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## THE EFFECT A LEVELS OF CINNAMON (*CINNAMOMUM BURMANII*) LEAVES EXTRACT IN THE DIET ON INTERNAL ORGANS WEIGHT AND ABDOMINAL FAT OF BROILERS

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### ABSTRACT

This research aims to determine the effect of level of Cinnamon (*Cinnamomum burmanii*) leaves extract on the diet to internal organs broilers. The study used an experimental method with a completely randomized design (CRD) with six treatments and four repetitions. The experimental animals were distributed into six treatments groups as follows: P0 (diet without cinnamon leaves extract), P1 (diet + 0.01% zinc bacitracin antibiotic), P2 (diet + 0.25% cinnamon leaves extract), P3 (diet + 0.5% cinnamon leaves extract), P4 (diet + 0.75% cinnamon leaves extract) and P5 (diet + 1% cinnamon leaves extract). The observed parameters were heart weight, liver weight, gizzard weight, spleen weight and abdominal fat weight of broiler's chickens. The data were analyzed by variance analysis. The results of this research showed that the treatment did not have a significant effect ( $P > 0.05$ ) to the heart weight, liver weight, gizzard weight, spleen weight and abdominal fat weight of broilers. It can be concluded that the addition of cinnamon leaf extract in feed up to a level of 1% is safe because it does not affect the performance of internal organs and can gradually reduce the weight of abdominal fat in the body of broilers.

### KEY WORDS

Cinnamon, leave extract, internal organs, broilers.

Broiler productivity needs to be increased considering its potential as a producer of animal protein for the community. Various efforts have been made by farmers, such as improving maintenance management, housing systems and feed formulations including the addition of feed additives such as antibiotics. However, the uncontrolled use of antibiotics in the feed mixture can cause residues in the livestock products that are produced so that it is detrimental to human health as consumers of livestock products. Therefore, it is necessary to find alternative sources of natural antibiotics that are safe to use by utilizing phytochemicals derived from herbal plants such as cinnamon.

Cinnamon plants are widely found in the tropics and sub-tropics. The bark of the tree is dark gray and has a characteristic odor. The leaves are small and stiff with red shoots. Young leaves are pale red colored (Safratilofa, 2016). The parts of the cinnamon tree that have been used are the bark, leaves, and essential oils. Cinnamon bark has active substances such as flavonoids, saponins, tannins and alkaloids (Azima *et al.*, 2004). Cinnamon essential oil contains chemical compounds such as cinnamaldehyde and eugenol (Yulius, 2013), as well as cinnamon leaves which contain alkaloids, flavonoids, phenolic hydroquinone, saponins, and tannins (Rolin *et al.*, 2015). Chang *et al.* (2001) stated that cinnamon leaf oil at a dose of  $250 \mu\text{g mL}^{-1}$  was effective in inhibiting bacterial growth.

Flavonoids are one of the active substances contained in cinnamon leaves. Flavonoids have biological activity as natural antibiotics (Cushnie and Lamb, 2005). Antibiotics are generally used as prevention and treatment of bacterial infections (Mushawwir *et al.*, 2019). In the livestock industry, antibiotics are used to increase production, as feed additives to stimulate growth (growth promoters), and increase feed efficiency (Bahri *et al.*, 2005). The addition of cinnamon leaf extract containing flavonoid compounds in feed is expected to improve the efficiency of feed use so that it can produce low conversion values and increase livestock productivity without causing abnormalities in the internal organs of broilers.



Feed given to livestock can affect the work of the internal organs and digestive tract of chickens (Regar *et al.*, 2018). The process of food metabolism in the poultry body will affect the work activities of the gizzard, liver, and heart. Poultry will increase their metabolic ability to digest crude fiber thereby increasing the size of the gizzard, liver, and heart (Hetland *et al.*, 2005). Abnormalities in internal organs are characterized by physical changes in internal organs such as changes in size and levels of fecal ammonia and olfactory metabolic receptors (Mushawwir *et al.*, 2011).

This study was conducted to determine the effect of the level of cinnamon (*Cinnamomum burmanii*) leaf extract in the diet on the weight of internal organs and abdominal fat of broilers.

