



## The starter growth performance of Indonesian local ducks (*Anas platyrhynchos domesticus*) fed the ration containing different levels of tofu waste product flour

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### Abstract

The high price of feed ingredients for rations are one of the factors considered in raising ducks. The purpose of this study was to compare the effect of adding cheap tofu waste product (TWP) flour to reduce expensive corn and concentrate ingredients on feed consumption, live weight and feed conversion of starter phase ducks aged 1-8 weeks. The 64 female day-old ducks (DOD) were involved using completely randomized design, allocated into 4 treatments with 8 replications where each replication consisted of 2 birds in a cage. The treatments were feeds of R0 (without TWP, 0%), R1 (with 15% TWP), R2 (with 30% TWP), and R3 (with 45% TWP) in ration. Results showed that the use of large amounts of TWP in R3 caused a decrease in feed consumption of around 4.20 percent, likely caused by the bulky nature of TWP due to their high fiber content. In addition, the percentage of TWP flour addition of 45% showed a lower live weight compared to other treatments. The feed conversion ratio (FCR) of starter growth phase ducks consuming feed ration with composition started from a FCR of 2.3522 - 2.4484 in week-1 tending to decrease until in week-3 reaching a value of 1.8574 - 1.9711 indicating increase efficiency in the use of rations by each duck. However, this tendency began to increase until it reached a value of 3.0955 - 3.0862 in week-8. These values indicated the increase in the cumulative amount of feed consumption of starter phase of ducks at the ages of 2 weeks up to 4 weeks tending faster than the increase in cumulative body weight (lower FCR) compared with FCR from the ages of 5 weeks up to 8 weeks, resulting in a higher FCR.

**Keywords:** *Anas platyrhynchos domesticus* duck; Live weight gain; Tofu waste feed ingredient

### 1. Introduction

Duck animal is known as laying or meat ducks which are new competitors of native chickens with their distinctive soft and meaty taste. Duck farming businesses in Indonesia have also been found in almost every province. Duck farming has made a major contribution to local revenue, absorbed labor, increased community productivity and of course the main result is duck meat and eggs which can meet the community's needs for animal protein [1]. Duck animal as a source of meat can be sold at the age of over 8 weeks because at that age their body weight is almost the same as the body of a native chicken aged around 8 months [2].

Rations are one of the factors that must be considered in duck farming [3]. High-quality rations will affect the final results of duck farming, such as slaughter weight and carcass weight [3]. The high price of feed ingredients for rations, such as corn, soybean meal and fish meal, means that farmers must be able to utilize the potential sources of cheap and quality animal feed ingredients, including utilization of industrial waste products [4, 5]. Rations are a determining factor in the success of duck farming, because the cost of feed that must be spent on duck farming and other poultry farming is very large, namely 60-70% of the total production cost [6,7,8]. These high production costs need to be overcome by compiling your own rations using easily available ingredients, at a relatively cheaper price, but still having good nutritional content for production and the health of the livestock animal itself [9,10,11].

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Tofu waste products are a by-product in the process of making tofu in solid form and are obtained from squeezed soybean pulp [12]. Tofu waste products still have a relatively high protein content because in the process of making tofu, not all protein content is extracted, especially if using a simple and traditional grinding process [12]. However, tofu waste products have not been optimally utilized, there are even tofu craftsmen who simply throw away waste or tofu waste products so that they cause environmental pollution in the surrounding area.

This tofu waste product can still be used as animal feed that contains a lot of protein [13]. In terms of its chemical composition, tofu waste product can be used as a source of protein. The content of tofu waste product is 8.66% protein, 3.79% fat, 51.63% water and 1.21% ash [12]. Fresh tofu waste products have a water content of around 84.5% of their weight and higher water content can cause a short shelf life [12]. Dried tofu waste product contained around 10.0 - 15.5% water, so their shelf life is longer compared to fresh tofu waste product [9]. Currently, not many farmers use tofu waste product as additional feed for ducks other than concentrate.

