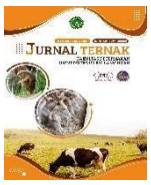
JURNAL TERNAK Volume 16 (1) 2025 pp. 140-147

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

Available online

S4-Accredited – SK No. 85/M/KPT/2020
Journal Page is available at http://www.jurnalpeternakan.unisla.ac.id/index.php/ternak/index



Implementation of Temulawak *(Curcuma xanthorrhiza* Roxb.*)* Extract Nanoemulsion on Production Performance and Income Over Feed Cost in Broiler Chickens

Utari [1], Dewi Ratih Ayu Daning [2], Luki Amar[2], Dyanovita Alkurnia[3]*

[1] *Students of the Animal Husbandry Agribusiness Study Program, Politeknik Pembangunan Pertanian Malang*
[2] *Lecturer of the Animal Husbandry Agribusiness Study ProgramPoliteknik Pembangunan Pertanian Malang*
*3*Lecturer of the Animal Science Islamic University of Lamongan*

email: Dyanovita_alkurnia@yahoo.com*

ARTICLE INFO

Article history:
Received 13 Maret 2025
Revised 25 Mei 2025
Accepted 18 Juni 2025

Keywords:
Broiler Chicken
Nanoemulsion
Temulawak Extract
Feed Additive
IOFC

IEEE style in citing this article: [citation Heading]
Utari, Dewi Ratih Ayu Daning, Luki Amar, Dyanovita Alkurnia, " Implementation of Temulawak (Curcuma xanthorrhiza Roxb.) Extract Nanoemulsion on Production Performance and Income Over Feed Cost in Broiler Chickens," Animal Husbandry Journal: Scientific Journal of the Faculty of Animal Husbandry, Lamongan Islamic University, vol. 16, no. 1, pp. 140-147, 2025.

ABSTRACT

This study aimed to evaluate the effect of temulawak extract nanoemulsion *(Curcuma xanthorrhiza* Roxb.*)* supplementation in drinking water on the production performance and Income Over Feed Cost (IOFC) of broiler chickens. The study utilized 100 broiler chickens of the Loghman MB 202 Platinum strain, which were randomly assigned into four treatments: P0 (control), P1 (4 mg/kg body weight), P2 (6 mg/kg body weight), and P3 (8 mg/kg body weight), with five replications per treatment. Data were analyzed using one-way ANOVA followed by Duncan's multiple range test. The results showed that the P2 treatment (6 mg/kg) produced the best performance, with a final body weight of 1,677 g/bird, feed intake of 202.83 g/bird, and the lowest feed conversion ratio of 1.34. The highest IOFC was also observed in P2, amounting to Rp11,367/bird. In conclusion, supplementation of temulawak extract nanoemulsion at a dose of 6 mg/kg body weight effectively improved production performance and IOFC in broiler chickens and is recommended for implementation.

Introduction

The demand for chicken meat as a source of animal protein in Indonesia continues to increase each year. According to data from the (Badan Pusat Statistik, 2022) the production of broiler meat in Indonesia reached 3,765,573.09 tons per year, making broilers one of the leading commodities supporting national food security. However, the high cost of feed, which accounts for approximately 70% of the total production cost (Kurnia, 2019; Zuprizal, 2004) poses a challenge for farmers to optimize productivity efficiently. One effort to improve broiler production performance is through the use of feed additives,

ISSN 2684-6799 (Online)
Dyanovita Alkurnia, et. al./Jurnal Ternak 16 (1) 2025 pp. 140-147 ISSN 2086-5201 (Print)

which are supplemental substances added to feed to enhance nutrient metabolism and support optimal growth.

One of the feed additives that has been widely used in the livestock industry is the Antibiotic Growth Promoter (AGP), which functions to accelerate daily growth by eliminating pathogenic bacteria in the digestive tract, improving feed efficiency, and reducing mortality rates (Kurnia et al., 2024). However, the use of AGPs also poses serious problems, such as antibiotic residues in chicken meat and the risk of pathogen resistance that may endanger human health (Raheem et al., 2021). Consequently, the use of AGPs has been prohibited under Ministry of Agriculture Regulation No. 14/PK.350/5/2017 since January 1, 2018. This ban has prompted the need to develop alternative feed additives that are safe, effective, and environmentally friendly (Kurnia et al., 2024).

