



Effects of Using Fermented Moringa (*Moringa oleifera*) Leaf Meal and Yellow Corn in the Diets on the Performances and Income Over Feed Cost of Broiler Chickens

(Pengaruh penggunaan campuran daun kelor dan jagung terhadap performan dan IOFC ayam broiler)

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ABSTRACT. This study aimed to examine the effect of including fermented moringa leaf meal (fMOL) + yellow corn (yC) to substitute fractionally commercial diet (CD) on the performances and Income over Feed Cost (IOFC) of broiler chickens. The study was done in the Field Laboratory of Animal Husbandry, Animal Husbandry Department, Syiah Kuala University from August 4 until September 15, 2020. The study used 100 broiler chicks strain CP 707, unsex. This study was set up into Block Randomized Design (BRD) consisting of 4 treatments and 5 blocks. The treatments were MC₀ = 100% CD, MC₁ = 95% CD + 2,5% fMOL + 2,5% yC, MC₂ = 90% CD + 5% fMOL + 5% yC, and MC₃ = 85% CD + 7,5% fMOL + 7,5% yC. The results of studies showed that including fMOL + yC to substitute partly commercial diet significantly (P<0.05) reduced final body weight (FBW) and increased feed conversion ratio (FCR) of the broilers. Feed consumption statistically was not significantly affected but tended to reduce. Using fMOL + yC reduced feed cost but revenue and IOFC also declined.

Keywords: Broiler, corn, fermentation, IOFC, moringa, performances

ABSTRAK. Tujuan penelitian ini adalah untuk melihat pengaruh penggunaan tepung daun kelor fermentasi (TKF) ditambah dengan jagung kuning (JK) sebagai pengganti sebagian ransum komersil (RK) terhadap performan ayam broiler. Penelitian ini dilakukan di Laboratorium Lapangan Peternakan, Fakultas Pertanian Universitas Syiah Kuala, Banda Aceh. Materi yang digunakan adalah 100 ekor DOC ayam broiler strain CP 707. Ransum perlakuan adalah MC₀ = RK 100%, MC₁ = 95% RK + 2,5% TKF + 2,5% JK, MC₂ = 90% RK + 5% TKF + 5% JK, dan MC₃ = 85% RK + 7,5% TKF + 7,5% JK. Rancangan yang digunakan adalah Rancangan Acak Kelompok (RAK) terdiri dari 4 perlakuan dan 5 kelompok. Pengelompokan didasarkan pada berat badan ayam pada awal minggu ketiga. Parameter yang diamati meliputi berat badan akhir, konsumsi dan konversi ransum, dan Income Over Feed and Cost (IOFC). Hasil penelitian memperlihatkan bahwa penggunaan TKF + JK sebagai substitusi sebagian ransum komersil nyata (P<0,05) menurunkan berat badan akhir dan meningkatkan konversi ransum. Konsumsi ransum tidak nyata berpengaruh, namun cenderung menurun. Penggunaan daun kelor menurunkan biaya ransum, dan IOFC

Kata kunci: broiler, jagung, fermentasi, IOFC, kelor, performan

INTRODUCTION

Many studies have been done to explore the potency of various alternative feed sources possibly formulated into the poultry diets to carry out more economic feeds. The major problems in involving unconventional feed ingredients were ordinarily thought about their lack of nutritional value and the potential contents of any anti nutrition found within innumerable composites. Recently, comprising unusual feedstuffs were not merely interested at the point of lower cost, but also a free residue of chemical compounds, herbals, and supporting bird health have been noticing on the critical assessments by poultry nutritionists to serve better meat.

Exploring the natural sources derived from the plants, for instance, moringa leaves (*Moringa*

oleifera Lamk) can be an alternative to offer low prices of feed ingredients rich in nutrients and other bioactive compounds that support the body health. The leaves of moringa are rich in minerals, vitamins, and other essential phytochemicals (Gopalakrishnan, 2016). Moringa leaves consist of high sources of vitamin C, calcium, potassium, and protein (Zaku *et al.*, 2015). The profile of essential amino acids (EAA) in the leaves is comparable to soybean meal (Makkar and Becker, 1997). Saini *et al.* (2013) investigated the *M. oleifera* leaves as an extraordinary source of carotenoids, which is significant for its implications in malnutrition programmer to alleviate the vitamin A deficiency. Moringa leaves can also improve the immune system of the body and enhance meat quality (Rahmat and Herdi, 2016).

