

# The Potential of Vegetable Waste-Based Pellets on Broiler Production Performance and Nutrient Digestibility

*by* Sri Umi Lestari

---

**Submission date:** 30-Nov-2020 12:48AM (UTC-0600)

**Submission ID:** 1459996352

**File name:** jurnal\_tim\_Bu\_Wahyu.pdf (447.08K)

**Word count:** 5229

**Character count:** 26820

## The Potential of Vegetable Waste-Based Pellets on Broiler Production Performance and Nutrient Digestibility

Eka Fitasari<sup>1</sup>, Wahyu Mushollaeni<sup>2\*</sup>

<sup>1</sup>Department of Animal Husbandry, University of Tribhuwana Tunggaladewi, Indonesia

<sup>2</sup>Department of Agroindustrial Technology, University of Tribhuwana Tunggaladewi, Indonesia

**Abstract:** Vegetable waste causes problems for environmental and air pollution if only wasted. The purpose of this study was to determine the level of vegetable waste in feed formulations on the performance of broiler chicken production and nutrient digestibility. The research method was using a completely randomized design (CRD) with 5 treatments, namely P1 (control feed without vegetable waste), P2 (using 5% vegetable waste in 100% feed formulation), P3 (using 10% vegetable waste in 100% feed formulation), P4 (using 15% vegetable waste in 100% feed formulation), and P5 (using 20% vegetable waste in 100% feed formulation). The parameters observed consisted of 2 groups, namely the performance of production by measuring feed consumption, body weight gain, and FCR, the second was on nutrient digestibility, consisted AMEn parameter, N retention, metabolic CP digestibility, and CF digestibility parameter. The results showed that the level of vegetable waste gave significantly different results ( $p < 0.05$ ) on live weight and FCR, AMEn, and metabolic crude fiber digestibility and gave very significant differences in feed consumption, N retention, and metabolic protein digestibility ( $p < 0.01$ ). The highest weight of broiler resulted from the use of 15% vegetable waste, then decreased at a higher level and resulted in a decrease in nutrient digestibility. It is recommended to use vegetable waste treatment so that the particles are smaller before being used in mixing feed formulations in the pelleting process.

**Keywords:** Vegetable waste, Pellet, Broiler, Performance, Digestibility

Date of Submission: 07-11-2020

Date of Acceptance: 21-11-2020

### I. Introduction

The increasing number of people globally demands a supply of protein sources at affordable prices. So far, the need for animal protein has been fulfilled by ruminants and poultry. However, compared to the price per kilogram of beef, the price of poultry meat is much cheaper. This causes the number of broiler chicken populations around the world to become increasingly every year to meet the demands of meat and animal products [1]. Even in developing countries and modern countries, the development of the broiler poultry industry has increased rapidly along with the increase in other production sectors [2], this shows that people are increasingly aware of the importance of protein intake in food for intelligence and growth. Broiler chicken has a very favorable flavor, tenderness, and juiciness [3] due to the subcutaneous and marbling fat content in the meat and skin, which makes the chicken taste more savory when processed.

The high demands for animal products must be balanced with the availability of sufficient feed sources. Almost all of the feed used by poultry comes from agricultural waste, whether in the form of grains, cereals, processed animal waste, or industrial or household waste. Vegetable waste can be defined as "food waste", which is a waste product obtained from production, crop residues, or can come from the market chain which is rejected vegetable waste with low-grade quality [4]. Vegetable waste is a problem because of its high amount every day because the harvest and sale of vegetables occur every day and vegetables are a type of commodity that cannot be stored for a long time, and if left untreated, it will cause air pollution, environmental pollution, and garbage accumulation. Several studies have shown that food waste can be a substitute for grains from cereals and protein feed sources, for example in poultry and pork feed [5, 6]. So that the ultimate goal of feeding is to reduce production costs related to feed costs.