Temulawak *(Curcuma xanthorrhiza* Roxb.*)* is a herbal plant that has significant potential as an alternative feed additive due to its curcuminoid content, which serves as an antibacterial, antioxidant, and immunostimulant (Desy, 2015; Diardadiantina, 2022). However, temulawak has hydrophobic characteristics and a low absorption rate in the digestive tract of broilers, resulting in suboptimal effectiveness when administered in conventional forms (Iriyanti & Hartoyo, 2019; Larasati & Nina, 2020). Therefore, technological innovations are needed to improve the bioavailability of the active compounds in temulawak, making them more easily absorbed by the broiler's body. One promising technology to address this issue is nanoemulsion, which can enhance the solubility, stability, and absorption of bioactive compounds in aqueous media (Ahmad et al., 2018; Gupta et al., 2016).

Previous studies have demonstrated the potential of temulawak as a feed additive in both powder and extract forms. Mustika et al. (2023) reported that adding temulawak herbal extract to feed can improve broiler performance. Ananda et al. (2022) also showed that the addition of 1% temulawak combined with 5% milk powder in feed improved broiler performance. Furthermore, Orinetha et al. (2022) reported that temulawak nanoemulsion at a dose of 4 mg/kg body weight could increase broiler body weight during the 30–34 day rearing period. However, studies on higher doses of temulawak nanoemulsion (above 4 mg/kg), as well as the integration of these research findings with economic feasibility analysis through Income Over Feed Cost (IOFC) for farmers, remain very limited.

This study offers a solution by testing the implementation of temulawak extract nanoemulsion on broiler chickens at various doses (4, 6, and 8 mg/kg body weight). The application of nanoemulsion is expected to improve the absorption of temulawak's active compounds, thus optimizing broiler performance compared to conventional forms. Additionally, this study evaluates economic feasibility through IOFC analysis to help farmers adopt this innovation practically.

Overall, this study presents novelty in three main aspects: first, the use of higher doses of temulawak nanoemulsion (6 and 8 mg/kg body weight) to explore the optimal dose, which has rarely been investigated previously; second, the integration of research findings with economic feasibility analysis, making them more applicable; and third, addressing the research gap regarding the effects of temulawak nanoemulsion on IOFC parameters in broiler chickens comprehensively. This research was conducted using a quantitative experimental method with a completely randomized design (CRD), ANOVA analysis, and Duncan's multiple range test. The objective of this study was to evaluate the effects of administering nanoemulsion of temulawak (*Curcuma xanthorrhiza* Roxb.) extract on the production performance of broiler chickens and the income over feed cost (IOFC) as a replacement for antibiotic growth promoters (AGPs).

Method

The research was conducted from December 2023 to January 2024 at the Broiler Chicken House Facility, Politeknik Pembangunan Pertanian Malang, while the nanoemulsion production was carried out at the Feed Laboratory, Politeknik Pembangunan Pertanian Malang.

Experimental Design

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

This study involved 100 Loghman MB 202 Platinum broiler chickens, which were randomly assigned into four treatment groups. A Completely Randomized Design (CRD) was used with four treatments and five replications each, as presented in Table 1.

Tabel 1. Completely Randomized Design

Replication	Control	4 mg / kg bw	6 mg / kg bw	8 mg / kg bw
1	P0U1	P1U1	P2U1	P3U1
2	P0U2	P1U2	P2U2	P3U2
3	P0U3	P1U3	P2U3	P3U3
4	P0U4	P1U4	P2U4	P3U4
5	P0U5	P1U5	P2U5	P3U5

The treatment doses were determined based on the study by Orinetha et al. (2022), which reported an effective dose of temulawak nanoemulsion at 4 mg/kg body weight. Therefore, in this study, doses below, equal to, and above this level were used to determine the most effective optimal dose.

Preparation of Temulawak Extract

The temulawak extract was prepared by maceration using 70% ethanol as the solvent. Dried and ground temulawak rhizomes were placed in a vial at a material-to-solvent ratio of 1:5 (w/v). The vial was tightly closed and left to stand for five days, with daily shaking for 10 minutes using a vortex mixer to facilitate the diffusion of active compounds. After the soaking period, the filtrate was separated using filter paper to remove the residue, then collected in a venoject tube and evaporated at 50°C in a water bath for 12 hours to obtain the thick temulawak extract (Reine et al., 2019).