## METHODS OF RESEARCH

The experimental animal used in this study was Day old chick (DOC) Lohman strain broiler chicken (MB 202) produced by PT. Japfa Comfeed Indonesia totaled 144 tails that were kept up to 35 days of age. The feed used during the study was commercial feed BR-1 from PT. Japfa Comfeed Indonesia. The litter used during the study was rice husk with a thickness of 5 cm from the bottom of the cage floor. The use of litter was carried out from the beginning of maintenance until the chickens were 35-days-old. The rearing system was carried out randomly and divided into 24 colony cages consisting of 6 treatments and repeated 4 times, with each replication consisting of 6 chickens. The six treatments were: P0 treatment in the form of feeding without the addition of cinnamon leaf extract as a control, P1 = basal feed + antibiotic zinc bacitracin 0.01%, P2 = basal feed + 0.25% cinnamon leaf extract, P3 = basal feed + 0.5% cinnamon leaf extract, P4 = basal diet + 0.75% cinnamon leaf extract and P5 = basal diet + 1% cinnamon leaf extract. Each experimental animal colony cage was coded according to the treatment group to facilitate observation and data collection during maintenance.

*Cinnamomum burmanii* leaf samples were obtained from UPT Materia Medica Batu City. Cinnamon leaves are dried in the open air (air dry) without being exposed to direct sunlight to avoid damage to the active ingredients contained in cinnamon leaves. Drying is carried out until the leaves can be crushed and sifted to obtain dry cinnamon leaf powder (*simplicia*).

The extraction method used in this study refers to the method used by Safratilofa *et al.* (2015) with some modifications. Cinnamon leaf powder was soaked in 96% ethanol solvent with a ratio of 1:10 (w/v) and macerated for 24 hours while being stirred using a magnetic stirrer. The result of maceration is left to stand until two layers of material suspension are formed. The top layer is the liquid produced by maceration and filtered using filter paper. The second layer is a precipitate of cinnamon leaf powder which is then added back with 1000 mL of 96% ethanol and macerated for 24 hours while being stirred. After settling and settling, the maceration liquid was again filtered with the first and the second filter. This is repeated until the maceration liquid becomes clear. The maceration liquid is then evaporated using an evaporator at a temperature of 40°C. The extraction results are then stored in the refrigerator until used. The parameters observed in this study were the weight and weight percentage of the organs of the heart, liver, gizzard, spleen and abdominal fat of broilers. The percentage of weight is calculated from the division between organ weight (grams) and live weight of broilers (grams) multiplied by 100% (Widiyanti, 2019).

Data on weight and percentage of internal organs were analyzed quantitatively using Microsoft Office Excel and statistical package for the social science (SPSS) version 16.0 for windows. One way analysis of variance (ANOVA) type of variance statistical test. If there is a significant difference, it is continued with Duncan's multiple distance test (DMRT) = 5%.

## RESULTS AND DISCUSSION

The results of the average percentage of internal organ weight and abdominal fat of broilers for each treatment P0, P1, P2, P3, P4 and P5 given cinnamon leaf extract as a feed



additive for 35 days are presented in Table 1. The results of the analysis of variance showed that the addition of extracts Cinnamon leaf as a feed additive had no significant effect ( $P > 0.05$ ) on the internal organ weight of broilers, either on the heart, liver, gizzard, spleen and abdominal fat.

The average percentage of heart organ weights in each treatment was 0.44% (P0), 0.50% (P1), 0.49% (P2), 0.55% (P3), 0.50% (P4) and 0.46% (P5). The average weight of the heart for each treatment was in the normal range. The results of this study are not much different from the research of Resnawati (2010) which reported that the heart weight ranged from 0.43-0.49%. According to Aqsa *et al.* (2016), the mean heart weight is 0.5-1.42% of live weight. These results indicate that the addition of cinnamon leaf extract in the feed does not damage the structure of the heart organ and does not affect the performance of the heart. The heart organ plays a role in the process of blood circulation in the poultry body and functions to distribute blood into the lungs to replace oxygen with carbon dioxide in the body's metabolic processes.

Heart weights in the treatment group tended to be greater than the control but were still within normal limits. In addition, no deformities were found in the heart organs of broilers as a result of the study. This indicates that the extract added to the feed is not toxic or contains anti-nutritional substances. According to Frandson (1992) in Suryanah *et al.* (2016), chicken heart organs are very sensitive to toxins and anti-nutritional substances. The accumulation of toxins and anti-nutritional substances can affect the size of the heart of broilers.

