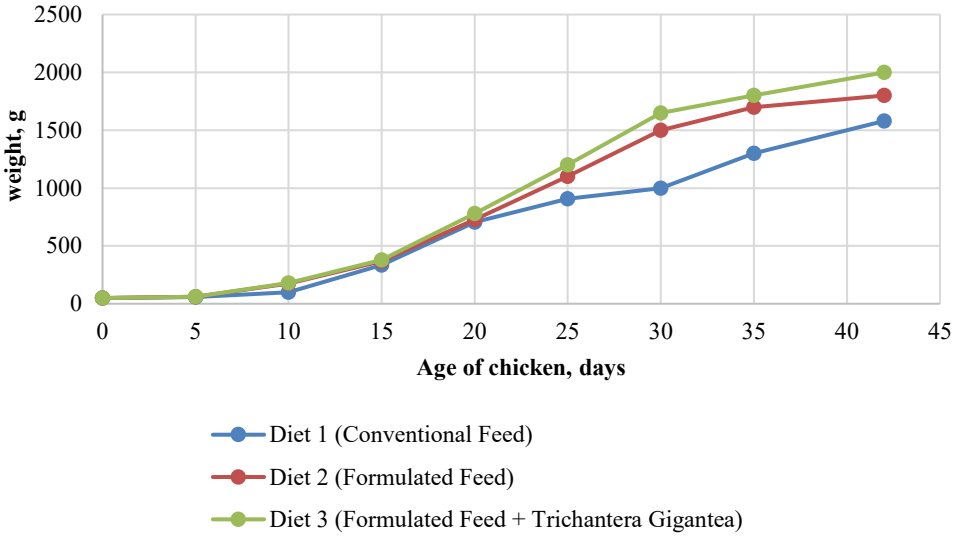

Figure 2. Growth performance curve

From Figure 2, it shows the effect of both types of diet on the growth performance of chickens throughout the experimental period. All chicken has a satisfactory growth performance. However, this study is to investigating the chicken growth rate towards formulated chicken feed with *Trichantera Gigantea*, D3 and formulated chicken feed, D2 by comparing with conventional feed, D1 which are corn. When livestock incapable of getting a feed that are effective and nutritional, the growth would be hindered, and good nutrient intake proves to have a positive effect towards the growth of the chicken. At day 20, the weight of the chicken that were fed with D1, D2 and D3 show a weight of 706.6 g, 727.4 g and 780.0 g respectively, while data from [18] at day 21 of chicken being fed with premium grade PKC showed a weight of 785-800 g which are almost similar to the weight of chicken being fed with D3 . This proves that the uses of solid waste PKC and *Trichantera Gigantea* are suitable to substitute imported ingredients from other countries and also increase the utilization of local agro-industrial waste [18].

Figure 2 also shows that there was no salient difference in the growth performance between the 3 diets until Day 25. The large difference in Day 25 could be owing to the weight increment factor being more prominent for commercial feed compared to palm-based feed. Rohaya et. al [18] also stated that using observation during this period, the size and weight of male birds was greatly enhanced due to environmental factors as well as crossbreeding of chicken strains. From the data of this project in comparison with the data conducted by Malaysian Palm Oil Board [18], this shows that the capabilities of the PKC and *Trichantera Gigantea* as the animal feed can no longer be denied which can substitute the commercial feed to produce a similar product or similar chicken weight within the experimental period. The BWC of chickens in return to the formulated chicken were measured by taking the individual chickens BW during the beginning of the project followed by weighing every 5 days for 42 days. The readings were documented for comparison. The measurement of chicken BW for all diets throughout the feeding period for 42 days were shown in Table 2.

Table 2 shows the measurement of body weight for all diets throughout the feeding period for 42 days. As formulated chicken feed which main ingredient are PKC and *Trichantera Gigantea* have higher dry matter (DM) and crude protein (CP) that could affect the BW of the chicken. This shows high level of nutrient content in chicken feed will improve BW of the chicken and growth performance. Increased nutrient intake lead to better performance in chicken feed diets [19].