Preparation of Temulawak Nanoemulsion

The temulawak nanoemulsion was prepared using a temperature inversion method to enhance the stability and bioavailability of the temulawak extract. The mixture was prepared by weighing the temulawak extract (active ingredient), Virgin Coconut Oil (VCO) as the oil phase, and Tween 80 and 70% ethanol as the surfactant and co-surfactant, respectively, in a ratio of 1:3:21:10:65 (b/v/v/v/v). All components were measured in milligrams, converted to milliliters, and mixed in a 500 ml beaker. The mixture was stirred using a magnetic stirrer at room temperature for two hours at 100 rpm to produce a pre-emulsion. This was then processed using a bath-type sonicator at 300 Hz for 10 minutes to produce nano-sized droplets. After sonication, deionized water (aquadest) was added at a 1:5 ratio, followed by homogenization by gentle shaking to obtain a stable temulawak nanoemulsion (Listyorini et al., 2018).

Data Analysis

The data obtained were analyzed using Analysis of Variance (ANOVA) at a 5% significance level to determine the statistical significance of treatment effects. If significant differences were found among treatments, Duncan's Multiple Range Test (DMRT) was used for further comparison to determine the most effective dose of nanoemulsion The steps for one-way ANOVA included:

1. Formulating hypotheses :
   $H_0 : \mu_1 = \mu_2 = \ldots = \mu_K$
   $H_1 : \mu_1 \neq \mu_2 \neq \ldots \neq \mu_K$
2. Determining the significance level (α) and F-table ($F\alpha(V1,V2)$), with à
   $F_\alpha (V_1,V_2)$
   Variabel Independen (V_1) = k — 1
   Variabel Dependen (V_2) = k (n- 1)
3. Establishing the testing criteria
   H_0 diterima jika $F_0 < F_\alpha (V_1,V_2)$
   H_0 ditolak jika $F_0 > F_\alpha (V_1,V_2)$

https://doi.org/10.30736/jt.v16i1.260

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

Tabel 2. *One-Way* ANOVA Summary Table

Source of Variation	Degrees of Freedom	Degrees of Freedom	Degrees of Freedom	Degrees of Freedom
Rata-rata kolom	(v1) = $k - 1$	JKK	$S^2 = \frac{JKK}{(K=1)}$	$\frac{S_2^1}{S_2^2}$
Galat/eror	(v2) = k (n – 1)	JKE	$S^2 = \frac{JKE}{K\,(n-1)}$	
Total	(nk – 1)	JKT		

Tabel 3. *One-Way* ANOVA Calculation Formulas

***One – Way* ANOVA**	
Same sample sizes	Unequal sample sizes
$JKT = \sum_{i=1}^{k} \quad \sum_{j=1}^{n} \; xij^2 - \frac{T2}{nk}$	$JKT = \sum_{i=1}^{k} \quad \sum_{j=1}^{n} \; xij^2 - \frac{T2}{nk}$
$JKK = \frac{\sum_{i=1}^{k} \; =1 \; T_1^2}{n} - \frac{T^2}{nk}$	$JKK = \frac{\sum_{i=1}^{k} \; =1 \; T_1^2}{n} - \frac{T^2}{nk}$
JKE = JKT – JKK	JKE = JKT – JKK

Note:

- JKT: Total Sum of Squares
- JKK: Treatment Sum of Squares
- JKE: Error Sum of Squares

The observed parameters in this study included:

Body Weight Gain (g/bird/week) measured weekly

$$PBB = Final\ Body\ Weight - Initial\ Body\ Weight$$

Feed Intake

$$FI = Feed\ given - Feed\ residual$$

Feed Conversion Ratio (FCR)

$$FCR \frac{Feed\ Intake \left(\frac{g}{\frac{bird}{week}}\right)}{Body\ Weight\ Gain \left(\left(\frac{g}{\frac{bird}{week}}\right)\right)}$$

Income Over Feed Cost (IOFC)

$$Revenue = Final\ Body\ Weight \times Chicken\ Price$$
$$Feed\ Cost = Feed\ Intake\ (kg) \times Treatment\ Feed\ Price\ (kg)$$
$$IOFC = Revenue - Feed\ Cost$$