Ressang (1984) in Aqsa *et al.* (2016) stated that heart size depends on sex, age, body weight, and animal activity. Based on observations during the study, the activity of chickens in each treatment was relatively the same, sex was unsex, body weight was relatively the same, and the age of the chickens was also the same, so this had an impact on the heart weight of the results of the study for each treatment were also relatively the same.

The process of enlarging the size of the heart can also be caused by the addition of cardiac muscle tissue (Aqsa *et al.*, 2016). The increase in heart weight in the treatment group was thought to be due to the presence of flavonoids in the cinnamon leaf extract. According to Ouyang *et al.* (2016), flavonoids can increase the expression of insulin-like growth factor (IGF1) which acts as a mediator in fibroblast proliferation and collagen synthesis, thereby triggering the growth of muscle mass.

Table 1 – Average Percentage of Internal Organ Weight and Abdominal Fat of Broilers

Parameter	Treatment					
	P0	P1	P2	P3	P4	P5
Heart (%)	0.44	0.50	0.49	0.55	0.50	0.46
Liver (%)	1.69	2.01	1.89	1.95	1.92	1.84
Gizzard (%)	1.28	1.46	1.45	1.30	1.44	1.41
Spleen (%)	0.08	0.10	0.11	0.09	0.16	0.11
Abdominal Fat (%)	1.49	1.76	1.49	1.31	1.06	1.18

Description: P0 = basal feed (control), P1 = basal feed + zinc bacitracin 0.01%, P2 = basal feed + 0.25% Cinnamon Leaf Extract (EDKM), P3 = basal feed + 0.5% EDKM, P4 = basal feed + 0.75% EDKM, P5 = basal feed + 1% EDKM.

The average percentage of liver weight in each treatment was 1.69% (P0), 2.01% (P1), 1.89% (P2), 1.95% (P3), 1.92% (P4) and 1.84% (P5). Putnam (1991) in Aqsa *et al.* (2016), stated that the percentage of chicken liver weight ranged from 1.7% - 2.8%, so that the weight of the liver of the research results in each treatment was in the normal range. This shows that the use of cinnamon leaf extract as a feed additive does not contain harmful compounds that are toxic to broilers. Wenno (2018) states that the liver is very susceptible to toxic compounds. Toxic compounds will undergo a detoxification process in the liver. Excess toxic compounds cannot be fully detoxified, so they will accumulate in the liver. The accumulation of these toxic substances will result in organ damage and swelling.

The content of flavonoids and tannins in cinnamon leaf extract plays a role in improving liver function so that the liver can function properly without organ damage. This is following with the research of Dasagupta *et al.*, (2013) which states that flavonoids and tannins are compounds that function as hepatoprotectors. Flavonoids act as radical scavengers that bind



directly to ROS/RNS and increase endogenous antioxidant activity (glutathione) in suppressing the production of free radicals in liver cells (Ramadhina *et al.*, 2019).

The average percentage weight of gizzard 35-days-old broilers with different levels of cinnamon leaf extract, respectively, for each treatment was 1.28% (P0), 1.46% (P1), 1.45% (P2), 1.30% (P3), 1.44% (P4) and 1.41% (P5). The average percentage of broiler gizzards in this study was within the normal range. According to Jumiati *et al.* (2017) that the percentage of broiler gizzard ranges from 1.26-1.46%. This result is lower when compared to the results of the study by Aqsa *et al.* (2016) which states that the normal weight of the gizzard ranges from 1.6-2.3% of the live weight.

The results of statistical analysis showed that the use of cinnamon leaf extract had no significant effect ( $P > 0.05$ ) on the percentage of 35-days-old gizzard broilers. The absence of a significant effect of giving cinnamon leaf extract to feed on gizzard weight is thought to be because cinnamon does not affect the growth of broiler organs, but organ growth, especially gizzards, is more influenced by other factors such as organ performance activity. The use of the same type of feed with the same texture and form of feed resulted in the absence of different activities in the gizzard of each treatment, so that there was no difference in the size and weight of the gizzard.

According to Usman (2010), the weight and size of the gizzard are influenced by the amount, nature, texture and content of crude fiber feed. Feeds with high crude fiber content will cause the gizzard's load to become larger to physically reduce the particle size of the feed, as a result the gizzard muscles work more actively and then thicken, thereby increasing the size of the gizzard. Weiss and Scott (1979) in Aqsa *et al.* (2016) also stated that high fiber in the feed will increase the size of the gizzard because the organ is stimulated to work more physiologically in processing fiber digestion, both mechanically and enzymatically.