The limited knowledge of farmers regarding information on raw materials, feed formulation and its manufacturing process has caused this potential to not be utilized optimally. What needs to be applied to the community, especially duck farmers, is to increase the knowledge and skills of farmers regarding the utilization of local feed ingredients competing with human needs [14,15,16]. Therefore, it is necessary to conduct research using tofu waste product given at different levels in feed rations to determine the effect of adding tofu waste product in feed rations on feed consumption, live weight and feed conversion ratio of ducks. The purpose of this study was to compare the effect of adding tofu waste product flour as a cheap tofu industry waste to reduce expensive corn and concentrate ingredients in ration on feed consumption, live weight and feed conversion ratio of starter growth phase of ducks at age of 1-8 weeks.

## 2. Materials and Methods

### 2.1. Animal Sample Collection and Maintenance

This research was conducted in groups for 60 days, starting from May 6 to July 5, 2024. Proximate analysis was conducted at the Manado Chemical Analysis Laboratory. This study used 64 female day-old ducks (DOD) that can be genetically distinguished from the color of their feathers since hatching with the characteristics of plain brown female ducks and brown mixed with black spots male ducks. This genetic selection has never been biased from the implementation of male and female sex selection on local ducks of Mojosari descent owned by duck farmers around the Tondano Lake where the source of duck seeds in this study.

The maintenance was carried out for 8 weeks and allocated into 4 treatments with 8 replications where each replication consisted of 2 duck birds. The cages used in this study were divided into 16 boxes with each box having a length of 90 cm, a width of 50 cm, and a height of 50 cm, filled with 2 DOD ducks in each box. The battery cages were made of wire and were given a layer of zinc under the wire floor that could be sprinkled with duck droppings during maintenance. The battery cage unit was equipped with a place to eat and drink in each box. At the beginning of maintenance at first age of 14 days, a lamp was used to illuminate all the boxes. Other equipment used in this study were electronic kitchen scales, buckets, basins, plastic and cleaning equipment. The placement of ducks in the boxes was done randomly because the ducks had a uniform level of body weight and hatching day on the same day.

**Table 1** The composition of nutritional substances in feed rations of ducks in the starter phase

Nutrients	Protein (%)	Crude Fiber (%)	Fat (%)	Ca (%)	P (%)	Gross Energy (kcal/kg)
Corn *	10,19	1,86	1,52	1,55	1,48	4301
Rice bran *	8,20	21,51	6,96	0,27	0,23	4251
Tofu Waste	24,50	19,94	9,96	0,14	1,13	3538
Concentrate #	35,00	5,00	12,00	1,10	0,50	2825

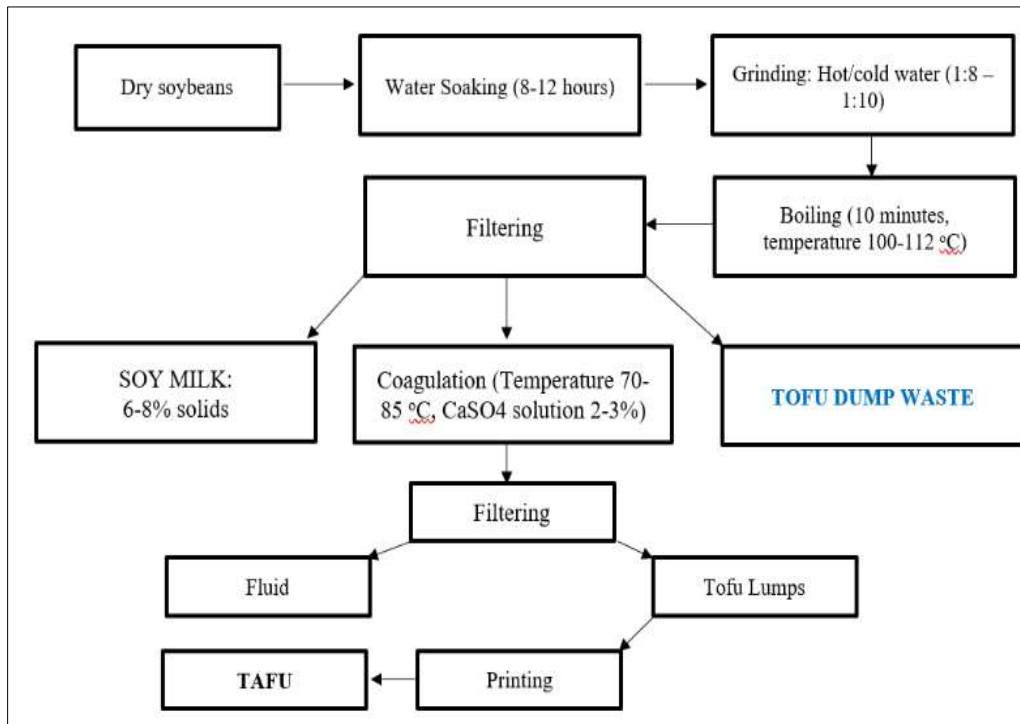
\*) Analysis results [17].#) Nutritional content of KKK Super concentrate feed ingredients of PT. Charoen Pohphand Indonesia.