Sumber : (Subekti B. A, 2022)

https://doi.org/10.30736/jt.v16i1.260

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

Results and Discussion

Implementation of Temulawak Nanoemulsion Supplementation on Broiler Production Performance

Table 4. Mean Results of One-Way ANOVA with Duncan's Multiple Range Test

Parameter	Dosage (mg/kg BW)			
	0	4	6	8
Weekly Body Weight Gain (g/bird)				
Week 2	554.4 ± 12.6^{a}	561.8 ± 5.5^{a}	604.9 ± 11.2^{b}	556.4 ± 14.3^{a}
Week 3	974.8 ± 21.1^{a}	995.1 ± 34.3^{a}	1078.9 ± 28.1^{b}	978.1 ± 8.9^{a}
Week 4	1510 ± 34.0^{a}	1594 ± 4.1^{b}	1677 ± 24.9^{c}	1539 ± 47.6^{a}
Average	1013,07±22,57	1050,30±14,63	1140,95±21,40	1024,50±23,60
Feed Intake (g/bird/day)				
Week 2	73.1 ± 1.57^{bc}	74.0 ± 2.75^{c}	72.1 ± .89^{b}	68.5 ± .62^{a}
Week 3	206.3 ± 14.4^{ab}	210.7 ± 8.0^{b}	207.4 ± 4.1^{ab}	198.5 ± 3.11^{a}
Week 4	326.4 ± 1.57^{c}	323.8 ± 3.3^{b}	322.6 ± 2.5^{bc}	315.1 ± 1.4^{a}
Average	201,93±5,85	202,83±4,48	200,70±2,50	194,03±1,71
Feed Conversion Ratio (kg)				
Week 2	1.31± .01^{c}	1.31± .01^{c}	1.19± .00^{a}	1.23± .03^{b}
Week 3	1.48±.06^{c}	1.48±.01^{c}	1.34±.03^{a}	1.42±.01^{b}
Week 4	1.50± .03^{c}	1.40± .00^{b}	1.34± .03^{a}	1.43± .04^{b}
Average	1,43±0,03	1,40±0,40	1,29±0,02	1,69±0,03

Note: Means within rows followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% level.

The results of the study demonstrated that supplementation with temulawak extract nanoemulsion at different doses had a significant effect on broiler production performance. Administration of 6 mg/kg BW (P2) resulted in the highest weekly body weight gain: an average of 604.9 g/bird in week 2, 1078.9 g/bird in week 3, and 1677 g/bird in week 4. This indicates that temulawak nanoemulsion at a dose of 6 mg/kg BW significantly increased body weight compared to the control (P0) and other treatments. These findings are supported by Anggraini et al, (2019) and Sutarto (2020) who reported that the curcumin and essential oils in temulawak function as antibacterial and antioxidant agents that enhance digestive function and nutrient absorption, thereby promoting broiler growth.

Feed intake for the P2 treatment also showed good stability, with an average intake of 322.6 g/bird/day in week 4. In contrast, the 8 mg/kg dose (P3) resulted in a lower feed intake of 315.1 g/bird/day due to the strong aroma of the nanoemulsion, which reduced palatability. These results are consistent with (Wahyuni et al, 2023) who noted that broiler chickens tend to be sensitive to strong feed aromas.

The lowest feed conversion ratio (FCR) was also observed at the 6 mg/kg BW dose, with a value of 1.34 in week 4, which was significantly different from the other treatments. A lower FCR indicates better feed efficiency, as the chickens are able to convert feed into meat more optimally (Saputra, 2018). Thus, it can be concluded that the administration of temulawak extract nanoemulsion at a dose of 6 mg/kg BW resulted in the best broiler production performance, characterized by optimal growth, stable feed intake, and high feed utilization efficiency.

https://doi.org/10.30736/jt.v16i1.260

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

Implementation of Temulawak Nanoemulsion on Income Over Feed Cost (IOFC)

Table 5. Income Over Feed Cost (IOFC)