Feeding vegetable waste for poultry needs attention in terms of its shape, because poultry, especially broilers are used to crumble, pellet, or mass feed forms, while in its original form vegetable waste is still in the form of leaves or stems in a wide size. Based on the results of the analysis of nutritional content for the year (2020) on some vegetable waste that has been analyzed in the form of flour, broccoli leaves with dry matter content (DM) 92.28%, crude protein (CP) 30.77%; mustard greens 90.79% DM, 24.51% CP; Cauliflower leaves 86.7% DM, 38.82% CP; Cabbage 88.55% DM, 26.07% CP; chicory 86.31% DM, 16.37% CP; lettuce has 87.66% DM, 21.67% CP. However, problems will arise when using fresh vegetable waste in poultry feed, because its content of crude fiber was higher and also has very high water content. Feed sources of energy and

protein still need to be added, so that protein deficiency from vegetable waste can be fulfilled. Therefore, it was necessary to use vegetable waste processing technology so that it can be consumed properly by chickens. One form of technology used was to process it into pellets and then process it into a crumble form

Pelleting is a technology commonly used in poultry feed processing which aims to unify particles of various types of feed to form a specific size called a "pellet" shape, its use in livestock is to increase production by increasing feed consumption, increasing production, and economically increasing feed efficiency. A pellet is a complete feed, it has a compact form of feed formed with a diameter of 1/8 inch and a length of 1/4 inch. Mechanically, in making pellets there is a pressing process to form a pellet [8]. In poultry feed, almost all of the feed ingredients are in the form of small grains or mass form, so that during the pelleting process all the feed particles come together in a compact and stable form so that when stored the feed will stable in the form of a pellet. Research on the use of pellets and crumble forms in broiler chickens strain Ross 308 showed that these two types of feed gave the same good results on body weight, feed consumption, and FCR of 6 weeks old chickens [9].

The purpose of this study was to determine the effect of vegetable waste in poultry feed formulation on broiler production performance and feed digestion. All feed used is arranged in a formulation according to the needs of the broiler and then made in pellet form.

## II. Materials and Methods

This research consists of several stages, the first stage was research to determine the appearance of livestock production and the second stage was the study aimed to determine the digestibility of nutrients from the conduct of the study. The first stage of research was to use a litter cage, where the chickens were kept for 39 days, then continued with the use of a metabolic cage where during the maintenance the feed consumption and fecal storage were measured.

The study was conducted at the broiler experimental unit, Integrated Field Laboratory, Tribhuwana Tunggal University, Indonesia. 100 one-day-old chicks (Cobb-500) were acquired from a local hatchery and fed a conventional diet (according to standard commercial broiler feed) for the first two weeks namely BR0 (broiler one). Birds were vaccinated regularly following standard for maintenance of broiler chickens including ND-IB at 5 days of age, Gumboro at 7 days of age, and ND vaccine at 14 days of age. At the age of 14 days, the chickens were selected and placed in litter plots (first stage research) with a size of 80x80 cm, which was equipped with a 25 W lamp which functions as a heater and light source. Daily ambient temperature was around 25 - 28 °C, with 70% humidity. The experimental design was using Completely Randomized Design (CRD) [10] with 5 treatments repeated 5 times. Each cage contains 4 chickens. The treatments consisted of P0 (feed formulation without vegetable waste), P1 (100% feed formulation with 5% vegetable waste level), P2 (100% feed formulation with 10% vegetable waste level), P3 (100% feed formulation with 15% vegetable waste level), and P4 (100% feed formulation with 20% vegetable waste level). All feeds were arranged based on iso energy and iso protein (Table 2). The type of vegetable used 3 types of vegetables, namely cauliflower leaves, mustard leaves, and cabbage. These three vegetables were selected from the results of a preliminary proximate analysis of 6 types of vegetables (Table 1). The selection of 3 types of vegetables was based on the protein content of the three types of vegetables which were higher than other vegetables, and the ease of drying and storage in wilted form. The nutritional content of the six types of vegetables has been analyzed in a proximate manner according to AOAC (1980) which is shown fully in Table 1. The basis for making feed formulations was based on dry matter content in the dry form of vegetables presented in table 2, and the content of feed ingredients. as a whole (table 3), then arranged in feed formulations (Table 4).

**Table 1.** The nutritional content of 6 types of vegetable waste

Vegetablewaste	The nutritional content				
	DM (%)	Mineral (%)	CP (%)	CF (%)	CF (%)*
Cabbage	2.835371	0.693553	0.834761	0.469733	0.124238
Cauliflower leaves	14.71588	1.85858	6.589048	2.038497	0.977664
Broccoli leaves	5.344858	1.20879	1.782198	0.785974	0.337094
Lettuce	3.085632	0.4752	0.762784	0.47696	0.177408
White mustard	5.38747	0.988733	1.059267	0.820199	0.142942
10 Green mustard	4.499552	1.109648	1.214716	0.625447	0.213604

DM (dry matter), CP (crude protein), CF (crude fat), CF\* (crude fiber)