Moringa leaves processed into the powder can be used in the poultry diet. The effect of using moringa in poultry diets had been reported contrary by any earlier workers. Ayssiwede *et al.*

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(2011) reported that the moringa leaves meal inclusion in the diets up to 24% in substitution groundnut cake meal had not caused any adverse impact on live body weight (LBW), average daily weight gain (ADWG), and feed conversion ratio (FCR), and in indigenous Senegal chickens compared to their controls. A study on laying hen reported by Kakengi *et al.* (2007) showed *Moringa oleifera* leaves meal (MOLM) reciprocally replaced sunflower seed meal (SSM) up to 20% significantly reduced egg weight and laying percentage showed a significant progressive decreasing trend as MOLM proportion increased in the diet. A similar result also was reported by Olugbemi *et al.* (2010), the inclusion of MOLM at levels up to 10% in cassava chip-based diets fed to commercial egg-laying hens was possible and without negative effects in terms of egg quality parameters. Therefore, various species of bird types should also bear in mind expected to offer wide responses in different levels of consumed moringa.

The plant leaves of the drumsticks are good sources of numerous nutrients beneficial for ruminants but not exactly acceded for poultry. The limiting factor of introducing the drumstick leaves is though digested by the chickens. As common plant leaves the content of crude fiber within moringa leaves is so high with approximately 19,2 gram/100 gram (Gopalakrishnan, 2016). Another obstruction of these leaves was the presence of any anti-nutritional factors such as antioxidant substances, including *α-tocopherol*, ascorbic acid, carotenoids, *polysaccharides*, *flavonoids*, *saponins*, *phenolics*, *tannins*, and *proanthocyanidins*. These compounds potentially cause negative effects as included in a high percentage within the diet.

The digestibility of the feed ingredient can be enhanced by directing the method of fermentation (Fardiaz, 1992). The fermentation can reduce crude fiber (Pasaribu, 2007). The fermentation also can remove any possible anti-nutritional compounds found within the feed assisting to support bird health. For this reason, the moringa leaves were firstly treated by fermentation before feeding to the chickens.

Since ME containing within the moringa is quite low, replacement of commercial diet with some moringa leaves can cause reduce the dietary ME. Therefore, the uses of moringa had been regarded to combine with other sources of feed ingredients containing high ME such as yellow corn. Based on this reason, the fermentation moringa leaves were mixed with yellow corn then

substitute in the partly commercial diet. The objective of this study was to examine the effect of the use of fermentation moringa leaves + yellow corn to substitute partly commercial diet on the broiler performance and Income over Feed Cost (IOFC).

MATERIALS AND METHODS

The study was conducted at the Field Laboratory of Animal Husbandry, Animal Husbandry Department, Syiah Kuala University from August 4 until September 15, 2020.

Materials and equipment

The study used 100 broiler chicks, CP 707 strain, unsex. A control diet was commercial diets with the market code of CP 511. Experimental diets utilized fermented moringa leaf meal (fMOL) and yellow corn (yC) to substitute fractionally commercial diets. Other materials consisted of vaccine ND and IBD, EM4, and molasses. Experimental units were set up by the 20 cages 1 x 1 m provided heating bulbs, feeders, and drinkers each.

Diets

The experimental diets included fMOL mixed with yC with equal numbers i.e. 2.5, 5, and 7.5% each. The mixture feeds were then used to partly replace the commercial diet, CP 511 Bravo (CD). The nutritional contents of the diets were met to the recommendation of NRC (1994). The computed composition and nutritional contents of the experimental diets were shown in Table 1. The dietary treatments were represented as follows:

MC ₀	=	CD 100% (control)
MC ₁	=	CD 95% + fMOL 2.5% + yC 2.5%
MC ₃	=	CD 90% + fMOL 5% + yC 5%
MC ₄	=	CD 85% + fMOL 7.5% + yC 7.5%

Fermentation Procedures

The moringa leaves were cropped from the plants wild grew in the uncultivated lands in Desa Rukoh and surrounding, Darussalam, Banda Aceh. The leaves then were cleaned and sorted off other materials such as stems then dried under a sunrise. The dried leaves were ground using a disk mill until resulting in the leaf powder.