The feed used in this study was a mixed concentrate feed (KKK Super) with corn, rice bran and tofu waste product flour with the composition as shown in Table 1. The formulation of the treatment ration and the nutritional content of each treatment feed are as presented in Table 2.

**Table 2** Feed formulation and nutritional content of duck feed in the starter growth phase

Feed Ingredients	Treatments			
	R0	R1	R2	R3
Yellow corn (%)	35	32	29	26
Concentrate (%)	40	35	30	25
Tahu waste product (%)	0	15	30	45
Rica bran (%)	25	18	11	4
Total (%)	100	100	100	100
Nutrient substances *				
Protein (%)	19,62	20,66	21,71	22,75
Crude Fiber (%)	8,01	9,21	10,39	11,57
Fat (%)	7,07	7,43	7,79	8,16
Ca (%)	1,05	1,09	1,12	1,19
P (%)	0,81	0,89	0,97	1,05
Gross Energy (kcal/kg)	3577,81	3617,00	3656,19	3695,45
Energy Metabolism (kcal/kg) #	2862,25	2893,60	2924,95	2956,36
*) Calculated based on the composition of nutrients Table 4. #) Calculated based on reference instructions [13,18]				

**2.2. Experimental Design and Measured Traits in Animals**



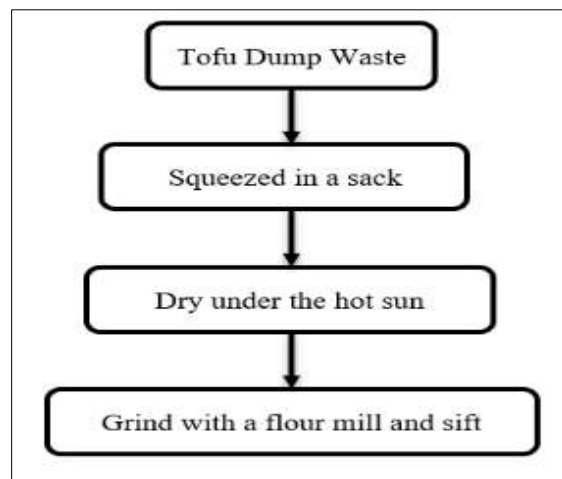
**Figure 1** Flowchart of Tofu Waste Production Process used in this Research

This study used a Completely Randomized Design (CRD), with 4 treatments and 8 replications. Each treatment and replication involved 2 starter growing phase ducks. The treatments to be studied were including R0 = Feed without tofu waste product (TWP) or 0%, R1 = Feed with 15% TWP, R2 = Feed with 30% TWP, and R3= Feed with 45% TWP. The

variables observed included feed consumption, body weight, body weight gain and ration conversion. Feed consumption was calculated once a week by weighing the amount of ration given subtracted the remaining ration given for a week. The feed ingredients used were including tofu waste product (Figure 1), corn, bran, and poultry concentrate.

Tofu waste product was taken from a tofu factory in Kotamobagu city, then squeezed with a cloth to reduce the water content and then dried under the hot sun for  $\pm$  3 days until completely dry (Figure 2). After the tofu waste products were dried, other feed ingredients such as corn, bran and concentrate were prepared. The feed ingredients were formulated according to the nutritional needs of starter growing ducks based on the growth phase [19], namely crude protein of 21 % and metabolic energy of 3000 kcal /kg.