**Table 2.** Proximate nutrient of 3 types of vegetables based on dry matter

Vegetable waste	Formulation %	DM (%)	EM (kcal/kg)	CP (%)	CF (%)	CF* (%)
White mustard	25	21.58	612.5	4.2425	0.5725	3.285
Cauliflower leaves	50	43.35	1225	19.41	2.88	6.005
Cabbage	25	22.14	612.5	6.5175	0.97	3.6675
	100.00	87.07	2450	30.17	4.4225	12.958

DM (dry matter), EM (energy metabolism) CP (crude protein), CF (crude fat), CF\* (crude fiber)

**Table 3.** The content of each feed ingredient to arrange the feed formulation

No	Feed source	DM (%)	GE (kcal/kg)	CP (%)	CF (%)	CF*(%)
1	Yellow corn	89.1	3370	8.6	3.9	2
2	Soybean meal	87.16	2240	42	0.9	6
3	Cane molasses	77	2280	4.2	0.2	7.7
4	Cassava flour	85	129.5	6	27	0.6
5	Meat Bone Meal	91.14	2590	49.58	5.84	3.39
6	Vegetable waste <sup>a</sup>	87.07	3237.6	30.17	4.4225	12.958
7	PREMIX	98	0	0	0	0
8	Palm oil	0.18	8000	0	100	0

DM (dry matter), GE (gross energy) CP (crude protein), CF (crude fat), CF\* (crude fiber),

**Table 4.** Formulation of treated feed and its nutritional content

No	Feed Source	Feed Formulation (%)				
		P0	P1	P2	P3	P4
1	Yellow corn	60	58	58	56.5	55
2	Soybean meal	3	0	0	0	0
3	Cane molasses	1.2	1.2	1	1	1
4	Cassava flour	5.9	5.9	5	4.5	4
5	Meat Bone Meal	27.2	27.2	23.3	20.3	17.3
6	Vegetable waste <sup>d</sup>	0	5	10	15	20
7	Premix	2	2	2	2	2
8	Palm oil	0.7	0.7	0.7	0.7	0.7
	Total	100%	100%	100%	100%	100%
Nutrien Content of Each Feed Formulation						
	DM (%)	88.77	88.72	88.60	88.46	88.32
	GE (kcal/kg)	2884.7	2912	2967.1	3000.1	3033.1
	CP (%)	20.31	20.481	20.088	20.045	20.001
	CF (%)	6.2509	6.3909	6.1647	6.041	5.9173
	CF* (%)	2.4299	2.8499	3.3369	3.8422	4.3475

# Vegetable waste is composed of 3 types of vegetables, namely 50% cauliflower leaves, 25% mustard greens, and 25% cabbage.

#### Feed Producing and Processing

Before producing feed, the broiler feed needs were calculated. Vegetable waste was obtained from vegetable farmers who have the main job of delivering vegetables to supermarkets and for this research, the researcher selected 3 types of vegetables (Table 2). Poultry feed formulation was prepared in advance based on Table 4. Each feed preparation was arranged for 10 kg based on dry matter. Then the conversion was carried out for 3 types of vegetables based on the actual dry ingredients with the formula :

$$\frac{100}{DM \text{ of vegetables}} \times \text{vegetables formulation in kilograms}$$

It means, that we need to change the portion of the feed formulation in the form of dry matter ingredients (table 4) into the form of fresh ingredients or fresh weight in kilograms. This formula was then adjusted to the portions of each type of vegetable. After counting in fresh form, the vegetables are dried for 8 hours in the sun. Furthermore, all feed ingredients (Table 3) and vegetable waste are processed into pellets using a gasoline-fueled pelleting machine. All ingredients were mixed and then gradually put into the pellet machine without any heating process in the machine. For the ingredient binding in pellets, we used cassava starch and molasses. The



result that comes out was pellet form feed which was expected but still in the form of wet so that the pellet-shaped feed must be dried in the sun for 1 day until the shape becomes hard. Once hard, the pellets were lightly hit so that they become pellet shards or called crumble. This size was given because it is adjusted to the size of the broiler beak. The treatment was given from the age of 14 days until harvest.