The next step was to fermentation the leaf powder. As much as 9 ml EM4 and 9 ml molasses were poured into a chamber containing 3 liters of freshwater then mixed homogenized then inserting into a sprayer. The liquid was sprayed into 6 kg of

moringa leaf powder while mixing homogenized then filled into a plastic bag tightly tied to meet anaerobe condition. Afterwards, the feed was incubated at darkroom temperature for 7 days. On the 8th day, the plastic bag was opened, and the feed was dried at room temperature.

Experimental Design

The study was performed into Block Randomized Design (BRD) consists of 4 treatments and 5 blocks. Every block represented an experimental unit consists of 5 birds. Block was designed based on the differences in body weights recorded on the last day of the second week. The mathematical model for this study was $Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$ where μ = overall mean, α_i = effects to the diet treatments i^{th} , β_j = effect due to BW block j^{th} , ε_{ij} = effect of the diet treatments i^{th} BW blocks j^{th} .

Feeding the Broilers

All chicks were fed on full commercial diets during the first two weeks. Feeding experimental diets had been commenced at the beginning of the third week until the last day of the 5th week. Feeds were served *ad libitum* with the addition twice a day. Drinking water also was supplied *ad libitum* supplemented with vita stress during the first four weeks.

Parameters

The parameters of broiler performances were included the average final body weight (FBW), the average body weight gain (BWG), feed consumption, feed conversion ratio (FCR), and mortality. The FBW was obtained by weighing the birds on the last day of 5 weeks. Feed consumption was obtained by subtracting the amount of feed furnished by the residual feed. The rest parameters were computed as follows:

$$\text{Average weekly BWG} = \frac{\text{FBW} - \text{DOC BW}}{5}$$

$$\text{FCR} = \frac{\text{Feed Consumption}}{\text{BWG}}$$

$$\text{IOFC} = \text{Revenue} - \text{Feed Cost}$$

$$\text{Feed Cost} = \text{Feed Consumption} \times \text{Feed Price}$$

$$\text{Revenue} = \text{FBW} \times \text{Broiler Price}$$

Data Analysis

The data of broiler performances were analyzed using Analysis of Variance (ANOVA). The analysis was continued by Duncan's Multiple Range Test (Steel and Torrie, 1991) as significant differences in results were detected among the treatments.

Table 1. The composition and nutrient contents of experimental diets (%)

Ingredients	2-5 weeks			
	MC ₀	MC ₁	MC ₂	MC ₃
			--- % ---	
Commercial diet CP 511 Bravo ¹	100	95.75	91.50	87.50
Moringa Leaf Meal, fMOL ²	0	2.50	5.00	7.50
Yellow corn (yC) ³	0	1.75	3.50	5.00
Total	100	100	100	100
Computed nutrient contents				
Protein (%)	21.00–23.00	21.00–22.92	21.01–22.84	21.04–22.79
ME (kcal/kg)	2.900–3.000	2.868–2.964	2.836–2.927	2.802–2.890
Crude fiber (%) (max)	5.00	5.05	5.10	5.16
Crude fat (%) (max)	5.00	5.04	5.09	5.14

¹ Nutrient contents based on the marked label of commercial diet CP511B Bravo produced by PT. Charoen Pokphand: crude protein min. 21.0–23.0%, crude fat 5.0%, crude fiber 5.0%, Ca min. 0.9%, and P min. 0.6%, and EM 2.900–3.000 kcal/kg.

² Nutrient contents based on Laboratory of Nutrition and Animal Feed, Brawijaya University, Malang 2007: crude protein 29.61%, crude fat 7.48%, crude fiber 8.98%, and EM 1.380 kcal/kg (estimated 70% of the GE, Patrick and Schaible, 1990)

³ Nutrient contents based on Hartadi *et al.* (2005)

RESULTS AND DISCUSSIONS

The average final body weight (FBW), weekly body weight gain (BWG), feed consumption, and feed conversion ratio (FCR) of

broilers fed the diets containing fermented *Moringa oleifera* leaf meal (fMOL) + yellow corn (yC) as partial substitution of commercial diets were shown in Table 2.