Treatment Dose	0	4 mg/kg	6 mg/kg	8 mg/kg
Revenue :				
Final Body Weight (kg/bird)	1,510	1,594	1,677	1,539
Live Chicken Selling Price (Rp/kg)	19,500	19,500	19,500	19,500
Total Revenue (Rp/bird)	29.445	31,083	32,701	30.010
Expenses :				
Feed Price (Rp/kg)	19,273	19.128	19,064	18,648
Temulawak Nanoemulsion Cost (Rp/bird)	-	1,520	2.270	3,030
Total Expenses (Rp/bird)	Rp 24,612	Rp 20.643	Rp27,364	Rp 21.678
IOFC (Rp/bird)	10.172	10.435	11.367	8331

The results of this study demonstrated that the supplementation of temulawak extract nanoemulsion in broiler chickens significantly affected the Income Over Feed Cost (IOFC) value. Administration at a dose of 6 mg/kg body weight (P2) resulted in the highest IOFC of Rp11,367 per bird, which was higher than the control (P0), P1 (4 mg/kg), and P3 (8 mg/kg). The high IOFC value in P2 was attributed to the optimal final body weight achieved (1.677 kg/bird), which increased revenue per bird, whereas the P3 treatment had a lower IOFC due to lower final body weight and higher production costs caused by excessive nanoemulsion use. This finding aligns with Kamilah et al. (2021) who highlighted that IOFC is an important indicator for evaluating the efficiency of broiler production enterprises. Feed costs and nanoemulsion expenses are the primary factors influencing the IOFC value, with a higher IOFC indicating better profitability. Therefore, the administration of temulawak extract nanoemulsion at a dose of 6 mg/kg in broiler drinking water has been proven to significantly increase the IOFC value and can be recommended as an efficient alternative feed additive.

Conclusions

Administration of nanoemulsion of *Curcuma xanthorrhiza* Roxb. extract at a dose of 6 mg/kg body weight was shown to significantly improve the production performance of broiler chickens. This treatment resulted in the highest final body weight (1,677 g/bird), the most efficient feed conversion ratio (1.34), and the highest income over feed cost (IOFC) value (IDR 11,367/bird) compared to other treatments. Therefore, nanoemulsion of *Curcuma xanthorrhiza* Roxb. extract at this dose 6 mg/kg is recommended as a safe and effective alternative to antibiotic growth promoters (AGPs).

Acknowledgment

The authors would like to express their gratitude to all parties who have supported this research, especially to Politeknik Pembangunan Pertanian Malang for providing the research facilities. Special thanks are also extended to the laboratory team and technical staff who assisted with data processing and the implementation of the study, as well as to everyone who contributed to the preparation of this manuscript.

References

[1] Ahmad, N. , Alam, M. A., Ahmad, F. J., Sarafroz, M., Ansari, K., Sharma, S., &Amir, M (2018). Ultrasonication techniques used for the preparation of novel Eugenol-Nanoemulsion in the treatment of wounds healings and anti- inflammatory. *Journal of Drug Delivery Science and Technology*, *46 (1)*, 461–473.

[2] Ananda, Suci Hidayat, Muhammad Nur, Anas Qurniawan, Handayani Indah Susanti, K. A. (2022). Addition of Temulawak (*Curcuma zanthorrhiza* Roxb.) and Retired Milk Powder at Different Levels

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

on the Relative Weight of Internal Organ Profiles of Broilers. *Journal of Animal Science and Industry*, *8(1)*, 58–74.

[3] Anggraini, A D Widodo, W Rahayu, I D Sutanto, A. P. (2019). Effectiveness of Adding Curcuma Flour to Rations as an Effort to Increase the Productivity of Super Kampung Chickens. *Indonesian Journal of Animal Science*, *14 (2)*, 222–227.

[4] Badan Pusat Statistik. (2022). *Broiler Chicken Meat Production by Province (Ton), 2020-2022.* Badan Pusat Statistik.

[5] Desy, D. E. (2015). *Potential Extract Curcuma (Curcuma xanthorrizal* Roxb. *) As Antibactericals Sub-divisi Curcuma. Jurnal Majority, 4(1)*, 5–11.

[6] Diardadiantina, F. N. (2022). *The Effect of Giving Different Essential Oils (EO) in Feed on the Performance and Histological Image of Broiler Chicken Liver* [Doctoral dissertation]. Universitas Gadjah Mada.

[7] Gupta A., H. Burak Eral, T. Alan Hatton, P. S. D. (2016). Controlling and Predicting Droplet Size of Nanoemulsions: Scaling Relations with Experimental Validation. *Soft Matter, 12 (5)*, 1452–1458.