#### Housing and Management

The chickens used in the research were reared since DOC, used a litter system cage, litter was covered by 5 cm rice husk, and then covered with newspapers, and all around the cage was covered with newspaper and the top was covered with plastic. Each cage box was equipped with a 25 W lamp that functions as brooding and each cage was given a canopy so that the ambient temperature was maintained 30-32 °C. Each plot was also equipped with a place to feed and drink for a capacity of 4 chickens. Every day the chickens were checked regularly on the development of chickens and the effect of environmental temperature on feed consumption. Each box was given a hanging feed holder and a drinking area so that the chicks can eat freely. At the age of 14 days, the brooding phase ends and the chickens begin to get used to the ambient temperature without the need for heating. At this age, the chickens were introduced to the treated feed

#### Growth Performance

The chicken maintenance from DOC (1 day of age) to 39 days of age was purposed to measure the growth of broilers. During the growth performance of birds, feed offers and feed residues were recorded to calculate feed intake (g) and weight gain (g) on weekly basis. Daily consumption was measured by the feed amount was given minus the amount of daily leftover feed. The weight measurements were carried out per week during the study. Furthermore, the measurement of these 2 parameters will be used to measure feed efficiency. Feed efficiency was calculated:

$$FCR = \frac{\text{feed intake}}{\text{live weight}}$$

Measurement of consumption, weekly body weight, and FCR was carried out until the age of 39 days. Mortality (if any happened) was recorded on daily basis to calculate percent mortality. At 40 days of age, 25 chickens were moved to a metabolic cage, where the feces consumption and storage were measured. Its purpose was to measure AME and digestibility of protein and fat.

#### Sample Collection and Chemical Analysis

A total of 25 chickens were transferred to metabolic cages. The adaptation process lasts 3 days. Total excreta were collected from 42 to 45 Day post-hatch from each cage to determine parameters of nutrient utilization which included apparent metabolizable energy (AME) based on the correction of N, nitrogen retention, metabolic crude protein, and crude fiber digestibility. Excreta were dried and GE of diets and excreta was determined by bomb calorimetry using C 200 brand IKA. AMEn (Apparent Metabolizable Energy) values with correction for N were calculated according to that given by Terpstra and Janssen (1976) [11] as follows:

$$AMEn = C - dW - 8,73 (N - dT) \text{ kcal/kg.}$$

AMEn = " Apparent Metabolizable Energy " based on the correction of N

C = Gross energy of the studied feed per kg (kcal)

d = amount of excreta produced per kg of feed ingredients

W = excreta gross energy produced per kg (kcal)

8,73 = nitrogen energy value per g

N = the amount of g nitrogen in 1 kg of feed ingredients

T = amount of g of nitrogen excreta produced by 1 kg of feed material.

N-corrected AME (AMEn MJ/kg DM basis) values were calculated by correcting N retention to zero using the factor of 8.73 kcal/g N retained in the body (Hilland Anderson, 1958)[12].

The retention calculation for N is to use the formula:

$$\text{Retention (\%)} = \frac{(\text{Feed intake} \times \text{Nutrient}_{\text{diet}}) - (\text{Excreta output} \times \text{Nutrient}_{\text{excreta}})}{(\text{Feed intake} \times \text{Nutrient}_{\text{diet}})} \times 100$$

#### Research Design and General Experimental Procedures

Proximate analysis testing includes dry matter, crude protein, crude fat, and crude fiber, using the AOAC method (1980). Proximate analysis was carried out on vegetable waste, feed ingredients, and feces. The best treatment testing uses the LSD method according to DeGarmo et al. (1984).

### III. Results and Discussion

#### Growth Performance

The treatment of using 4 concentrations of vegetable waste was used in broiler chickens from the age of 14 days. Starting from DOC (Day Old Chick) until the age of 14 days, researchers used Commercial Feed (BR0) with an EM content of 2900 kcal/kg and 21-23% protein. At the age of 15 to 39 days, the researchers gave 4 levels of vegetable waste (5%, 10%, 15%, and 20%) as treatment feed. Based on table 2, it shows that the use of vegetable waste levels could replace the use of soybean meal used in control feed, likewise this treatment also reduces the use of the MBM portion up to treatment P4. This shows that vegetable waste could substitute protein sources. The results of research on poultry growth are presented in Table 5.