Table 2. Body weight, weekly BWG, feed consumption, and FCR of broilers

Parameters	Experimental diets composed of moringa + yellow corn (MC)			
	MC ₀	MC ₁	MC ₂	MC ₃
Total feed consumption (g bird ⁻¹)				
2–5 weeks	2.317,5±53,2	2.291,8±11,4	2.276,2±26,1	2.262,6±26,9
0–5 weeks	2.808,7±53,2	2.782,9±11,4	2.767,4±26,1	2.753,8±26,9
Avg feed consumption (g bird ⁻¹ week ⁻¹)				
2–5 weeks	772,5±17,7	763,9±3,8	758,8±8,7	754,2±9,0
0–5 weeks	561,7±10,6	556,6±2,3	553,5±5,2	550,8±5,4
FBW (g bird ⁻¹)	2.054.9±40,4 ^a	1.923,6±55,5 ^b	1.961,5±36,7 ^b	1.884,4±87,8 ^b
Weekly BWG (g bird ⁻¹ week ⁻¹)				
2–5 weeks	514,2±17,7 ^a	471,2±13,6 ^b	483,8±16,6 ^b	458,1±29,4 ^b
0–5 weeks	402,7±8,1 ^a	376,49 ^b ±11,1 ^b	384,1±7,3 ^b	368,8±17,6 ^b
FCR				
2–5 weeks	1,50±0,03 ^a	1,62±0,04 ^a	1,57±0,06 ^{ab}	1,65±0,11 ^b
0–5 weeks	1,39±0,02 ^a	1,48±0,04 ^a	1,44±0,03 ^{ab}	1,50±0,07 ^b

^{a, b} The numbers in the same rows with different superscripts indicated significant differences (P<0.05)

Feed Consumption

Results of ANOVA showed that the use of fMOL + yC as partial substitution of commercial diet did not significantly (P>0.05) influence feed consumption. However, broilers fed the diets containing fMOL + yC (MC₁–MC₃) had a slight tendency to lower feed intake. The decreased feed consumption was highly suspected due to the influence of the moringa leaves. A study reported by Banjo (2012) showed that the inclusion of up to 2% of *Moringa oleifera* significantly (P>0.05) increased feed intake but significantly decreased at the level of up to 3%. As reported by Ntila *et al.* (2019), moringa leaves had a bitter taste with significantly lower acceptability as indicated by the caregivers. A high concentrate of *saponins* and *phenolics* existing within moringa leaves (Makkar and Becker, 1997) are responsible for the bad taste. It might be possible that the inclusion of MOL in low numbers may increase feed consumption conversely decrease at the higher level of the inclusion.

Various types of drumstick plants can lead to varying feed intake. As reported by Chodur *et al.* (2018), the types of moringa included wild type and domesticated *M. oleifera* strongly differ in taste depending upon the content of direct antioxidant potential and their proportions of the two predominant *glucosinolates* which were *glucomoriginin* and *glucosoonjnain*. Then reported that wild type plant had significantly more *glucosoonjnain* (33.79 µmol/g with 95% CI 13.35–54.23) than cultivated moringa (1.16 µmol/g with 95% CI 0.85–1.49). Feed consumptions of the broilers during 5 weeks of feeding the diets at the different levels of the inclusions of the drumstick leaf meals were illustrated in Figure 1.