Research Variables were including feed consumption, body weight and feed conversion ratio (FCR). Feed consumption was calculated daily by weighing the amount of ration given subtracted the remaining ration given for a day. The research feed was given daily by weighing the treatment ration given and then subtracting the remaining ration consumed daily by bird. The variable of duck body weight was weighed once a week by subtracting the initial body weight from the final body weight of the ducks for a week. The difference in body weight for a week was divided by seven to obtain the average daily gain (ADG). The variable of feed conversion ratio (FCR) was obtained from the sum of feed consumption for 1-8 weeks old divided by body weight gain for 1-8 weeks.



**Figure 2** Scheme for making tofu waste product flour

### 2.3. Statistical analysis

The analysis used in estimating variables using the Complete Random Design method was in the same direction as the statistical model [20, 21] as follows:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

Where:  $Y_{ik}$  = Result of observation the-j uncontrolled environmental and genetic influences;  $\mu$  = Average observation;  $\alpha_i$  = Effect of the-i treatment level of tofu waste product in ration and  $\varepsilon_{ij}$  = Deviation of uncontrolled environmental and genetic influences of livestock.

## 3. Results

### 3.1. Feed Consumption

The average feed consumption of ducks aged one to eight weeks in the starter period among treatments was presented in Table 3. The average results of the study on the use of tofu waste product flour in starter phase duck feed, reviewed from feed consumption, live weight and feed conversion ratio from the results of the analysis of variance, showed that the provision of tofu waste product flour had a significant effect ( $P < 0.05$ ) on feed consumption in starter growth phase ducks.

The use of tofu waste product (TWP) flour of large quantities in R3 (45% TWP) caused a decrease in feed consumption of around 4.20 percent (Table 3) which was likely caused by the bulky TWP due to their high fiber content. The bulky

nature of feed ingredients may cause ducks' crops to fill up quickly, resulting in a decrease of feed consumption, even though the ducks' needs have not actually been met. In addition, feed palatability greatly affects feed consumption values and ultimately affects live weight [22].

**Table 3** Average feed consumption of ducks (*Anas platyrhynchos domesticus*), body weight at 1 week old (BW-1-week), body weight at 8 weeks old (BW-8-week and body weight gain (BWG) during the study and feed conversion ratio (FCR)

Observation Variables	Treatments				P
	R0	R1	R2	R3	
Cumulative feed consumption (g/bird)	5.253,81±30.54 <sup>a</sup>	5.228,75±49.72 <sup>a</sup>	5.215,81±48.67 <sup>ab</sup>	5.203,50±51.22 <sup>b</sup>	.012
BW-1-week (g/bird)	131,19 ±1.02 <sup>a</sup>	124,06 ±0.92 <sup>b</sup>	121,94 ±1.09 <sup>b</sup>	121,38 ±1.08 <sup>b</sup>	.012
BW-8-week (g/bird)	1.704,37±16.17 <sup>a</sup>	1.702,00±15.68 <sup>a</sup>	1.697,31 ±16.79 <sup>ab</sup>	1.681,07 ±16.68 <sup>b</sup>	.012
BWG (g/ekor)	1.573,18 ±15.15 <sup>a</sup>	1.577,94±14.76 <sup>a</sup>	1.575,37±15.70 <sup>ab</sup>	1.559,69±15.58 <sup>b</sup>	.012
FCR (at 8 mgg)	3,08 ± 0.21	3,07 ± 0.20	3,07 ± 0.26	3,09 ± 0.23	.296
Description: R0, Feed without TWP (0%); R1, Feed with 15% TWP; R2: Feed with 30% TWP and R3: Feed with 45% TWP. Different superscripts in the same row indicate significant differences (P<0.05).					