The average percentage of spleen weight of 35-days-old broilers with different levels of cinnamon leaf extract in each treatment was 0.08% (P0), 0.10% (P1), 0.11% (P2), 0.09% (P3), 0.16% (P4) and 0.11% (P5). The average percentage of broiler spleen weight in this study was within the normal range. This result is not much different from the research by Widiyanti *et al.* (2019) which reported that the percentage of spleen weight ranged from 0.08-0.15%. Research conducted by Mulyadi (2001) also showed that the spleen weight of broilers ranged from 0.10 to 0.18%.

The results of statistical analysis showed that the use of cinnamon leaf extract had no significant effect ( $P > 0.05$ ) on the percentage of spleen weight of 35-days-old broilers. The spleen is located near the gizzard in the abdominal cavity which acts as a store for red blood cells. Enlargement of the spleen occurs if the body of the broiler is infected with bacteria. One of the functions of the spleen is to form lymphocyte substances associated with the formation of antibodies. This spleen activity causes the spleen to enlarge or even shrink in size because the spleen is attacked by the disease or foreign object (Suryanah *et al.* 2016).

Giving cinnamon leaf extract which contains flavonoid active substances can increase the number of lymphocytes that affect the development and growth of the spleen organ. According to Eriani *et al.* (2018), flavonoid compounds in herbal plants can increase the number of lymphocytes, resulting in the proliferation of the spleen. According to Merryana *et al.* (2007) enlargement of the spleen occurs if the broiler's body is infected with bacteria because the spleen acts as a supporter of the immune system by producing lymphocytes. According to Jamilah *et al.* (2013) the spleen is in charge of taking antigens from the blood that binds to lymphocytes and if the size of the spleen enlarges, it means that more and more antigens are accommodated, resulting in reduced free lymphocytes in the blood.

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The average percentage of abdominal fat weight of 35-days-old broilers with different levels of cinnamon leaf extract in each treatment was 1.49% (P0), 1.76% (P1), 1.49% (P2), 1.31% (P3), 1.06% (P4) and 1.18% (P5). The average percentage of abdominal fat weight in this study was within the normal range. According to Becker *et al.* (1979) in Mangais *et al.* (2016), the percentage of broiler abdominal fat ranged from 0.73% to 3.78%. This result is lower than the research of Salam *et al.* (2013) who reported that the percentage of abdominal fat weight was in the range of 2.12%. Research conducted by Massolo *et al.* (2016) showed that the abdominal fat weight of broilers ranged from 1.99 – 2.15%.

The results of statistical analysis showed that the use of cinnamon leaf extract had no significant effect ( $P > 0.05$ ) on the percentage of abdominal fat weight of 35-days-old broilers. The abdominal fat weights of broilers in the control ration group (P0), positive control (P1) and the treatment group with the addition of cinnamon leaf extract in the feed were not significantly different ( $p < 0.05$ ), so that the cinnamon leaf extract supplementation in the feed was up to level 1 % has not been able to significantly reduce the weight of broiler abdominal fat ( $p < 0.05$ ).

Although statistically there was no significant effect, biologically the average abdominal fat weight of each treatment group tended to decrease when compared to the control ration group (P0). This shows that feeding with the addition of cinnamon leaf extract with different levels in broilers provides variations in the weight of abdominal fat in the chicken body. The decrease in abdominal fat weight in the body of chickens is thought to be due to the addition of cinnamon leaf extract containing polyphenolic compounds that can inhibit the formation of triacylglycerol/ triglycerides which are the main deposits of fat in the body (Rolin *et al.*, 2015). Pratikno (2011) states that fat deposits in the body of broilers come from triglycerides. Triglycerides in poultry tissue come from the diet by 95% and only 5% is synthesized by the liver.

Abdominal fat correlates with total carcass fat, so the higher the abdominal fat content in the broiler body, the higher the carcass fat content in the broiler body (Salam *et al.*, 2013). The low percentage of abdominal fat produced indicates that the resulting fat condition tends to be better. Abdominal fat is a by-product that can affect carcass quality. The high and low quality of broiler carcass is determined by the weight of the abdominal fat contained in the chicken body. The lower the percentage of abdominal fat in the body, the better the quality of the carcass obtained (Massolo *et al.*, 2016).

## CONCLUSION

Supplementation of cinnamon leaf extract in feed up to a level of 1% is safe because it does not affect the performance of internal organs and can gradually reduce the weight of abdominal fat in the body of broilers.