Table 2. Comparison of BWC for each diet

Parameter (g)	Diet 1 (D1) Conventional Feed	Diet 2 (D2) Formulated Feed	Diet 3 (D3) Formulated Feed + *Trichantera Gigantea*
Initial BW	49 ±	49.5 ±	49 ±
Final BW	1580 ±	1800 ±	2000 ±
BWC	1531 ±	1750.5 ±	1951 ±

3.2 Reduction of Waste

Figure 3 illustrates the percentage of components that are generated during the processing of fresh fruit bunches (FFB). The percentages of palm kernel cake (PKC) derived from the processing of fresh fruit bunches (FFB) are 7% [20]. Despite the relatively low percentages, for every 1000 metric tonnes of fresh fruit bunches (FFB) undergo processing, there is a potential to extract 70 metric tonnes of palm kernel cake (PKC) for utilisation as animal feed. The project offers the potential to mitigate the solid waste disposal in the palm oil sector by capitalising on its ample volume and cost-effectiveness as a source of animal feed thus securing national food security issue.

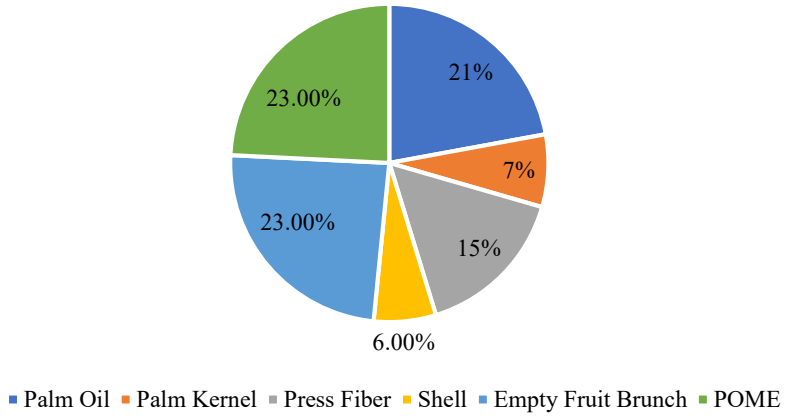

Figure 3. Percentage of components in FFB

Numerous agro-industrial wastes possess the potential to serve as viable sources of animal feed or alternative goods, hence mitigating the need for landfilling and its associated environmental concerns. The utilisation of solid wastes has been widely regarded as a highly attractive alternative from both environmental and economic perspectives [21]. Nevertheless, before employing them, it is imperative to do a thorough analysis of the environmental and economic implications, as the utilisation of these resources must not be undertaken haphazardly. Extensive documentation exists about the chemical composition, nutritive values, improvement procedures, and poultry feeding methods. PKC and *Trichantera Gigantea* exhibits significant levels of nutrient content, making it a valuable resource for animal feed especially poultry which could lead to solve solid waste management problems and food security problems on dependency on imported ingredients.

4. CONCLUSION

Several conclusions can be drawn from the research. The palm oil waste characteristics in PKC are proven that these by-products are high in nutrient that can fulfil the animal feed requirement that can be seen from the weight gains of the chickens. Next, formulated chicken feed by using PKC and *Trichantera Gigantea* have been proven to help the growth rate of chickens and control the agro-industrial waste. Lastly, the growth rate of chicken towards the formulation of chicken feed which shows that D3 has the best result in the growth performance curve of chickens.

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AUTHOR CONTRIBUTIONS

Muhammad Amirul Syafiq Nasarudin.: Study Conception and Design, Writing – Original Draft Preparation, Reviewing and Editing

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

Ali Zainal-Abidin Mohamad Termizi.: Data Collection, Writing – Reviewing

Nurul Farah Anisa Hairolnizam, Farah Amalina.: 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.

REFERENCES

[1] F. Amalina, S. Krishnan, A. W. Zularisam, and M. Nasrullah, "Biochar and sustainable environmental development towards adsorptive removal of pollutants: Modern advancements and future insight," *Process Safety and Environmental Protection*, vol. 173, pp. 715–728, 2023.

[2] P.K. Sadh, S. Duhan, and J.S. Duhan, "Agro-industrial wastes and their utilization using solid state fermentation: A review," *Bioresources and Bioprocessing*, vol. 5, no. 1, pp. 1–15, 2018.

[3] Z.M. Salleh, N.Y. Yahya, M.A.S. Nasarudin, and D.N. Herman, "Transesterification of used frying oil by activated banana peels waste catalyst for biodiesel production," *Materials Today: Proceedings*, vol. 57, pp. 1235–1240, 2022.

[4] M. Gregory, "Palm oil production, consumption and trade patterns: The outlook from an EU perspective," *FERN, Brussels, Belgium*, 2022.