The results of the analysis of the variance of this study showed that the cumulative feed consumption of 8-week-old ducks obtained from the highest to the lowest was R0 (5,253.81 ± 30.54) g, R1 (5,228.75 ± 49.72) g, R2 (5,215.81 ± 48.67) g and R3 (5,203.50 ± 51.22) g. The average for the highest cumulative feed consumption was R0 without the addition of tofu dregs flour, which was 5,253.81 ± 30.54 g, significantly different from the cumulative feed consumption of R3 with a percentage of TWP flour addition of 45%, which was 5,203.50 ± 51.22 g, but not significantly different from R2 with a percentage of TWP flour addition of 30%, which was 5,215.81 ± 48.67 g and R1 with a percentage of TWP flour addition of 15%, which was 5,228.75 ± 49.72 g.

### 3.2. Body Weight

Live weight was obtained by weighing the ducks before being fed in the morning (g). The results of this study indicate that the addition of tofu waste product flour in duck feed with different treatment levels showed a significant difference (P <0.05) in live weight (Table 3). This significant difference may be caused by the increase in body weight which decreased in each treatment of adding tofu waste product flour in the feed, resulting live weight also decreased. The increase in body weight was closely related to the live weight of livestock. This is in accordance with the research report [14] which states that the final body weight of livestock was influenced by the increase in body weight and age of livestock, while the increase in body weight was influenced by nutrient intake and digestion in the livestock's body. The better the digestion and absorption of nutrients, the better the increase in body weight and directly affects the body weight of livestock.

The provision of tofu waste product flour up to 45% has given a significant effect (P<0.05) on live weight, but the provision of tofu waste product flour up to 40% did not give a significant effect on the body weight of chicken livestock [5]. In this study, the provision of rations with tofu waste product up to 45% can still support the growth of ducks quite well so that they produce body weight that is relatively the same as ducks given rations without tofu dregs as a control.

The results of the analysis of the variance of this study showed that the highest to lowest live weights obtained at 8 weeks of age were R0 (1704.37 ± 16.17) g, R1 (1702.00 ± 15.68) g, R2 (1697.31 ± 16.79) g, R3 (1681.07 ± 16.68) g. The average for the highest live weight was R0 without the addition of tofu waste product flour, which was 1704.37 ± 16.17 g, significantly different from R3 with a percentage of tofu waste product flour addition of 45%, which was 1681.07 ± 16.68 g, but not significantly different from R2 with a percentage of tofu waste product flour addition of 30%, which was 1697.31 ± 16.79 g and R1 with a percentage of tofu waste product flour addition of 15%, which was 1702.00 ± 15.68 g. The significant difference in the addition of tofu waste product up to 45 percent in the duck feed in this study could be caused by several things, namely feed consumption, livestock activity and livestock conditions that may also affect live weight. This is in accordance with the report [11] that the factors that affect the live weight of poultry including broiler chicken consumption and quality of rations due to the increase in the level of crude fiber in the feed.

### 3.2.1. Feed Conversion Ratio (FCR)

Feed conversion is a comparison between the amount of feed consumed and the increase in body weight in a certain period of time. In this study, feed conversion was calculated per week by comparing the amount of feed consumed and the increase in body weight carried out every week. The results of this study indicated that the addition of tofu waste product flour in starter phase duck feed gave an insignificant difference ( $P > 0.05$ ) to feed conversion (Table 3). This insignificant difference can be caused by the same efficiency in the use of feed containing tofu waste product in the ration by ducks. The feed consumed by ducks containing tofu waste product can still be balanced by the increase in body weight of starter phase ducks. This is still in accordance with the results of the report on poultry [6] that a high feed conversion rate indicated inefficient feed use.