Table 5, shows that feed consumption and body weight did not show significant differences in commercial feeding until the age of 14 days. This shows that the poultry has a uniform body weight, which means that the effect of feed was not seen in all the chickens tested during the use of BR0 feed. At the age of 15 days, the chickens were introduced to treated feed (4 treatment levels of vegetable waste) and 1 control feed based on MBM soybean meal. To facilitate the adaptation phase, at first, the commercial feed was mixed with 1: 1 treatment feed, then every 2 days it was replaced by 3: 1 (treated feed: commercial feed), then 2 days later the full treated feed was started. From the results of the study, the use of vegetable waste treated feed showed very significantly different results ( $p < 0.01$ ) on feed consumption compared to control and showed a significant increase ( $p < 0.05$ ) in the weight of the harvest. This shows that the use of vegetable waste can improve the nutrition of the meat bone meal-MBM based feed formulation. The increase in weight gain and reduction in FCR has resulted from the use of a 15% vegetable waste level (P3) which showed significantly different results compared to the control ( $p < 0.05$ ), although the overall results on body weight gain during the study from baseline to harvest did not show any results, which was significantly different in all treatments.

The results of this study were still not able to reach the maximum standard, which should be at the age of 35 days the chickens should reach a standard weight of 1.7-1.9 kg per head (Broiler standard) [13]. The difference in nutrition was the reason the maximum weight has not been achieved. The use of vegetable waste caused an increase in crude fiber content in the treated feed thereby reducing digestibility [14,15]. An-depth study of the use of vegetable waste in feed has shown to reduce protein and globulin serum contents compared to commercial feed [16]. The correlation of decreased serum protein and globulin is the result of defatted parts of the vegetable due to high levels of fiber and low protein, thus decreasing absorption in the intestine [17]. Even though the feed formulation was based on a dry matter (Table 4) that the crude fiber and protein content has met the needs of broilers, it is suspected that during the pellet-making process, the mixing process in the machine which consists of mixing and pressing feed ingredients and vegetable waste, was not able to reduce the length of fiber chain from vegetable waste fibers so that long polysaccharide chains from vegetable waste could not be digested in the intestine, which is influenced in the absorption of other nutritional components such as protein, fat, and energy. The pellet machine used in this research was a simple pellet machine without heating in it. From these results, the researchers suspect that it should be necessary to do the grinding process first on all vegetable so that smaller particle sizes can be obtained so that it will break down the length size of the polysaccharide from the vegetable fiber.

The results showed that the level of vegetable waste in the feed decreased the absorption of nutrients and had an impact on growth. This condition can be seen in feed consumption after 14 days to 39 days, which showed that consumption tends not to increase significantly. High crude fiber content reduces feed efficiency (causes poor efficiency) and causes broiler growth to slow down [18, 19]. This can be seen from the high FCR value in all treatments (Table 5). During the maintenance, no livestock was found that experienced illness or death. This was supported by the results of research on the use of Moringa leaves (*Moringa oleifera*) in poultry feed as much as 5%, 10%, and 20% which do not cause death in livestock [20].

#### Nutrient Digestibility

Measurements of the digestibility level of vegetable waste were measured against the measurement of Apparent Metabolizable Energy (AME), N retention, and metabolic crude protein and crude fiber digestibility (Table 6). The results showed that the treated feed gave significantly different results ( $p < 0.01$ ) on AME than the control feed. This showed that the poultry could able to digest the energy from the feed given, including the formulation of feed containing vegetable waste. Energy sources can be in the form of saccharides or polysaccharides, and when birds lack energy, poultry can convert some protein into energy. These results were comparable to the N retention values and Crude Protein Digestibility which also showed significantly different results ( $p < 0.01$ ) and significantly different on crude fiber digestibility ( $p < 0.05$ ) compared to the control feed. Crude protein and crude fiber digestibility values were very low. This was because the fiber content in waste feed blocks the digestion of protein [18]. Compared with the control, the use of vegetable waste gave higher results on all crude fiber digestibility and N retention. This is in line with the results of other research studies, where the use of a high level of vegetable waste, namely 25% in broiler feed, gave a higher body weight than

control. [21] and the use of 0%, 10%, 20%, 30% gave the same weight results compared to control in ostriches, whereas using levels of 20% and 30% gave the best results

Based on the results of research, the use of vegetable waste from P4 treatment shows a decrease in nutrient digestion, influenced on AME, crude fiber digestion, and N retention. This means that the use of vegetable waste (a combination of 3 types of leaves, cauliflower, cabbage, and mustard greens) could be used up to a level of 15% in feed formulations. The highest outcome for the weight gain was achieved by P3 treatment, but not significantly different from P4, although at P4 treatment the body weight began to decrease. The use of vegetable waste could be a choice of feed raw materials, but based on the discussion, the initial treatment process should be done, so that the nutritional components of feed can be digested and absorbed in the digestive system of birds