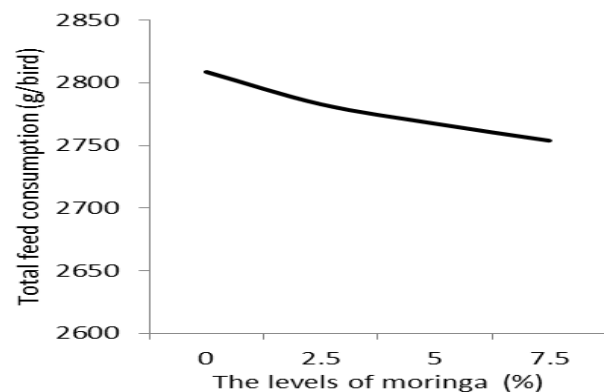


Figure 1. Total feed consumption at different levels of moringa leaves

The declined feed consumption in the present study only occurred in a small quantity. The birds did not quite refuse the MC diets. It could be explained that MOL had undergone a fermentation process considering assist to reduce the unpleasant smell of these meals. Fermentation could improve a flavor and taste (Pelczar and Chan, 2007). Another reason was fMOL was not included solely but combined with yellow corn, one of the most palatable feedstuffs for the broilers.

Final Body Weight (FBW) and Body Weight Gain (BWG)

Results of ANOVA showed that using fMOL + yC as partial substitution of commercial diet significantly (P<0.05) affected BW and BWG. Broilers fed the diets containing fMOL + yC (MC₁–MC₃) had FBW and BWG lower than those fed the control diet (MC₀). Hence, the use of fMOL + yC depressed FBW and BWG. Decreased BW might be due to the declined feed consumption. According to Jull (1992), BWG

correlated to the types and the numbers of the consumed feed. Reduced feed intake caused reduced protein and other nutrient intakes. The final body weights of the broilers at 5 weeks of ages at the different levels of the inclusions of the fMOL in the diets were illustrated in Figure 2.

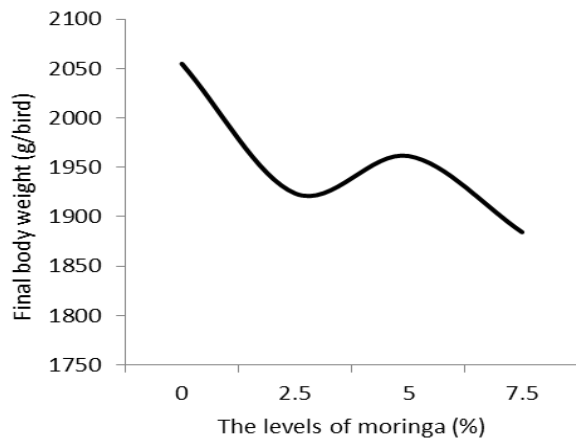


Figure 2. Final body weight at different levels of moringa leaves

Moringa leaf powder contains high crude fiber (CF) as reported by Gopalakrishnan *et al.* (2016) while the birds are not able to digest a high amount of the CP. As reported by Banjo (2012), the inclusion of moringa significantly ($P < 0.05$) enhanced the weight gain of birds at the 2% level of inclusion but significantly decreased at 3%. Different result report by Paguia *et al.* (2014), supplementation up to 0.5% *Moringa oleifera* in broiler diet did not quite trigger well FBW. Cui *et al.* (2018) reported BW decreased linearly and quadratically in response to the increase of dietary MOL supplementation. Kavoi *et al.* (2016) found the decline of BWG in broilers fed dietary *Moringa oleifera* leaves meal (MoLM) at levels 15% as the impacts negatively on intestinal structure i.e. degenerative changes in the lamina propria and crypts and also in the villus muscle strands. Contrary results were reported by Alnidawi *et al.* (2016) the effect of supplementation of *M. oleifera* poultry diets at treatments of 5 and 10% increased on BW of broilers.

Although fermentation can enhance the digestibility of the feeds (Winarno *et al.*, 1990), it seemed a fermentation treatment in moringa leaves supported to improve the feed quality in the restricted capacity. The BWG reduced not more than 200 gram/bird. However, a balanced diet with the proper dietary nutrients was most crucial in achieving optimally FBW.

Feed Conversion Ratio (FCR)

Results of ANOVA showed that the use of fMOL + yC as partial substitution of commercial diet significantly ($P < 0.05$) increased FCR. The decline of FBW and BWG on the broilers fed the MC diets (MC₁–MC₃) in this study should not be solely caused by the reduction of feed consumption but also the potential influence of losing some dietary nutrients within the substituted diets were regarded. Remove some commercial diet then replaced with fMOL + yC possibly caused by the deterioration of any important nutrients within the diet required by the birds. The feed conversion ratio of the broilers during 5 weeks of feeding the diets at the different levels of the inclusions of moringa was illustrated in Figure 3.