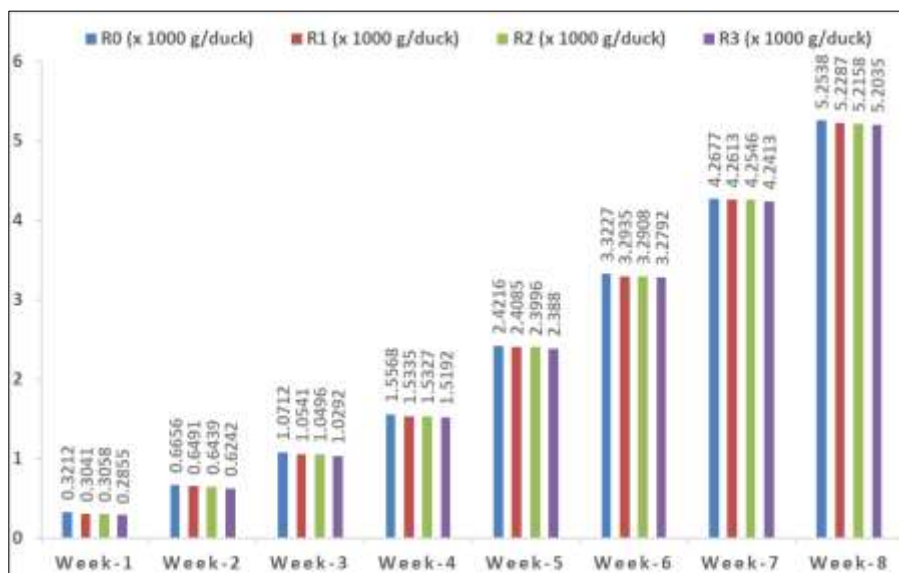
The feed conversion rate was influenced by livestock strains and environmental factors, as well as food factors. The results of research by previous researchers [2] have reported that Muscovy ducks fed with tofu waste product with treatments of 25%, 30% and 35% showed a significant difference ( $P < 0.05$ ) in their feed conversion, namely that the feed conversion results of the research showed that the most efficient treatment was in the R0 treatment because the feed conversion was low.

The results of the analysis of variance of this study for the feed conversion value from the highest to the lowest, namely R0 ( $3.08 \pm 0.21$ ), R1 ( $3.07 \pm 0.20$ ), R2 ( $3.07 \pm 0.26$ ), R3 ( $3.09 \pm 0.23$ ) as seen in Table 3. The average for the feed conversion above with the percentage of tofu waste product flour addition of 15%, 30% and 45% showed the balance between the amount of feed consumption and the amount of body weight produced by the growth of ducks in the starter phase, until the age of 8 weeks. The average feed conversion in 8-week-old Muscovy ducks with the use of 30-40% tofu waste product in the ration was in the range of  $4.02 \pm 0.47$  to  $6.83 \pm 0.78$  [2]. The difference in feed conversion, not significant in this study was caused by ration consumption which could be balanced by the increase in livestock body weight due to ration conversion closely related to ration consumption.

## 4. Discussion

### 4.1. Feed Consumption

The best average cumulative feed consumption occurred in the control feed (R0), the quality of the feed ingredients used included a fairly good source of protein with low crude fiber content. The source of nutrients in concentrate feed are ingredients containing amino acids with good quality and low crude fiber content. High crude fiber content in feed may reduce feed consumption because high crude fiber can reduce the availability of energy and other nutrients [23]. Crude fiber also has the property of being filling or bulky, so that the crop capacity in ducks is quickly fulfilled and feed consumption will stop causing feed consumption decreases. Bulky feed causes the digestive tract to fill up quickly, so that animals reduce their feed consumption [23].



**Figure 3** Feed Cumulative Consumption of Ration Containing Tofu Waste Product (TWP) with Levels of R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP and R3 = 45% TWP of Duck at the Starter Growth Period

The cumulative consumption of feed containing tofu waste product (TWP) for ration feed (R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP, R3 = 45% TWP) of ducks each week during the 8-week starter phase can be seen in the distribution as in Figure 5,3. The cumulative consumption of feed at four levels of TWP in the ration has a tendency to increase from the first week to the eighth week, starting from 285.5 - 321.2 g/head in week-1 to reach 5,203.5 - 5,253.8 g/head in week-8 (Figure 3).