**Table 3.** Growth performance of broilers fed increasing levels of vegetable waste (means±SEM).

Treatments	Feed Intake		Live Weight		Weight Gain		FCR <sup>(+)</sup>		FCR <sup>(-)</sup> **
	Age 0-14 days <sup>+</sup>	VW <sup>d</sup> (15-39 day)**	Initial Weight (at 14 days)	Final weight (age 39 days)*	Weight Gain of 14 days	Weight Gain of treatments (25 days)	FCR (initial 14 days)	FCR (final 25 days)	Total (39 days)
P0	689.42±27.2	2083.21±133.01	509±7.5	1171.2±38.8	462.7±7.5	662.2±35.4	1.4±0.1	3.2±0.27	2.44±0.1
P1	666.67±37.3	2599.45±261.8	483.4±43.1	1144.7±96.01	437.1±43	661.2±78.1	1.53±0.2	3.9±0.23	2.86±0.2
P2	672.9±9.2	2536.05±14.5	485.7±10.3	1165.7±8.1	439.4±10.3	679.9±15.8	1.55±0.04	3.8±0.1	2.76±0.04
P3	689.72±25.2	2710.15±268.9	502.4±20.1	1291.7±81.5	456.05±20.1	789.3±86.4	1.51±0.1	3.5±0.5	2.64±0.13
P4	647.9±39.8	2623.45±96.9	482.8±44.7	1245.3±74.4	436.45±44.7	762.3±75.9	1.49±0.1	3.5±0.4	2.63±0.4

\* Means followed by different superscripts indicate significant differences ( $p < 0.05$ ) among treatments.

\*\* Means followed by different superscripts indicate very significant differences ( $p < 0.01$ ) among treatments.

+CF: Commercial Feed)

\$VW: Vegetable Waste)

§Feed efficiency based only on commercial feed intake

$$^{+)} FCR = \frac{\text{Feed Intake}}{\text{Weight Gain}}$$

$$^{-)} FCR = \frac{\text{Feed Intake}}{\text{Final Live Weight}}$$

**Table 4.** Effect of Treatments on Nutrient Digestibility

Treatments	AMEn (kkal/kg)*	Nitrogen Retention (%)**	Crude Protein Digestibility (%)**	Crude Fiber Digestibility (%)*
P0	2745.8±215.4	84.85±7.4	41.48±1.36	65.06±16.3
P1	2764.2±164.6	73.46±5.7	28.84±7.81	28.92±15.24
P2	3092.12±30.5	80.83±0.9	34.85±0.81	47.18±2.52
P3	3085.7±257.2	86.73±4.3	40.09±4.8	54.64±14.57
P4	2824.6±191.3	82.94±3.4	39.86±5.58	47.39±10.58

\* Means followed by different superscripts indicate significant differences ( $p < 0.05$ ) among treatments.

\*\* Means followed by different superscripts indicate very significant differences ( $p < 0.01$ ) among treatments.

P0= Feed formulation without vegetable waste

P1= treatment of the used 5% vegetables waste in 100% feed formulation

P2= treatment of the used 10% vegetables waste in 100% feed formulation

P3= treatment of the used 15% vegetables waste in 100% feed formulation

P4= treatment of the used 20% vegetables waste in 100% feed formulation

#### IV. Conclusion

The results showed that the use of vegetable waste levels in broiler feed gave significantly different results on feed consumption, final body weight, FCR, and nutrient digestibility which are AME value, N retention, metabolic crude protein, and crude fiber digestibility compared to the control. The best use of vegetable waste is generated at a level of 15%

#### Acknowledgements

Thanks to The Ministry of Research, Technology, and Higher Education of the Republic of Indonesia 2020 for the financial support through the PKM Grant. Thank you to all who have helped to carry out this research.

#### References

- [1]. Godfray, H.C.; Beddington, J.R.; Crute, I.R.; Haddad, L.; Lawrence, D.; Muir, J.F.; Pretty, J.; Robinson, S.; Thomas, S.M.; Toulmin, C. Food security: The challenge of feeding 9 billion people. *Science* 2010, 327, 812–818.