## REFERENCES

1. Aqsa, A.D., Kiramang, K. dan Nurhidayat, M. (2016). Profil organ dalam ayam pedaging (broiler) yang diberi tepung daun sirih (*Piper betle* linn.) sebagai imbuhan pakan. JIP. 3 (1): 148-159.
2. Azima F, Muchtadi D, Zakaria FR, Priosoeryanto. 2004. Potensi anti-hiperkolesterolemia ekstrak cassia vera (*Cinnamomum burmanni* Nees et Blumo). Jurnal Teknologi dan Industri Pangan, 15(2): 145-153.
3. Bahri, S.,E. Masbulan dan A. Kusumanginsih. 2005. Proses praproduksi sebagai faktor penting dalam menghasilkan produk ternak yang aman untuk manusia. Jurnal Litbang Pertanian. 24:123-127.
4. Chang ST, Chen PF, Chang SC. 2001. Antibacterial activity of leaf essential oils and their constituents from *Cinnamomum smophloeum*. Journal Ethnopharmacology. 77 (1): 123–127.
5. Cushnie, T. P. T and A. J. Lamb. 2005. Atimickrobial activity of flavonoids. Int. J. off Antimicrobial Agents. 26: 343–356.



6. Dasagupta, P., P. Chakraborty and N. N. Bala. 2013. Averrhoa Carambola: an update review. *International Journal of Pharma Research & Review*. 2:54-63.
7. Eriani, K., Ainsyah., Rosnizar dan Ichsan. 2018. Uji efek imunostimulan ekstrak methanol daun flamboyan [*Delonix regia* (Boj. Ex Hook.) Raf.] Terhadap peningkatan sel-sel imun pada mencit strain swiss-webster. *Jurnal Natural*. 20 (6): 39 – 44.
8. Hetland, H., Svihus, B., & Choctt, M. 2005. "Role of insoluble fiber on gizzard activity in layers". *J. Apply. Poultry Res*, 14, 38-46.
9. Jamilah, N. Suthama dan L. D. Mahfudz. 2013. Performa produksi dan ketahanan tubuh broiler yang diberi pakan step down dengan penambahan asam sitrat sebagai acidifier. *Jurnal Ilmu Ternak dan Veteriner*. 18 (4): 251-257.
10. Jumiati, S., Nuraini dan A. Rahim. 2017. Bobot potong, karkas, giblet dan lemak abdominal ayam broiler yang diberi temulawak(*Curcumaxanthorrhiza*, Roxb) dalam pakan. *UHO. JITO*. 4:56-58.
11. Mangais G., Najooan M., Bagau B., Rahasia C.A. 2016. Persentase Karkas Dan Lemak Abdomen Broiler Yang Menggunakan Daun Murbei (*Morus alba*) Segar Sebagai Pengganti Sebagian Ransum Basal. *Zootek Journal Vol. 36 No. 1*.
12. Massolo R., Mujnisa A., Laily A. 2016. Persentase Karkas Dan Lemak Abdominal Broiler Yang Diberi Prebiotik Inulin Umbi Bunga Dahlia (*Dahlia variabilis*). *Buletin Nutrisi dan makanan Ternak* 12(2): 50- 58.
13. Merryana, F. O., M. Nahrowi, A. Ridla, R. Setiyono dan Ridwan. 2007. Performa broiler yang diberi pakan silase yang ditantang *Salmonella typhimurium*. *Prosiding Seminar Nasional AINI VI*. Yogyakarta, 26-27 Juli 2007. Hal. 186-194.
14. Mulyadi, E. 2001. Pengaruh Pemberian Berbagai Level Cacing Tanah Segar (*Lumbricus rubellus*) dalam Ransum terhadap Persentase Bobot Karkas dan Organ dalam Broiler. *Jurusan Peternakan, Fakultas Pertanian. Universitas Sumatera Utara*.
15. Mushawwir, A., L. Adriani and K.A. Kamil. 2011. Prediction models for olfactory metabolic and sows% RNAreticulocyt (RNArt) by measurement of atmospheric ammonia exposure and microclimate level. *J. of the Indon. Tropical Anim. Agric*. 36:14-20.
16. Mushawwir, A., N. Suwarno dan A.A. Yulianti. 2019. Profil malondialdehyde (MDA) dan Kreatinin itik fase layer yang diberi minyak atsiri garlic dalam kondisi cekaman panas. *J. Ilmu dan Industri Peternakan* 5:1-11.
17. Ouyang, K., M. Xu, Y. Jiang and W. Wang. 2016. Effect of alfafa flavonoids on broiler performance, meat quality and gene expression. *Canadian J. of Anim. Sci*. 96:332-341.
18. Pratikno, H. 2011. Lemak abdominal ayam broiler (*Gallus sp*) karena pengaruh ekstrak kunyit (*Curcuma domestica* Vahl.). *BIOMA*. 13:1-8.
19. Putnam, P. A. 1991. *Hand book of Animal Science*. San Diego, California: Academic Press.
20. Ramadhina, I.A., L. Adriani and E. Sujana. 2019. Pengaruh Pemberian ekstrak daun kepel (*Stelechocarpus burahol*) terhadap kadar kolesterol darah dan telur puyuh (*Coturnix-coturnix japonica*). *J. Nutrisi Ternak Tropis dan Ilmu Pakan*. 1:34-40.
21. Regar, N, M., Kowel S. H. Y, B. Betty dan E. A. S. Moningkey. 2018. Pemberian kombinasi kunyit, bawang putih dengan mineral zink terhadap bobot organ dalam ayam pedaging yang diinfeksi *E. coli*. *Prosiding Seminar Nasional Unggas Lokal: Pengembangan Unggas Lokal di Indonesia*. 2:168-172.
22. Resnawati, H. 2010. Bobot organ-organ tubuh pada ayam pedaging yang diberi pakan mengandung minyak biji saga (*Adenanthera pavonina* L). *Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner*. 670-673.
23. Rolin F., Mia S. dan Dedi J. 2015. Evaluasi pemberian ekstrak daun kayu manis *Cinnamomum burmannii* pada pakan terhadap kinerja pertumbuhan ikan patin *Pangasianodon hypophthalmus* Sauvage, 1878. *Jurnal Iktiologi Indonesia* 15(3): 201-208
24. Safratilova, Dinamella W., Dedi J., Mia S. 2015. Pengaruh ekstrak daun kayu manis *Cinnamomun burmannii* terhadap respon imun non spesifik ikan patin *Pangasianodon hypophthalmus* (Sauvage, 1878) yang diinfeksi *Aeromonas hydrophila*. *Jurnal Iktiologi Indonesia* 15(3): 223-233