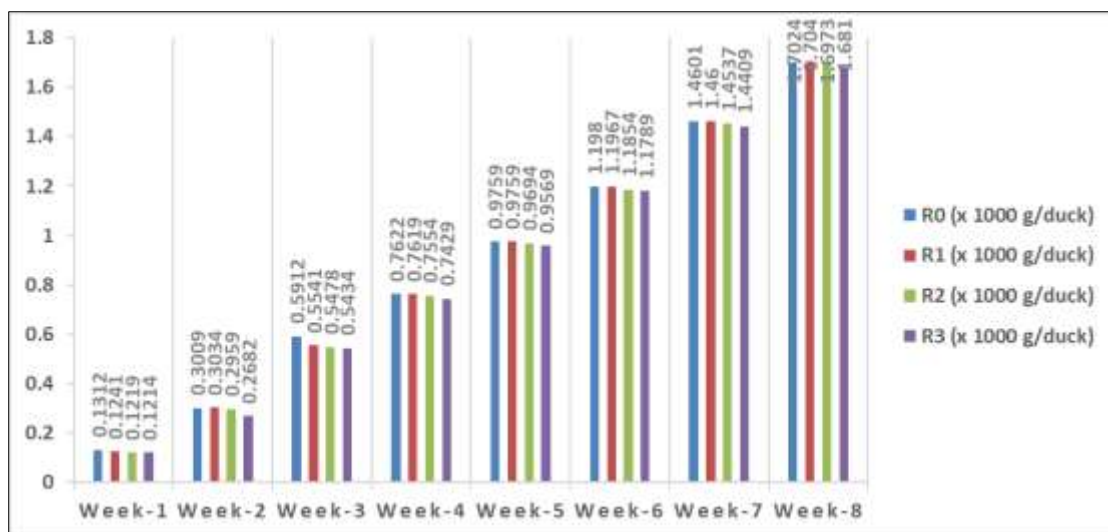
Tofu waste products are a by-product of processing soybeans into tofu, so that most of its nutritional content has been reduced. Soybeans are one of the sources of high-quality vegetable protein because their protein content can reach around 40% along with a more complete amino acid composition in soybeans such as isoleucine, leucine, lysine, methionine, cystine, phenylalanine, glycine and many other amino acids [24]. The results of the study can show changes in the amino acid composition of soybeans, tempeh and tofu where the results showed that soybean amino acids have a higher content than fermented tempeh [24]. This is suspected to be tofu waste product originating from soybeans. In this product, amino acids are greatly reduced and cause a decrease in nutrient consumption (amino acids) [24].

Waterfowl (ducks) prefer wet feed rather than dry feed. Providing more dry tofu waste products in the ration will leave quite a lot of feed. This causes a decrease in body weight gain, along with decreased feed consumption [18]. From the explanation above, providing tofu waste products in higher amounts can affect reducing feed consumption.

#### 4.2. Body Weight

Live weight decreased along with the increase in the level of tofu waste product flour in the feed. In this study, the feed treatment with a percentage of tofu waste product flour addition of 45% showed a lower live weight compared to other treatments. This can be caused by the high content of crude fiber contained in feed containing tofu waste product, as in previous research reports [11]. The high crude fiber content in tofu waste product causes the absorption process in digestion to be hampered. The results of previous studies stated that rations containing tofu waste product have quite high crude fiber; however, it turns out that Sentul chickens can still digest it well up to a level of 40 percent [5]. This is possible because livestock animals, both ducks and local chickens, have the habit of eating fibrous plants, so this ability can be passed down through their generations.

The cumulative body weight of the starter growth phase of ducks consuming ration feed containing tofu waste product (TWP) with treatments R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP and R3 = 45% TWP can be seen as in Figure 4. The cumulative body weight of ducks fed with four levels of tofu waste product in the ration has a tendency to increase from the first week to the eighth week, starting from a body weight of 121.4 - 131.2 g/head in week-1 reaching a body weight of 1,681.0 - 1,702.4 g/head in week-8. The growth condition of the starter phase ducks was in line with the increase in the cumulative amount of feed consumed each week as seen in Table 5 above.