- [2]. Alexandratos, N.; Bruinsma, J. World Agriculture Towards 2030/2050: The 2012 Revision; Food and Agriculture Organization of the United Nations, Agricultural Development Economics Division (ESA): Rome, Italy, 2012.
- [3]. Mir, N.A., Rafiq, A., Kumar, F., Singh, V., and Shukla, V. 2017. Determinants of broiler chicken meat quality and factors affecting them: a review. *J Food Sci Technol* (September 2017) 54(10):2997–3009
- [4]. Gustavsson, J.; Cederberg, C.; Sonesson, U.; Otterdijk, R.; McYbeck, A. Global Food Losses and Food Waste: Extent, Causes and Prevention; Food and Agriculture Organization of the United Nations: Rome, Italy, 2011.
- [5]. Westendorf, M.L. Food Waste as Animal Feed: An Introduction. In *Food Waste to Animal Feed*; Westendorf, M.L., Ed.; Iowa State University Press: Iowa City, IA, USA, 2000; pp. 3–16
- [6]. Gaorganas, A., Giamouri, E., Pappas, A. C., Papadomichelakis, G., Galliou, F., Manios, T., Tsiplakou, E., Fegeros, K., and Zervas, G. 2020. Bioactive Compounds in Food Waste: A Review on the Transformation of Food Waste to Animal Feed. *Foods* 2020, 9, 291; doi:10.3390/foods9030291.
- [7]. Abdollahi, M.R., Ravindrana, V., and Svihus, B. 2012. Pelleting of broiler diets: An overview with emphasis on pellet quality and nutritional value. *Animal Feed Science and Technology* 179 (2013) 1–23
- [8]. Banerjee G.C. 1998. Poultry. Third edition, Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta, pp: 120-121
- [9]. Chehraghi, M., Zakeri, A. and Taghinejad-Roudbaneh M. 2013. Effects of different feed forms on performance in broiler chickens. *European Journal of Experimental Biology*, 2013, 3(4):66-70
- [10]. Oehlert, G. W. 2010. A First Course in Design and Analysis of Experiments. Library of Congress Cataloging-in-Publication Data. University of Minnesota. <http://users.stat.umn.edu/~gary/book/fcdae.pdf>
- [11]. Terpstra, K. and Janssen, W.M.M.A. 1976. Method for determination of the metabolizable energy and digestibility coefficients of poultry feeds. Raport number 101.75, Spelderholt Institute For Poultry Research, Beekbergen, Holland.
- [12]. Hill, F. W., and D. L. Anderson. 1958. Comparison of metabolizable energy and productive energy determinations with growing chicks. *J. Nutr.* 64:587–603.
- [13]. Aviagen. 2007. Broiler Stock Performance Objectives. [www.aviagen.com](http://www.aviagen.com)
- [14]. Livingstone R, Baird BA, Atkinson T. Cabbage (Brassica oleracea) in the diet of growing-finishing pigs. *Animal Feed Science and Technology*. 1980;5:69–75.
- [15]. Mustafa AF, Baurhoo B. Evaluation of dried vegetables residues for poultry:II. Effects of feeding cabbage leaf residues on broiler performance, ileal digestibility and total tract nutrient digestibility. *Poultry Science* 2017;96(3):681–686.
- [16]. Raza, A., Hussain, J., Hussain, F., Zahra, F., Mehmood, S., Mahmud, A., Amjad, ZB., Khan, M.T., Asif, M., Ali, U., Badar, I.H., and Nadeem, M. 2018. Vegetable Waste Inclusion in Broiler Diets and its Effect on Growth Performance, Blood, Metabolites, Immunity, Meat Mineral Content and Lipid Oxidation Status. *Brazilian Journal of Poultry Science*. Jan - Mar 2019 / v.21 / n.1/001-008. <http://dx.doi.org/10.1590/1806-9061-2018-0723>
- [17]. Zhang GF, Yang ZB, Wang Y, Yang WR, Jiang SZ, Gai GS. 2009. Effects of gingerroot (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science* 2009;88:2159–2166
- [18]. Thacker PA, Petri D. 2009. Nutrient digestibility and performance of broiler chickens fed regular or green canola biodiesel press cakes produced using a micro-scale process. *Journal of the Science of Food and Agriculture* 2009;89:1307–1313
- [19]. Westendorf, ML, Myer RO. Feeding food waste to swine [cited 2010 Aug 18]. Gainesville: University of Florida; 2009. Available from: <http://edis.ifas.ufl.edu/an143>.
- [20]. Oghenebrohie O, Oghenesuvwe O. 2016. Performance and hematological characteristics of broiler finisher fed *Moringa oleifera* leaf diets. *Journal of Northeast Agriculture University* 2016;23(1):28–34
- [21]. Onu PN. 2010. Evaluation of two herbal spices as feed additives for finisher broilers. *Biotechnology in Animal Husbandry* 2010;26:383–392
- [22]. Tasimafas ME, Seidavi AR, Rasouli B, Kawka M. 2015. Effect of vegetable waste and energy in ostrich chick diet on performance and hematology. *Tropical Animal Health and Production* 2015;47:1017–1026.