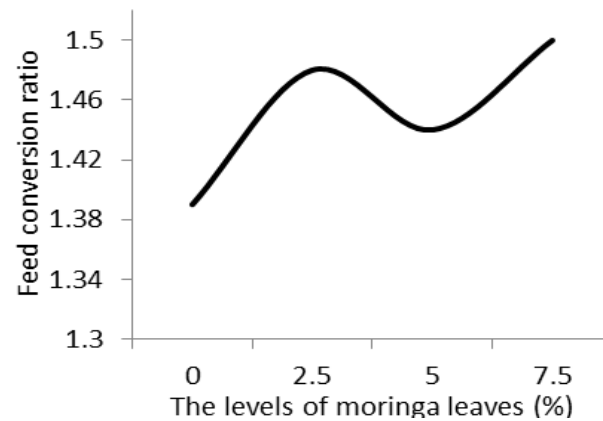


Figure 3. Feed conversion ratio at different levels of moringa leaves

Plant sources usually were lack methionine which is abundantly found in a fish meal to designate that birds highly need animal protein. The nutritive value endowed from the fMOL + yC were thought not comparable to those existing in the removal commercial diet. It indicated that the use of plant leaves to substitute partly commercial diets should not be used exclusively but better combined with animal feed sources. Zulfan *et al.* (2020) showed that the use of indigofera leaf combined with a fish meal as a substitute for a partial commercial diet could maintain the egg production of the quails without adverse effect on FCR then generated better income.

High FCR meant that the utilization of the dietary nutrients by the birds were less efficient. Although moringa leaves contain high amino acids (Makkar and Becker, 1997), the birds were not able to make use of any nutrients available in the leaves at the high levels of the inclusion of MOL. Physiologically, the system of avian

digestion was constructed for the grains, not for the foliage. Therefore, utilizing feed ingredients invented from the plant leaves in the poultry diet must be in limited number. Supplementation up to 0.5% MOL in the broiler diet did not significantly ($P < 0.05$) influence FCR as reported by Paguaia *et al.* (2014). Cui *et al.* (2018) calculated the optimal inclusion of MOL in broiler diets was 1.56% evaluated by quadratic regression analysis with a reliable equation for FCR (whole phase) i.e. $y = 0.00154x^2 - 0.00482x + 1.86382$ ($P < 0.05$, $R^2 = 0.6669$). These positive effects of MOL were mostly observed at a supplemental level not more than 5% of intake (Cui *et al.*, 2018).

Mortality

The total numbers of bird death during this study were 3 birds (3%) found in the MC₀, MC₂,

and MC₃. The reason for bird death was highly thought due to heat stress. There was no indication bird died was caused by the impression of included moringa. The mortality rate was very low not more than 5% which was the convenient threshold for raising broilers (North and Bell, 1990). It assumed that the moringa save introduced into the diet based on the given levels without detrimental effect on broiler performances.

Income Over Feed Cost (IOFC)

Income over feed cost (IOFC) computed the income after subtracting revenue by the only feed cost. The analysis on IOFC of growing broilers fed the experimental diets was shown in Table 3.

Table 3. Income over feed cost (IOFC) of broilers feeding on experimental diets

Parameters	Experimental diets composed of moringa + yellow corn (MC)			
	MC ₀	MC ₁	MC ₂	MC ₃
	--- (Rp bird ⁻¹) ---			
Total revenue (TR) ¹	36,9881.56	34,894.08	35,299.08	34,197.84
Variable cost (VC)				
Feed cost	22,750.23	22,044.67	21,427.70	20,832.39
Other cost	11,741.91	11,741.91	11,741.91	11,741.91
Total VC	34,492.14	33,786.58	33,169.61	32,574.30
Fixed cost (FC)	220.00	220.00	220.00	220.00
Total cost (TC)	34,712.14	34,006.58	33,389.61	32,794.30
IOFC	14,238.33	12,849.41	13,871.38	13,365.45
Total income	2276.42	887.50	1909.47	1403.54
R/C	0.066	0.026	0.057	0.043
B/C	1.066	1.026	1.057	1.043