25. Safratilofa. 2016. Uji Daya Hambat Ekstrak Daun Kayu Manis (*Cinnamomum burmanii*) Terhadap Bakteri *Aeromonas hydrophila*. *Jurnal Ilmiah Universitas Batanghari Jambi* Vol.16 No.1.
26. Salam, S., A. Fatahilah., D. Sunarti, Isroli. 2013. Bobot karkas dan lemak abdominal broiler yang diberi tepung jintan hitam (*Nigella sativa*) dalam ransum selama musim panas. *Jurnal Sains Peternakan*, 11 (2): 84-89.
27. Suryanah, H. Nur dan Anggraeni. 2016. Pengaruh Neraca Kation Anion Ransum Yang Berbeda Terhadap Bobot Karkas Dan Bobot Giblet Ayam Broiler. *J. Peternakan Nusantara* Vol. 2 No. 1.
28. Usman, A.N.R. 2010. Pertumbuhan Ayam Broiler (Melalui Sistem Pencernannya) yang Diberi Pakan Nabati dan Komersial Dengan Penambahan Dysapro. *Institute Pertanian Bogor. Bogor*.
29. Wenno D. 2018. Persentase Bobot Organ Dalam Ayam Broiler Yang Diberi Tepung Biji Pepaya Dalam Ransum Dengan Level Berbeda. *J. Fapertanak* Vol. 3 No. 1.
30. Widiyanti E., F. Wahyono, N. Suthama, dan L. Krismiyanto. 2019. Ketahanan Tubuh Pada Ayam Broiler Yang Diberi Ekstrak Buah Mengkudu (*Morinda citrifolia* L.). *Seminar Nasional Pendidikan Biologi dan Saintek (SNPBS) ke-IV*. Hal 127-132.
31. Yulius, Ferry. 2013. Prospek Pengembangan Kayu Manis (*Cinnamomum Burmanii* L) di Indonesia. *Balai Penelitian Tanaman Industri dan Penyegar. Sirinov* Vol. 1, No. 1. Hal: 11 – 20.