Eka Fitasari, et. al. "The Potential of Vegetable Waste-Based Pellets on Broiler Production Performance and Nutrient Digestibility." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 13(11), 2020, pp. 18-24.



# The Potential of Vegetable Waste-Based Pellets on Broiler Production Performance and Nutrient Digestibility

## ORIGINALITY REPORT

10%

SIMILARITY INDEX

6%

INTERNET SOURCES

7%

PUBLICATIONS

3%

STUDENT PAPERS

## PRIMARY SOURCES

- 1** A Raza, J Hussain, F Hussain, F Zahra, S Mehmood, A Mahmud, ZB Amjad, MT Khan, M Asif, U Ali, IH Badar, M Nadeem. "Vegetable Waste Inclusion in Broiler Diets and its Effect on Growth Performance, Blood Metabolites, Immunity, Meat Mineral Content and Lipid Oxidation Status", Brazilian Journal of Poultry Science, 2019  
Publication 3%
- 2** [worldwidescience.org](http://worldwidescience.org)  
Internet Source 1%
- 3** Submitted to Petroleum Research & Development Center  
Student Paper 1%
- 4** Peter V. Chrystal, Amy F. Moss, Ali Khoddami, Victor D. Naranjo, Peter H. Selle, Sonia Yun Liu. "Effects of reduced crude protein levels, dietary electrolyte balance, and energy density on the performance of broiler chickens offered maize-based diets with evaluations of starch, protein, 1%

and amino acid metabolism", Poultry Science,  
2020

Publication

---

5	<a href="https://docplayer.net">docplayer.net</a> Internet Source	1%
6	<a href="http://www.waset.org">www.waset.org</a> Internet Source	<1%
7	Peter V. Chrystal, Amy F. Moss, Dafei Yin, Ali Khoddami, Victor D. Naranjo, Peter H. Selle, Sonia Y. Liu. "Glycine equivalent and threonine inclusions in reduced-crude protein, maize-based diets impact on growth performance, fat deposition, starch-protein digestive dynamics and amino acid metabolism in broiler chickens", <i>Animal Feed Science and Technology</i> , 2020 Publication	<1%
8	<a href="https://link.springer.com">link.springer.com</a> Internet Source	<1%
9	<a href="https://mafiadoc.com">mafiadoc.com</a> Internet Source	<1%
10	<a href="http://www.redalyc.org">www.redalyc.org</a> Internet Source	<1%
11	Submitted to Universitas Brawijaya Student Paper	<1%
12	Sonia Y. Liu, Peter H. Selle, David	

---

Raubenheimer, Rob M. Gous et al. "Growth performance, nutrient utilisation and carcass composition respond to dietary protein concentrations in broiler chickens but responses are modified by dietary lipid levels", British Journal of Nutrition, 2017

Publication

<1%

13

[www.atlantis-press.com](http://www.atlantis-press.com)

Internet Source

<1%

14

[doczz.net](http://doczz.net)

Internet Source

<1%

15

J.M. Fuente, P. Pérez<sup>^</sup>de Ayala, M.J. Villamide. "Effect of dietary enzyme on the metabolizable energy of diets with increasing levels of barley fed to broilers at different ages", Animal Feed Science and Technology, 1995

Publication

<1%

16

[hdl.handle.net](http://hdl.handle.net)

Internet Source

<1%

17

[www.researchsquare.com](http://www.researchsquare.com)

Internet Source

<1%

18

El-Far El-Far. "Biochemical and hematological evaluation of Costus speciosus as a dietary supplement to Egyptian buffaloes", African Journal of Pharmacy and Pharmacology, 2013

Publication

<1%

19

[www.scielo.br](http://www.scielo.br)

Internet Source

<1%

---

20

[www.pjbs.org](http://www.pjbs.org)

Internet Source

<1%

---

21

T. W. Perry, T. S. Stewart. "Effect of Fat and Lecithin and of Moisture Levels of Corn and Corn Silage on Nutrient Digestibility by Ruminants<sup>3</sup>", Journal of Animal Science, 1979

Publication

<1%

---

Exclude quotes      On

Exclude matches      Off

Exclude bibliography      On