[8] Iriyanti, Ning Hartoyo, B. (2019). Encapsulated Fermeherbafit Bioavailability and the Application to Broilers. *Ournal of Agricultural Science and Technology, 9 (1)*, 157–165.

[9] Kamilah M.T., Dian L. D., (2021). Increasing Performance of Broiler Chicken With Feed Additions of Curcumin and Capsicum Annum L. *Journal of Agriculture and Animal Science, 1*(2), 75–84.

[10] Kurnia, D. A., (2019). Daily Body Weight Gain (PBBH) in Starter Grower Layer Chickens Given Resveratrol Grape Seed Meal. *Journal of Animal*, *10 (1),* 8-11.

[11] Kurnia, D. A., Zuprizal, Dono, N. D., Martien, R., and C. Hanim., (2024). The Abundance of Bioactive Compound in Fingerroot Essential Oil Before and After Self Nanoemulsifying Drug Delivery System (SNEDDS). *Indonesian Journal of Pharmacy*, *35 (2),* 305-314.

[12] Larasati P. Shinta, N. J. (2. (2020). Nanoemulsion Formulation Of Tumeric Extract a longa L.) As An Antioxidant. *Jurnal of Pharmaceutical and Sciences (JPS)*, *3(1)*, 33–41.

[13] Listyorini N.M.D., Wijayanti, N.I.P.D., and Astuti, K.W.(2018). Self Nano-Emulsifying Drug Delivery System. *Jurnal Kimia*, *12 (1)*, 8–12.

[14] Mustika, A. A. , Andriyanto, Kusdiantoro Mohamad, Lina Noviyanti Sutardi, Siti Rabi'ah, Utami Idha Pangesti, & SM Leluala. (2021). Broiler Performance with Combination of Ginger, Turmeric, and Javanese Curcuma Herbal Medicine. *Acta Veterinaria Indonesiana*, *10 (3),* 253–261.

[15] Orinetha, J. , Salsabil, J. K., Putri, S. M., & Pratama, A. M. (2022). Temulawak *(Curcuma xanthorrhiza Roxb.)* Nanoemulsion can be Substituted as Natural Growth Promoter in Broiler Chickens. *Pakistan Veterinary Journal*, *42 (3),* 409–413.

[16] Raheem, M. A., Jiangang, H., Yin, D., Xue, M., Rehman, K., Rahim, M. A., Qi, K. (2021). Response of lymphatic tissues to natural feed additives, curcumin (*Curcuma longa*) and black cumin seeds (*Nigella sativa*), in broilers against *Pasteurella multocida*. *Poultry Science*, *100 (5)*, 1-12.

[17] Reine R.R, Ririn. S. Wulansari. Devyani. D. A. T. J. (2019). Determination of Curcuminoid Levels in Mixed Extracts of *Curcuma domestica* Val. and *Curcuma xanthorrhiza* Roxb. as Raw Materials for Scientific Herbal Medicine by TLC Densitometry. *Pharmaceutical Journal of Indonesia*, *5 (1),* 1–23.

[18] Subekti B. A, Badat Muwakhid, U. A. (2022). Determination of Curcuminoid Levels in Mixed Extracts of *Curcuma domestica* Val. and *Curcuma xanthorrhiza* Roxb. as Raw Materials for Scientific Herbal Medicine by TLC Densitometry. Journal of Animal Engineering Dynamics, *5(2),* 134–138.

[19] Sutarto S., N. T. (2020). Drinking of temulawak and turmeric extracts to increase productivity and as an immunostimulator of avian influenza in broiler chickens. *Ziraa'ah Majalah Ilmiah Pertanian*, *45 (3),* 1–9.

ISSN 2684-6799 (Online)
ISSN 2086-5201 (Print)

[20] Wahyuni, N. M. , Indrati, R., & Widodo, E. (2023). Effect of Acidifier and Turmeric (Curcuma domestica) in Feed on Broiler Production Performance. *International Research Journal of Advanced Engineering and Science*, *8 (1)*, 288–292.

[21] Zuprizal. (2004). Antibiotik, probiotik, dan fitobiotik dalam pakan unggas. Majalah Poultry Indonesia, *1 (1)*, 52-54.

https://doi.org/10.30736/jt.v16i1.260