[5] U. S. Department of Agriculture, "Palm Oil Explorer," 2023. https://ipad.fas.usda.gov/cropexplorer/cropview/-commodityView.aspx?cropid=4243000 (accessed Nov. 19, 2023).

[6] Y.W. Cheng, C.C. Chong, M.K. Lam et al., "Holistic process evaluation of non-conventional palm oil mill effluent (POME) treatment technologies: A conceptual and comparative review," *Journal of Hazardous Materials*, vol. 409, p. 124964, 2021.

[7] Malaysian Palm Oil Board, "Overview of the Malaysian Oil Palm Industry," 2023.

[8] S.I.S. Bahri, A.S. Ariffin, and S. Mohtar, "Critical review on food security in Malaysia for Broiler Industry," *International Journal of Academic Research in Business and Social Sciences*, vol. 9, no. 7, pp. 869–876, 2019.

[9] H. Belkhanchi, Y. Ziat, M. Hammi, and O. Ifguis, "Formulation, optimization of a poultry feed and analysis of spectrometry, biochemical composition and energy facts," *South African Journal of Chemical Engineering*, vol. 44, pp. 31–41, 2023.

[10] Malaysian Investment Development Authority, "Animal feed - A critical component in the global food chain," 2023. https://www.mida.gov.my/animal-feed-a-critical-component-in-the-global-food-chain/ (accessed Nov. 19, 2023).

[11] N.K.E. Suwitari, L. Suariani, N.M. Yudiastari, N. Kaca, and Y. Tonga, "Performance of 0-14 weeks-aged super free-range hens that are fed by fermented coconut pulp flour-contained ration," *Journal of Physics: Conference Series*, vol. 1402, no. 5, pp. 1–7, 2019.

[12] F.O. Libatique, "Growth performance, blood dynamics and sensory characteristics of broilers fed with Madre de Agua (Trichanthera gigantea) Leaf Meal," *The Journal of Emerging Research in Agriculture, Fisheries and Forestry*, vol. 2, no. 1, pp. 1–12, 2021.

[13] Y.L. Kuan, "Rising concerns over food security," *The Star*, 2022. https://www.thestar.com.my/news/nation/-2022/11/15/rising-concerns-over-food-security (accessed Jan. 11, 2023).

[14] Richi, "What is complete feed pelleting plant production process of making animal feed pellet?" *RICHI*, 2023. https://www.cn-pellet.com/faq/1274.html (accessed Nov. 19, 2023).

[15] A. Machinery, "Livestock feed pellets processing technology & equipment – Buy high quality livestock feed pellet machine for feed pellet making," https://www.feedpelletplants.com/livestock-feed-pellets-processing-technology.html (accessed Nov. 19, 2023).

[16] S. Nematbakhsh, J. Selamat, L.H. Idris, A. Faizal, and A. Razis, "Chicken authentication and discrimination via live weight, body size, carcass traits, and breast muscle fat content clustering as affected by breed and sex varieties in Malaysia," vol. 10, no. 7, p. 1575, 2021.

[17] M. Buzala and B. Janicki, "Review: Effects of different growth rates in broiler breeder and layer hens on some productive traits," *Poultry Science*, vol. 95, no. 9, pp. 2151–2159, 2016.

[18] R. Halim, R.M. Ramli, N.C. Mat, C.R. Hadi, N.A. Abu Bakar, and A.A. Aziz, "Highly digestible palm kernel cake (PKC) for animal feed," *Malaysian Palm Oil Board*, vol. 758, pp.1-4, 2017.

[19] G. Borreani, E. Tabacco, R.J. Schmidt, B.J. Holmes, and R.E. Muck, "Silage review: Factors affecting dry matter and quality losses in silages," *Journal of Dairy Science*, vol. 101, no. 5, pp. 3952–3979, 2018.

[20] I.C. Okoli, "Oil palm tree wastes 1: Oil Processing and waste production," *Research Tapioca*, 2020. https://researchtropica.com/oil-palm-tree-wastes-1-oil-processing-and-waste-production/ (accessed Nov. 19, 2023).

[21] C.L. Boechat, A.M. de S. Arauco, R.M. Duda, A.F.S. de Sena, M.E.L. de Souza, and A.C.C. Brito, "Solid waste in agricultural soils: An approach based on environmental principles, human health, and food security," *Solid Waste Management Rural Areas*, pp.81-102, 2017.