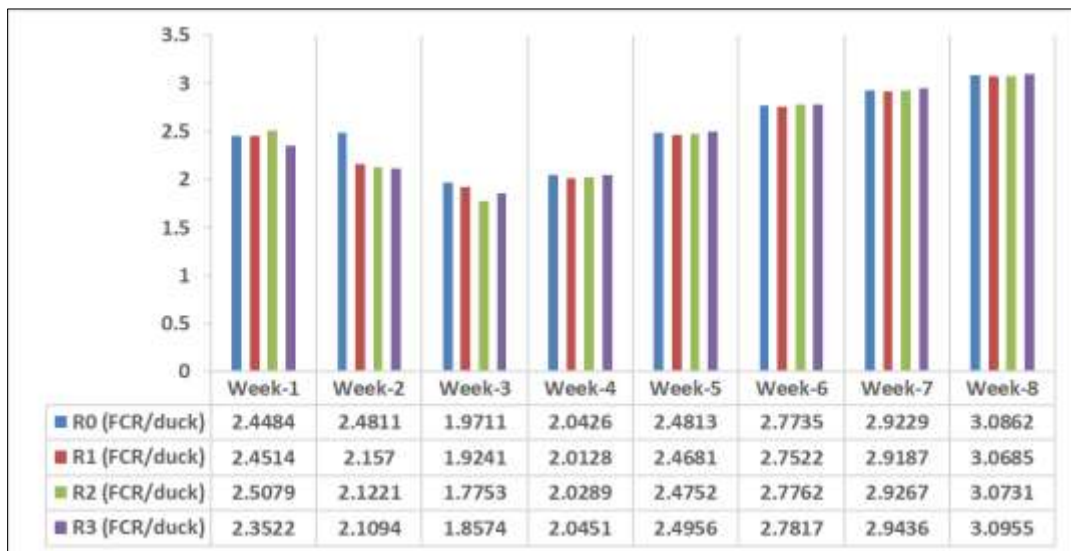


**Figure 4** Cumulative Growth Weight of Duck Consuming Ration Containing Tofu Waste Product (TWP) with Levels of R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP and R3 = 45% TWP at the Starter Growth Period

#### 4.2.1. Feed Conversion Ratio (FCR)

The results of this study were in accordance with the results of previous research reports [15] that the high and low value of ration conversion was greatly influenced by ration consumption and daily body weight gain. The better the quality of the ration, the lower the feed conversion value. The good or bad quality of the ration was determined by the balance of nutrients in the ration, needed by livestock. The feed conversion was influenced by genetics, body size, environmental temperature, health, adequacy of ration nutrients, management and use of superior livestock seeds [3]. This study had results similar to previous researchers' reports [2, 9] which stated that the higher the level of tofu waste product substitution above 40% in basal feed showed a lower growth rate. This condition was influenced by the higher crude fiber content in the ration along with the increasing level of tofu waste product substitution.

The feed conversion ratio (FCR) of starter growth phase of ducks consuming ration feed containing tofu waste product (TWP) with treatments R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP and R3 = 45% TWP can be seen as in Figure 7. This feed conversion ratio (FCR) of starter growth phase of ducks consuming ration feed with this composition started from a conversion value of 2.3522 - 2.4484 in week-1 decreasing until in week-3 to touch a value of 1.8574 - 1.9711 which showed increasing efficiency in the use of rations by each duck. However, this tendency began to increase until it touched a value of 3.0955 - 3.0862 in week-8 (Figure 5). These values indicated that the increase in the cumulative amount of feed consumption of starter phase of ducks at the ages of 2 weeks up to 4 weeks was faster than the increase in cumulative body weight (lower FCR) compared with FCR from the ages of 5 weeks up to 8 weeks, resulting in a higher FCR as a form of cumulative feed consumption compared to the amount of cumulative body weight increase, produced by starter growth phase of ducks up to the eighth week.



**Figure 5** Feed Conversion Ratio (FCR) of Duck at the Starter Growth Period Consuming Ration Containing Tofu Waste Product (TWP) with Levels of R0 = 0% TWP, R1 = 15% TWP, R2 = 30% TWP and R3 = 45% TWP

## 5. Conclusion

The use of tofu waste product flour over 30 percent resulted in a decrease in feed consumption and body weight compared to control ration without tofu waste product flour. The feed conversion rate at each additional level of tofu waste product flour of 15% up to 45% showed similarity of a relative insignificant feed conversion rate. The increase in the cumulative amount of feed consumption of starter phase of ducks at the ages of 2 weeks up to 4 weeks was faster than the increase in cumulative body weight (lower FCR) compared with FCR from the ages of 5 weeks up to 8 weeks, resulting in a higher FCR.

## Compliance with ethical standards

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*Disclosure of conflict of interest*

The authors declared no conflict of interest.

*Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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