¹ Bird price based on market price when study conducted

Analysis of revenue showed that using fMOL + yC as a partial substitution of commercial diet reduced revenue. The declined revenue resulted from the decreased FBW on the broilers fed the diet containing fMOL + yC while the broilers were sold at the same prices for all types of carcasses. The broilers produced with fMOL + yC should be offered at a higher market price than those produced with the absence of these feeds but the consumers did not assure the additional values of the current yields yet. Therefore, when the products may be likely to demand a higher price, the revenue can upturn over the usual product selling.

The total cost of fMOL + yC diets dropped because the variable cost lessened as the impact of lowering feed costs. Since the moringa leaves meal was fabricated at a lower cost the inclusion

of this meal combined with yellow corn to substitute partly commercial diet brought to minimize linearly feed price. The diet prices of the experimental diet counted for MC₀, MC₁, MC₂, and MC₃ were Rp8.100,00, Rp7.882,97, Rp7.6650,94, and Rp7.448,91 per kg, respectively. This result was in accordance with Ayssiwede *et al.* (2011), feed costs recorded in growing indigenous chickens fed the diets containing *Moringa oleifera* leaves were more economically profitable. The relationship on revenues, feed costs, and IOFC of produced broilers during 5 weeks liaisoned on feeding the diets at the different levels of the inclusions of the drumstick leaf meals were illustrated in Figure 4.

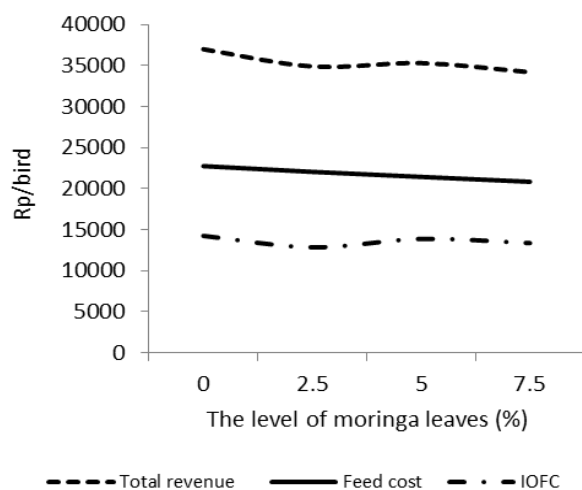


Figure 4. Revenue, feed cost, and IOFC at different levels of moringa leaves

Reduced feed cost does not always mean increased income. In the present study, producing broilers with a lower cost by the way feeding them the commercial diet of which few were excluded to replace with fMOL + yC would not be qualified to heighten an IOFC. Depressed feed costs were not in the expectation on the escalated revenues or at least those were equal or allowed at the pace of the latter should not be higher than the former. This result agreed to Sjöfjan (2000), the use of moringa in broiler diets could not upraise IOFC. A similar result also was reported by Paguia (2014), using *Moringa oleifera* up to 0.5% was not relatively better IOFC over the control.

The MC diets did not cause the negative income. The moringa leaves were permissible to include in the diet recorded by $R/C > 0$ and $BC > 1$. Considering costumers' acceptance for a higher price of birds' selling, the income value of producing broilers fed the diet containing the moringa would prospectively enlarge. In addition, the potentially increased demands for broilers produced by feeding the vegetable-based diets could enhance a better income need not for more expensive products.

CONCLUSION

The results of the present study concluded that the inclusion of *Moringa oleifera* leaves collected from the plants of wild type up to 7.5% combined with yellow corn in the same number as partial substitution of commercial diet significantly reduced final body weight, body weight gain, and feed consumption, and increased feed conversion of broiler chickens. Including the moringa + yellow corn to replace partially

commercial diet also resulted in the decline of income over feed cost (IOFC). The advantages of using moringa were supposed to support bird health with low mortality and morbidity as well as improve the appearance of the carcass with deeper yellow coloration and possibly furnished valuable nutrition.

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